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FOREWORD

I am pleased to put into the hands of readers Volume-3; Issue-6: Nov-Dec 2018 of **"International Journal of Environment, Agriculture and Biotechnology (IJEAB) (ISSN: 2456-1878)",** an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to **Environment, Agriculture and Biotechnology**. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release issue with DOI (Digital Object Identifier) from CrossRef also, now using DOI paper of the author is available to the many libraries. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind.

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Editor-in-Chief
Date: Jan, 2019

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Measuring the Economic Benefits of Forests in Relation to Households' Welfare and Forest Dependence in South-western Nigeria

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***Abstract*— *The study assesses the contributions of forest resources income on poverty among rural households in South-western Nigeria. A multi-stage random sampling approach was adopted while descriptive analysis and* [Foster-Greer-Thorbecke (FGT 1984) poverty index] were used. *Poverty index results showed that 68 percent of the rural households were living below the poverty line in the region. Disaggregated to state level, the highest proportion was found in Osun state (77 percent), followed by Ogun state (70 percent) and Oyo state with about 50 percent. The minimum cost required to bring those poor households to the poverty line (that is, to eliminate poverty) across states include: ₦4, 553, ₦9, 664 and ₦8918 in Oyo, Osun and Ogun states respectively. This indicates that poverty is more severe in Osun state followed by Oyo state but less severe in Ogun state. Also, forest income has tendency to stem the tide of poverty in the region. Therefore, Government and authority concerned should increase opportunities for entrepreneurship and employment in forestry while avoiding deforestation and forest degradation.*
***Keywords*— Poverty; rural households; forest income; South-western Nigeria; FGT model.**

I. INTRODUCTION

The Nigeria poverty scenario became exacerbated on yearly basis and there was scary increase in poverty which led to a very piercing inequality between the rich and the poor in terms of income distribution (World Bank, 2008). Going by the antiquity of Nigerian fortune in the early 70s, Nigeria was one of the richest 50 countries in the early 1970s, but declined to become one of the 25 poorest countries in the twenty first century (Okon, 2012: 32).

According to the National Bureau of Statistics report (NBS) (2011), around 112.519 million out of a projected 163 million Nigerian live in relative poverty. That is, when it comes to comparison of the living standard of people living in a specified society within a given period of time. Looking at it from the angle of absolute poverty, the country's poverty profile was put at 60.9 percent; the dollar per day measure puts the poverty profile at 61.2 percent and the subjective measure put the poverty profile at 93.9 percent, possibly, the Harmonized National Living Standard Survey (HNLSS) which put the country's poverty profile at 69.0 percent might strike the balance (NBS, 2011).

Further, the preponderance of Nigeria's poor are rural, female, but cut across age bracket. Most of these people are farmers who largely dependent on renewable natural resources for their living (World Bank/DFID, 2005). However, hope is not lost since forest has been considered as a preference for poverty alleviation as it often serves as an employer of last resort for the rural poor (Sunderlin *et al.*, 2003:1). Thus, the enduring contributions of forests in solving the problem of poverty and inequality then indicate that forests are massively valuable in achieving sustainable livelihood particularly among rural community [United Nations Forum on Forest (UNFF), 2013: 3].

According to FAO (2011), many households subsist in part by collecting leaves, roots, fruits and nuts from trees and other wild plants, and by hunting wild animals, fish, and insects for consumption and income generation. Many people living in and around forest areas harvest a range of products from forests for sale, trade, or barter, such as wood for timber, fuel wood, roof thatching materials, construction poles, honey, mushroom, caterpillars, and medicinal plants.

In addition, NTFPs activities that rural households explore include; mat and basket-making, cane, furniture production, pestle and mortar and wood craft which fetch a lot of money to rural households. Others are; sales of leaves of various species, chew sticks from various species, sales of fruits and seeds of all kinds, bush meat, snails and fish in rural and urban markets also generate a lot of income (FAO, 2011).

Although, quite very few studies have been conducted on the contributions of forest income in sub- Sahara Africa but of such few, the results seem to be inconclusive. For instance; in Zimbabwe, poverty and inequality measures were calculated with and without forest income and the results showed that when calculated without forest income, poverty and inequality can be increased by as much as 98 percent and 44 percent respectively, depending on the poverty line and measure used (Cavendish, 1999). Also in Southern Malawi, Fisher (2004) found that by excluding income from forestry when measuring inequality, income inequality in the region increased by as much as 12 percent. In Malawi as well, Jumbe and Angelsen (2007) found out that forest income has contrasted welfare impacts across study villages and that forest dependence was poverty neutral.

Likewise, Makoudjou *et al.* (2017) found quite mixed results on the role of forest resources in income inequality in Cameroon. For instance, in terms of logging, overall contribution of forest income increases income inequalities by 3 percent while income from gathering and hunting activities on the contrary contributes to reducing inequalities. In Northern Ethiopia, Babulo *et al.* (2009) found that, including forest environmental incomes in household accounts showed that there was significant decrease in rural poverty and income inequality. This was corroborated by the study in the Democratic Republic of Congo by Nielsen *et al.* (2012) who also found out that Gini coefficient rose significantly when forest income was excluded from inequality comparison.

Also, Fonta & Ayuk (2013) worked on 'measuring the role of forest income in mitigating poverty and inequality' in South- eastern region Nigeria, and the results showed that when poverty and inequality were measured without forest, poverty and inequality can be overstated by as much as 6.8 percent and 20.3 percent respectively, depending on the poverty line and measure used. Nonetheless, the shortcoming on this work is that, their case study was restricted to South-eastern region alone. Therefore, comparative empirical data on forest income role in mitigating poverty in South-western region Nigeria are very essential in order to complement the data base in other regions to broaden the scope of application of the results of the study.

Regrettably, based on extensive literature search and to the best of the researchers' awareness, it is quite amazing and disturbing to note that, there is a gross paucity of micro level data on forest role in mitigating poverty in South–western region of Nigeria. It is thus evidenced that there is a knowledge gap on measurement of forest role on poverty mitigation as far as South-western region of the country is concerned. So, this observed knowledge gap is clearly a shortcoming when it comes to developing informed policies for sustainable welfare and developmental programme in forestry. Against this backdrop, this study therefore seeks to close these gaps by providing empirical data on the economic benefits of forests in relation to households' welfare and forests dependence in South - western Nigeria. Specifically, the study seeks to assess the poverty status of rural households and the economic benefits of forests on poverty status of the rural households in the study area.

II. MATERIALS AND METHODS

2.1. Study area

This research work was carried out in South-western region of Nigeria. It is one of the six geo-political zones in the country (Agunwamba *et al.*, 2009: 8). The area lies between longitude 30^0 and 7^0E and latitude 4^0 and 9^0N and thus, west of the lower Niger and south of the Niger Trough. South-west region includes Osun, Oyo, Ogun, Lagos, Ondo and Ekiti States. The total land area is about 191,843 square kilometers (Agunwamba *et al.*, 2009:8). According to the FAO (2011), 9.9% or about 9,041,000 ha of Nigeria is forested. Nigeria had 382,000 ha of planted forest. The report also stated that there were changes in forest cover between 1990 and 2010 as Nigeria lost an average of 409,650 ha or 2.38% per year. In total, between 1990 and 2010, Nigeria lost 47.5% of its forest cover or around 8,193,000 ha. Nigeria's forests contain 1,085 million metric tons of carbon in living forest biomass (FAO, 2011). Specifically, the study area where data were collected include: Ogun, Osun and Oyo States.

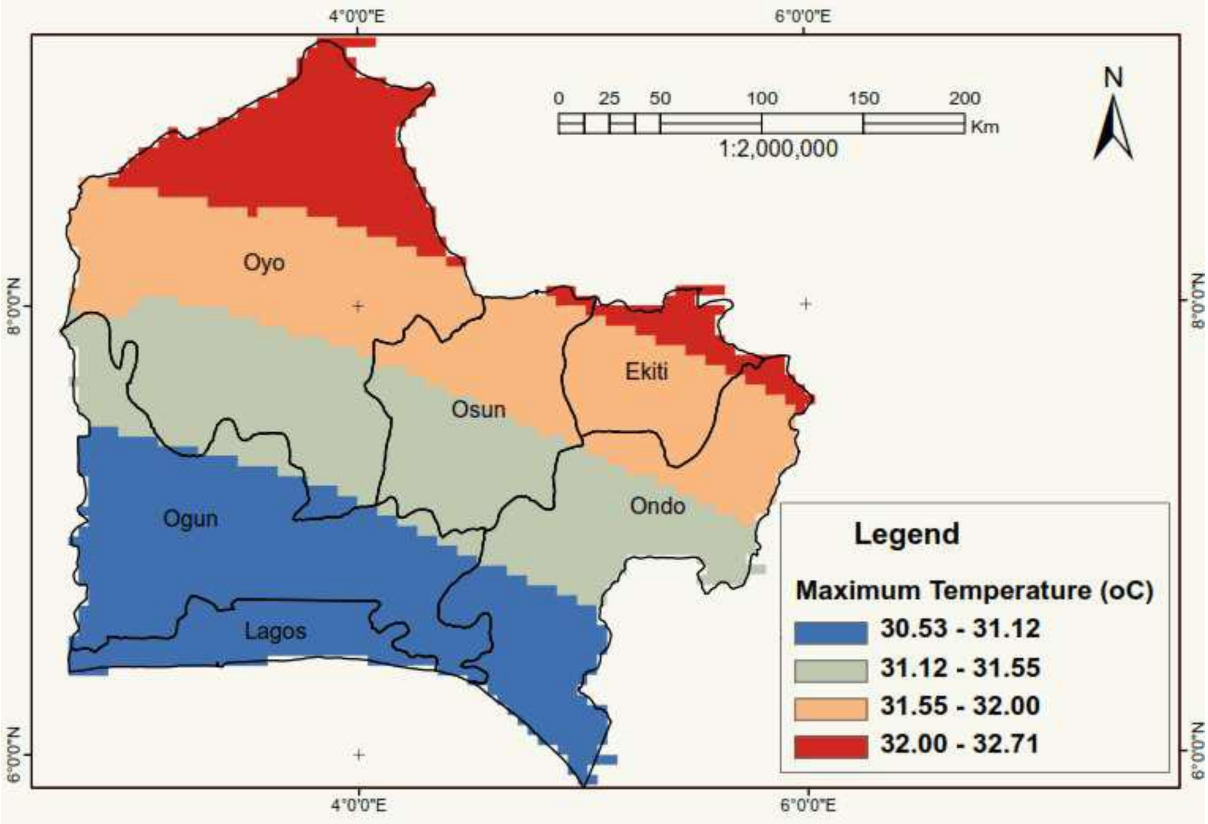

Fig.1: Map of South-west Nigeria

2.2. Sampling frame and procedure

The sample frame for the study include rural households' heads who engage in forest-based activities such as plank trading, carpentry/furniture, basketry/mat/bag making, wood carving, rattan and bamboo utilization, rattan and bamboo utilization, charcoal production and selling, fuel wood collection and selling, chew stick, bush meat, snail, fish, fruits and vegetables, medicinal plants, gum and dye, broom, poles, locust bean, spices/ leaves and fibre, mushroom, honey, shea butter, local wine, local wine and farmers who practise agro-forestry system within and around the forest community. The questionnaire was structured to elicit information on individual basis about their involvement in various forest based enterprises with respect to their income. Focus Group Discussion (FGD) method was also adopted in this regard.

A multi-stage random sampling approach was adopted in selecting the respondents for the study. At first stage, three states were randomly selected from the five states that make up the South-west geo-political zone of the country excluding Lagos state due to its cosmopolitan and less forested nature. In the second stage, eighteen Local Government Areas (LGAs) distributed among the three selected states were purposively selected based on their potentials in forestry and their population size. At this stage, one forested village was randomly selected in each selected LGA, for a total of eighteen villages: seven in Oyo state, four in Ogun state and seven in Osun state. In the third stage, twenty-five households were randomly selected from each village. A total of four hundred and fifty households' heads were interviewed in the eighteen selected villages (271 males and 179 females). Each respondent was interviewed separately and each interview lasted for about 1 hour. The exercise was carried out between December 2016 and April 2017. The questionnaire was structured to elicit information on individual basis about the sources of income and the contributions of forest income with respect to their livelihoods.

2.3. Analytical tools and model specification

Descriptive analysis using frequency distribution and percentage analysis was used to discern the respondents' household characteristics and statistics. This describes the socio-economic characteristics of the respondents. For the empirical model, [Foster-Greer-Thorbecke (FGT 1984) poverty index] was used to estimate the required variables accordingly as used by Anyanwu (1997) and Fonta *et al.* (2013). (FGT, 1984) describes the poverty status of the rural households as well as the socio-economic benefits of forest on households' level of poverty. The analysis of poverty incidence using FGT measure usually starts with ranking of expenditures in ascending order Yi ≤ Y, ≤ ... ≤; Yn: The FGT index is given by:

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$$P_\alpha = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{G_i}{z}\right]^{\alpha} \quad , (\alpha \geq 0) \qquad (1)$$

Where α is a measure of the sensitivity of the index to poverty and the poverty line is z, the value of expenditure per capita for the ith person's household is x_i, and the poverty gap for individual i is $G_i = z - x_i$ (with $G_i = 0$ when $x_i > z$).

Here, to determine the poverty line, the two-thirds of the mean per capita household expenditure of the sample was taken as the poverty line. The following specifications were used to determine poverty level.

Headcount Index: This simply measures the proportion of the population whose welfare fall below poverty line, that is, considered poor. This usually denoted by P_0 and may be represented thus; $P_o = \frac{N_p}{N}$ (2)

Where

P_o = = the head count ratio

N_p= the number of poor (i.e. numbers of rural household living below the poverty line)

N= the total sampled population

P_0 can be written thus:

$$P_o = \frac{1}{N}\sum_{i=1}^{N} 1(y_i < z) \qquad (3)$$

Now, $I(\cdot)$ is an indicator function that has a value of 1 if $(y_i < z)$ is true, and 0 if otherwise. So if expenditure (y_i) is less than the poverty line (z), then $I(\cdot)$ equals 1 and the household would be counted as poor. The poverty gap was calculated as poverty gap (G_i) = poverty line (z) minus actual income (y_i) for poor persons; the gap was considered to be zero for everyone else.

The index form is written as; $G_i = (z - y_i) \times I\,(y_i < z)$

I = {(Z-Y)/Z} (4)

Where:

I = the poverty gap

Z = the poverty line using the mean household expenditure

Y = the average income of rural poor farm household

The poverty gap index (P_1) may be written thus;

$$P_1 = \frac{1}{N}\sum_{i=1}^{N}\frac{G_i}{z} \qquad (5)$$

Given this, the calculated poverty gaps was divided by the poverty line and averaged to give poverty gap index (P_1). Thus, squared poverty gap index may be written as;

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{G_i}{z}\right]^{\alpha} , (\alpha \geq 0) \qquad (6)$$

Where α = a measure of the sensitivity of the index to poverty,

z = poverty line,

x_i = the value of expenditure per capita for the *i*th person's household,

G_i = the poverty gap for individual *I*,

The index function is $G_i = z - x_i$ (with $G_i = 0$ when $x_i > z$).

When parameter α = 0, P_0 is simply the headcount index. When α = 1, P_1 is the poverty gap index P_1, and when α = 2, P_2 is the poverty severity index. At whatever time α > 0, the measure shows that there is decrease in the welfare of the poor (i.e. the lower the welfare, the more one become poor and vice-versa). Similarly, for α > 1, the index indicates that there is increase in the measured poverty and decrease in the welfare. Hence, the measure is then said to be strictly convex in incomes but weakly convex when α = 1

III. RESULTS AND DISCUSSION

3.1. Sample households statistics

This section presents the socio economic characteristics of the rural households that engage in forest related enterprises. The households' head age distribution shows that 47.2 per cent of the respondents were between 41 - 60 years, followed by 37.4 per cent that corresponds to 21 - 40 years. A total of 14.7 per cent respondents were over 60 years of age whereas only 0.7 per cent of the respondents were less than or equal to 20 years in the study areas. This reflects that about 80percent of the respondents are still in their working age. Table 1 presents the distribution of socioeconomic characteristics of rural households.

Table.1: Distribution of Socioeconomic Characteristics of Rural Households

Item	Frequency	Percentage
Household's Head Age		
Household's Head Sex		
Male Female	271 178	60.4 39.6
Household's Head Year of Education		

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No Formal Education Primary Secondary Tertiary	60 107 184 98	13.4 23.8 41.0 21.8
Marital Status		
Single Married Divorced Separated	54 325 18 52	12.0 72.4 4.0 11.6
Household size		
<2 3 - 4 5 - 6 7 – 8	313 16 109 11	69.7 3.60 24.3 2.40
Religion		
Islam Christianity Traditional	213 223 13	47.4 49.7 2.90
Total	449	100

Source: Calculated from field survey, 2017

Male headed households represent about 60.4 per cent of the sample while less than 22 per cent of household heads had tertiary education. Large proportion of households (about 41per cent) had secondary education while only 23 per cent had primary or elementary school and about 13 per cent had no formal education. It is apt to note that the level of education in the study area is commendable which align with the general perception that households in South West Nigeria are well educated.

In terms of marital status, almost three quarter of the sampled households were married while the remaining one quarter shares 12 percent as single, 4 percent as divorced and 11.6 percent separated. Furthermore, it was revealed from the Table 1 that 47.4 percent of the respondents were Muslims while 49.7 percent were Christians and less than 3 percent were practising traditional religion. This therefore indicates that religious factors may not have much impact in venturing into forest related businesses given credence to the two most commonly practised religions in the study area (Islam and Christianity) which abhors the traditional use of forest products through trado-medicine or alternative medicine most especially when the usage has some fetish beliefs attached to it.

3.2. Decomposition of poverty status by states and socio-economic characteristics

In this section, the study decomposes the poverty status of the rural households generally based on their states and socio economic characteristics using FGT model as summarised in Table 2 below. Using the headcount index (P_0) to measures the proportion of the population that is poor, the results showed that 68 percent of the rural households[1] are living below the poverty line. This therefore indicates that close to three-quarter of the sampled households had their monthly per capital expenditures that is less than ₦ 18,331[2]. These households however fell within the category of moderately poor because their average monthly expenditures are greater than one-third of total households' per capita expenditure but less than two-thirds of the total households' per capital expenditure while the extremely poor households had their average monthly expenditures that is less than ₦9,166 (that is, one third of the total expenditure).

[1] *Survey data are almost always related to households, so, to measure poverty at the individual level, we must make a critical assumption that all members of a given household enjoy the same level of well-being.*

[2] *₦18331 set as poverty line for the study area (South-western Nigeria) was calculated by dividing total households' monthly expenditure by total households' size. Then, the two third of the answer was calculated. It coincidentally matched the present Nigerian workers' minimum wage (2016)*

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Table.2: Decomposition of poverty by states and socio-economic characteristics

State	Poverty incidence	Poverty gap	Poverty severity
Oyo	0.4968	0.2484	0.3532
Osun	0.7703	0.5272	0.4415
Ogun	0.7055	0.4865	0.3095
Region	0.6603	0.6940	0.5965
Age			
Less than 20 yrs	0.6667	0.4903	0.3156
21-40 yrs	0.6667	0.5081	0.3153
41-60yrs	0.6226	0.4353	0.258
61-80yrs	0.7272	0.6008	0.443
Sex			
Male	0.6089	0.4776	0.2904
Female	0.7247	0.5068	0.336
Education			
No formal education	0.8333	0.6736	0.4944
Primary	0.7583	0.5693	0.3703
Secondary	0.625	0.4385	0.26
Tertiary	0.5102	0.3222	0.1682
Marital status			
Single	0.7593	0.6136	0.4444
Married	0.6308	0.4656	0.2847
Divorced	0.6111	0.4778	0.2845
Separated	0.7115	0.6303	0.4474
Religion			
Islam	0.6808	0.504	0.3333
Christianity	0.6188	0.4751	0.2839
Traditional	0.8462	0.5037	0.3414

Source: Calculated from field survey, 2017

By decomposing across states within the study area, the incidence of poverty indicates that the proportion of households living below poverty line is noticeably the highest in Osun state followed by Ogun state where 77 percent and 70 percent of rural households average monthly expenditures respectively were not up to ₦18,331. Oyo state was thus recorded lowest of about 50 percent in terms of poverty head count index. These findings thus suggest that there are some insignificant improvements in living standard of people in Oyo state compare to other two states probably because Oyo state is business oriented and disposed than Ogun and Osun states. Conversely, the results also reveal that poverty incident rate is higher in Osun state perhaps due to the fact that most people in the state are employed in formal sector and there was irregularity in the payments of their salaries because of cash crunch in the government coffers which dwindled the state economy.

In terms of poverty gap *index* (P_1), Table 2 therefore revealed the minimum cost required to bring these poor households to the poverty line across states. For example, in Oyo state, the poverty depth (P_1) value of 0.2484 will require ₦4,553 (that is, 0.2484 multiplied by N18331) per household per month to close the poverty gaps in the state while a sum of ₦9,664 (that is (P_1) 0.5272 × N18331) is needed to bring the households in Osun state to the poverty line. Likewise in Ogun state, individual household would require a sum of ₦8,918 (that is, (P_1) 0.4865 × N18331) to eliminate poverty in that state. In other words, if each respective state could mobilise resources or receive transfer of resources equal to corresponding percentages of poverty line for every household and were perfectly targeted and appropriately

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allocated to the poor in the amount needed so as to bring each household up to the poverty line, it is expected that poverty could be at least eradicated, even though in theoretical term.

Regarding poverty severity, Table 2 also revealed poverty severity (P_2) estimate of 0.3532, 0.4415, and 0.3095 in Oyo, Osun and Ogun states respectively. This indicates that poverty is more severe in Osun state followed by Oyo state but less severe in Ogun state. These results reflect a measure of poverty that takes into account inequality among the poor within the households and the amount of weight that was put on the income (or expenditure) level of the poorest household as it varies across all households. This therefore suggest that economic severity was higher among households in Osun state than Oyo and Ogun states in that order. Part of the possible reasons that may be advanced for this scenario was perhaps due to the fact that Oyo state has a very high forest regeneration inclination compare to any other South-western states in the region (Faleyimu *et al*., 2013:3383) and may be because of her enhanced forest business potentials.

Table 2 also shows decomposition of index of poverty by socio-economic characteristics of rural households that engage in forest related activities in the study area. Poverty incidence was less among the middle (40 - 50) aged households than the older (61-80) aged households. The same thing was applicable to their poverty gap index as well as poverty severity index. These results might be due to the rate of unemployment particularly among the younger population in the region.

Male-headed households had less poverty than their female-headed counterparts across all poverty measure indices. The reason may be partly due to strength and requisite potentials inherent in men in some more lucrative aspects of forest businesses (e.g. logging) that responsible for such (Shackleton (2011). It could also be as a result of the fact that in most parts of rural Nigeria, female-headed households are always involved in many other trading occupations (Omonona, 2009). Although, this assertion runs contrary to the findings of Ogwumike and Akinnibosun (2013) which stated that female-headed households had less poverty than their male-headed counterparts.

Moreover, households' years of education reduces poverty as those with tertiary education have less poverty than those with little or no formal education. Predictably, poverty is lower when the level of education increases. Therefore, this result is plausible because educated households' heads would apply some entrepreneurial skills and marketing strategies to their advantages. It may be a form of value addition such as advertisement, promotional services, packaging, rebranding and host of other factors across the value chain mechanism. In the same vein, most of local people may lack skills for appropriate extraction that would allow harvesting, processing, packaging and marketing NTFPs to the full potential of commercialization. This matched the findings of Kimaro and Lulandala (2013) on contribution of non-timber forest products to poverty alleviation and forest conservation in Rufiji District - Tanzania. Though, it is contrary to the findings of Fonta & Ayuk (2013) when measuring the role of forest income in mitigating poverty and inequality for the case of South-eastern Nigeria where years of education was positively correlated with poverty.

Furthermore, by decomposing poverty by marital status, Table 2 revealed a very surprising result such that both single and separated households' heads recorded almost the same high poverty results for the headcount, poverty gap index and poverty severity index on one hand, and both married and divorced also recorded almost similar less poverty across all measures of poverty index on the other hand. The reason may be due to the fact that married and divorced were more involved in forest related activities than others in the study area.

Lastly, across poverty measure indices, there was no much distinction among religious faithful in terms of their participation in FREs. However, Muslim households' heads recorded relatively high poverty gap and poverty severity index than their Christian counterparts in the study area. There is a certain assumption to the variance between the two religious faithful which hitherto include; high family size in most Muslim households which could probably increase their per capita expenditure.

3.3 Classification of poverty status of rural households with and without forest income

This section presents the classification of poverty incidence of rural households with forest and without forest income in the study site. Following the method of classification of poverty adopted by Sen (1981) as used by Aiyedogbon (2012) and Dubihlela (2014), households are classified into extremely poor, moderately poor and non poor based on their poverty index measures.

However, there are two approaches (monetary and non-monetary indicators) through which this poverty categorization can be measured (Coudouel *et al*., 2002; Adekoya, 2014:329).

The most common indicators used in practice are based on household consumption expenditure and household income. The study adopts the standard practise of using per capita consumption expenditure as a measure of living standard as used by many authors such as Okunmadewa *et al*. (2005); Olaniyan and Bankole (2005); Oni and Yusuf (2006) and Addae-Korankye (2014) in most poverty studies in Nigeria. Example here is *setting the*

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two-thirds of the mean per capita households' expenditure (see Rogers 2015).

Having set this, any household whose per capital consumption expenditure is below this poverty line is regarded as poor while those above it are considered non-poor. Further, households whose per capita expenditures are less than one-thirds of the total households' per capita expenditure are regarded as extremely poor while those households with average monthly expenditures greater than one-third of total households' expenditure but less than two-thirds of the total households' expenditure are considered moderately poor (see Sen, 1981; Aiyedogbon, 2012; and Dubihlela, 2014)[3]. Table 3 presents the distribution of poverty status of rural households with and without forest income.

Table.3: Classification of poverty status of rural households with and without forest income

Poverty index	Poverty index with forest income	Poverty index without forest income	Percentage Relative change
Extremely poor	0.541	0.660	11.9%
Moderately poor	0.457	0.563	10.6%
Non poor	0.515	0.612	9.7%
Total	0.614	0.721	10.7%

Source: Calculated from field survey, 2017

[3] Households are considered non poor since their per capital monthly expenditure is equal to or greater than the pre-determined poverty line of N 18,331. Poverty line for the study area (South-western Nigeria) was calculated by dividing total households' monthly per capita expenditure by total households' size. Then, the two third of the answer was calculated. It coincidentally matched the present Nigerian workers' minimum wage (2016).

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Table 3 introduces the disparities that exist in terms of the contribution of forest income to the households' poverty status in South-western Nigeria. The results revealed that if forest income was included in the econometric analysis, the proportion of extremely poor household was reduced to 66 percent, about 12 percent relative change. Likewise, using the same phenomenon in the moderately poor category, the disparity in proportion was 10.6 percent while that of non poor was 9.7 percent (that is, a relative drop of 12.9 percent, 13.8 percent and 10.7 percent poverty index respectively).

This decrease in poverty index is in conformity with the finding of Fonta and Ayuk (2013) with a difference of 16.4 percent when the like of this study was carried out in the South-east region in Nigeria. Their findings therefore argued that forest income is more pro-poor and has tendency to mitigate poverty than any other income source in South-eastern Nigeria. Similarly, Tangem (2012) also argued that small and medium scale forest enterprises have the potential to diversify rural livelihoods and improve their standard of living because they require only small initial investment to set up which can make them accessible and attractive to the poor and in turn diversify their economic opportunities and improve their livelihood security (UNFF, 2013). This is not surprising because most rural households found reliance in forest income in terms of "safety net" functions than in non-forest related enterprises. Rural people usually draw on available natural resources to meet emergency shortfalls and to keep them from being worse off in times of need (Belcher, 2005).

In sum, using conventional income measure, the households poverty index was 72 percent whereas the inclusion of forest income reduces the headcount poverty to 61 percent, a relative drop of 10.7 percent. These results are in conformity with Federal Republic of Nigeria study for poverty profile (Africa) final reports published in March 2011, which gave almost the same figure (63.27 percent) for the rural poverty in Nigeria [(see NBS, 2011) Poverty Profile for Nigeria].

For the South-west region, the outcome is also in agreement with such other related studies as revealed from literature. For example, the Nigeria poverty profile 2010 report by National Bureau of Statistics revealed that in 2010, the South-west geo-political zone recorded the poverty incidence of about 59.1percent which is close to 65.5percent poverty incidence observed in this study with specific reference to rural forest households in the region in 2016. These findings therefore suggest that poverty has established itself as a palpable and endemic scourge among the majority of rural people in Nigeria especially in the South-west region of the country.

3.4. Socio-economic benefits of forest income on households' welfare for the region

In Table 4, the study presents the socio-economic benefits of forest on poverty status of the households in South-western region Nigeria. Like in many prior studies where a negative correlation between forest dependence and rural household income has been established, this research finding is not exceptional although, the correlation is relatively not much. This however corroborates the findings of Fonta & Ayuk (2013) on the role of forest income in mitigating poverty and inequality in South-eastern Nigeria'. The simple explanation for this positive effect of forest is that the economic value of forest resources transcends the welfare of the poor alone but also takes care of various income groups in the region. This means that it is not only the poor households that depend on forest income but including the rich (Angelsen *et al*., 2011; Nielsen *et al*., 2012; UNFF, 2013) although; poor people are relatively more dependent on forest income than wealthier people (Inoni, 2009).

Furthermore, three different ways of constructing extent of poverty using FGT class of poverty measure such as poverty incidence, poverty gap index and poverty severity index were calculated for poverty status with and without forest incomes included in household income accounts. The results showed that forest income is capable of stemming the tide of poverty in the region even though with relative magnitude. Table 4 presents the distribution of FGT analysis with FREs and without FREs for the South-western Nigeria.

Table.6.4: FGT analysis with FREs and without FREs for the region

Poverty index	with FREs	without FREs
Poverty incidence	0.6369	0.6837
Poverty gap	0.6559	0.7320
Poverty severity	0.5051	0.6879

Source: Calculated from field survey, 2017

First, in terms of poverty headcount measure, almost 68 percent of the households are regarded as poor in conservative income measure (i.e. with exclusion of forest income), whereas the inclusion of forest income reduces the headcount poverty to 64 percent, a relative drop of 4 percent. The poverty gap indices was conventionally

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measured to be 73 percent but reduced to about 66 percent with a drop of about 7 percent when forest income was included. However, poverty severity indices recorded a relatively large drop, that is, a fall of about 18 percent with inclusion of forest income. This is not surprising, since most rural households found trust in forest income than in non-forest related enterprises. This results run in conformity with the findings of Tangem (2012) who stated that small and medium scale forest enterprises have the potential to diversify rural livelihoods and alleviate poverty because they require only small initial investment to set up which can make them accessible and attractive to the poor and in turn diversify their economic opportunities and improve their livelihood security (UNFF, 2013).

IV. CONCLUSION

This study has examined households' welfare and forest dependence in South-western Nigeria. The results give credence to the observed relationship between rural households' poverty status and dependence on forest resources income. Using the headcount index (P_0) to measures the proportion of the population that is poor, the results showed that 66 percent of the rural households are living below the poverty line in the region. At state level, the highest proportion is Osun state (77 percent), followed by Ogun state (70 percent) and Oyo state with about 50 percent.

The study also revealed the minimum cost required to bring these poor households to the poverty line across states. For example, in Oyo state, the poverty depth (P_1) value of 0.2484 will require ₦4, 553 per household per month to close the poverty gaps while a sum of ₦9,664 is needed in Osun state. In Ogun state, individual household would require a sum of ₦8918 to eliminate poverty. The severity of poverty (P_2) among households surveyed are 0.3532, 0.4415, and 0.3095 in Oyo, Osun and Ogun states respectively. This indicates that poverty is more severe in Osun state followed by Oyo state but less severe in Ogun state.

Moreover, classifying the poverty status into extremely poor, moderately poor and non-poor categories, the findings showed that the impact of forest income on the poverty status of the households has improved the welfare of extremely poor households by 12 percent whereas that of the moderately poor households has been improved by approximately 11 percent with the inclusion of forest income. Likewise, the welfare of the non-poor households has been improved by about 10 percent when measured with forest income. In total, the inclusion of forest income in the econometric analysis for the region has improved the welfare of the rural households generally by 11 percent. This showed that forest income is capable of stemming the tide of poverty in the region even though with a relative magnitude.

In terms of FGT poverty index analysis (that is, poverty incidence, poverty gap and poverty severity), poverty incidence measure showed that almost 68 percent of the households are regarded as poor in conservative income measure (i.e. with exclusion of forest income), whereas the inclusion of forest income reduces the headcount poverty to 64 percent, a relative drop of 4 percent. The poverty gap indices was conventionally measured to be 73 percent but reduced to about 66 percent with a drop of about 7 percent when forest income was included. However, poverty severity indices recorded a relatively large drop, that is, a fall of about 18 percent with inclusion of forest income.

V. RECOMMENDATIONS

Owing to the above findings, three major policy recommendations can be posited. First, the fact that the study results suggested that almost three-quarter of the sampled rural households are living below the poverty line in the region, the realization of this fact required the restructuring and reintegration of a series of pro-poor poverty alleviation initiatives that will be all inclusive and targeted mainly on the grassroots who have been economically marginalized from previous poverty alleviation schemes.

Secondly, the study results also suggested that the livelihood of the rural poor seems inextricably attached to forest resources exploitation, and has been considered as a preference for poverty mitigation as it often serves as an employer of last resort for the masses. Government at all strata should therefore diversify the grass root economy by providing alternative sources of incomes that will ensure subsistence benefits, generating formal and informal work opportunities (employment), supporting the development of sustainable small and medium-sized forest enterprises and galvanize reservoirs of economic values that help ameliorate shocks to household incomes in order to mitigate too much pressure and over dependence on forest resources.

Lastly, the study also identify that forest income play a significant function in improving the welfare of rural household and provide a safety net function in South-western Nigeria. Unfortunately, these distinctive roles are poorly understood and recognized by many poverty-based policymakers and planners in Nigeria which needs to be properly fine tuned. However, this positive relationship between forest income and household welfare deserves closer attention due to the high degree of forest dependence in the region. Therefore, Government and authority concerned should increase opportunities for entrepreneurship and employment in forestry while avoiding deforestation and forest degradation. That is, rural development policies that address the issues of poverty that will be environmentally friendly and ensure correct targeting and judicious distribution of resources must be formulated and adequately implemented.

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Effect Inundation Period to Summed Dominant Ratio (SDR) and Biomass Rice Weeds of Method SRI (System of Rice Intensification) in Indonesia

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***Abstract*— *Research by title the effect inundation period to summed dominant ratio (SDR) and biomass rice weeds of method SRI (system of rice intensification) in Indonesia. Research have been conducted in the Faculty of Agricultural Land Andalas University, Limau Manih, Padang, from February to May 2018. The study aims to identify noxious weed found in SRI method of paddy cultivation in Indonesia. Weeds that have summed Dominance Ratio (SDR) and the highest biomass in this study is a weed Cyperus rotundus, Scirpus juncoides Roxb., Fimbristylis miliacea (L.) Vahl, Cyperus pedunculatus and Richardia brasiliensis Gomez. Highest weed biomass obtained in the treatment of inundation 3 days old and weed biomass lowest is 15 days long inundation.*

Keywords*— *Weeds, SDR, Biomass Weeds.

I. INTRODUCTION

Rice is a staple food crop in Indonesia. Increasing the number of people demanding an increase in production. Increased rice production can be done by using improved varieties and applying the SRI method. Rice production could be increased if given good farming technology such as planting SRI method. SRI rice cultivation methods will produce vegetative growth components and parts better results (Lita et al., 2013). However, rice cultivation with moist soil conditions cause high weed competition with rice. Antralina (2012) stated weeds can lower rice yields to 1-2 tons SRI method. Based on observations Antralina et al., (2014) obtained seven dominant weed species in rice cultivation are capable of lowering hpertumbuhan SRI and rice yields are *Fimbristylis miliacea* (46, 13) and *Cyperus iria* (13.33), four from the class of broad-leaved namely *Ludwigia octovalvis* (14.70), *Alternanthera sessilis* (L) (13.72), *Portulaca oleracea* (17.26) and *Monochoria vaginalis* (11.31) one class of Gramineae is *Echicocloa crussgalli* (14.70) whereas in conventional cultivation there are three types, two from the class of broadleaf is *Portulaca oleracea* (49.20) and *Ludwigia octovalvis* (26.18). This is the reason the author to see what kind of noxious weed that of the SRI cultivation in the area of Padang and how the competition ability of rice varieties impera 30 with the noxious weed that.

II. MATERIALS AND METHODS

Materials used in this research is tractor, rice seeds, seed beds, fertilizer. Observations weeds after treatment is done at the age of 100 days after planting. The area of the map is used as a weed observation is 1 m^2. Observations were carried out on all plots are weed biomass, species, the area of ground cover, the amount of any weeds in the end of the study for observation and SDR and biomass of weed.

III. DISCUSSION

3.1 Dominant summed Ratio (SDR) Weeds

Table 1 shows that five types of weeds that have the highest value of the SDR is a kind of puzzle particular weed *Cyperus rotundus*, *Scirpus juncoides* Roxb., *Fimbristylis miliacea (L.) Vahl*, *Monochoria vaginalis and Richardia brasiliensis Gomez*. These five types of weeds belong to the noxious weed species for rice cultivation for weed SRI method has a very rapid proliferation of both vegetative and generative, lush canopy so as to cover the rice crop in the early phases of growth and issued a alelokimia compound.Another thing that can be described by the value of the SDR is the level of mastery of the weed against biotic and abiotic factors that exist in the land.

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Table.1: The Value of SDR Various Type Weeds in Rice Planting Area of SRI Method

Type of Weeds	Dominant Summed Ratio (%)				Average
	Group				
	1	2	3	4	
Cyperus rotundus	33.50	25.50	25.75	25.00	27.44
Scirpus juncoides Roxb.	9.75	17:50	14:00	10:00	12.81
Fimbristylis miliacea (L.) Vahl	13:25	14.75	11:00	9:25	12:06
Monochoria vaginalis	7:00	7.75	6:25	14.75	8.94
Cammelina difusa Burm. f.	5:50	4:50	6:25	9.75	6:50
Cyperus pedunculatus	2:50	4.75	8:50	9:25	6:25
Cyperus iria L.	6:50	7:25	7:25	2:50	5.88
Digitaria ciliaris (Retz.) Koel.	6.75	4:50	4.75	2:50	4.63
Hedyotis corymbosa	5:25	2:50	3:25	3:25	3:56
Eclipta prostrata	4:00	3:00	0:00	4.75	2.94
Brachiaria reptans	1:25	2.75	2:50	3:00	2:38
Hygrophilla auriculata	1:00	1:25	2:25	4.75	2:31
Asistasia gangetica	0:00	1:25	2.75	0:00	1:00
Echinochloa crus-galli (L.)	0:00	0:00	4:00	0:00	1:00
Limnocharis flava	3:00	0:00	0.75	0:00	0.94
ageratum conizoides	0.75	1:25	0.75	0:00	0.69
Richardia brasiliensis Gomez	0:00	1:25	0:00	1:25	0.63
Polygala paniculata	0:00	1:00	0:00	0:00	0:25

According Holom et al., (1970) *Cyperus rotundus* is one of the worst weeds in the world. This is due to weeds is not dead at the time of getting flooding, can grow well in the humid conditions of SRI land, and proliferation is very fast and a lot. According to Kris (2006) gulma puzzle has a very good competition ability. This is due to able to multiply very quickly generative and vegetative, producing alelokimia compounds that can lower the number, area and other vegetation leaf chlorophyll content as well as by Khamsan et al., (2011) alelokimia in this puzzle can inhibit the germination and growth of broadleaf weeds like Mimosa Pigra, Mimosa Invisa, Casia alata, and Porophylum ruderale.

Research has been done by Kusuma et al., (2017) show senyawa alelokimia puzzle suspected to affect the growth of weeds, the other is 2-methoxy-4-vinylphenol; phenol, 2,6-dimethoxy; and 2-furanmethanol. According to Darabi et al., (2007), 2-methoxy4-vinylphenol is a natural compound that can inhibit the germination of the grain so that the grain to avoid germination before harvest. Puzzle tuber extract the age of 3 months after planting seeds germination lowered Asistasia gangetica to 32%, with an emphasis of 54.7% compared to controls. Boreria germination extract alata in all parts of the puzzle age of 2 months after planting amounted to 21.3%, with an emphasis of 60.9% compared to controls.

weed *Scirpus juncoides* Roxb. a weed that is able to multiply even though only get a little sunlight for very efficient at using sunlight. This weed also has a height 0.75 m so as to overshadow other plants. The annual life cycle also cause a great loss for the rice crop because there will be competition during its lifetime. Weeds Fimbristylis miliacea (L.) Vahl is a weed that has a size of 0.6 m which grows upright and strong seedlings. This weed has the ability of strong competition on the roots so as to reduce the absorption of nutrients for other plants. This weed also has elelokimia compounds that can suppress the growth. Monochoria vaginalis is a wide berdau class weeds. The competitiveness of this weed with rice is being,

1. Biomass Weeds

Table 2 shows that the long inundation affect weed biomass. Lowest weed biomass was obtained at 15 days of flooding and the highest weed biomass was obtained at 3 days of flooding.

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Table.2: Biomass Old Flooding Weeds at Various Planting Rice SRI method

Inundation Period (Day)	Weed biomass (g)
3	37.47 a
6	31.25 b
9	27.34c
12	22:27 d
15	21:04 e

Figures follow the same small letters on the same column indicate no significant treatment based Test DNMRT level of 5%.

In Figure 1 we can see that the addition of long inundation able to reduce weed biomass. Extra long inundation led to a reduction of weed biomass by the equation y = -1.394x + 40.42. 40.42 constant flooding means do long for 0 days then the weed biomass is 40.42 and each additional flooding during 1 day old can lower weed biamassa at -1394.

This is due to the inundation of 3 day long there are weeds Cyperus rotundus with the highest value of the SDR. One of the factors which influence the value of the SDR is the biomass of weeds weed itself. SDR high value indicates that any weeds that also have a high weed biomass. Another thing that can be described by the value of the SDR is the level of mastery of the weed against biotic and abiotic factors that exist in the land. According Holom et al., (1970) Cyperus rotundus is one of the worst weeds in the world. This is due to weeds is not dead at the time of getting flooding, can grow well in the humid conditions of SRI land, and proliferation is very fast and a lot.

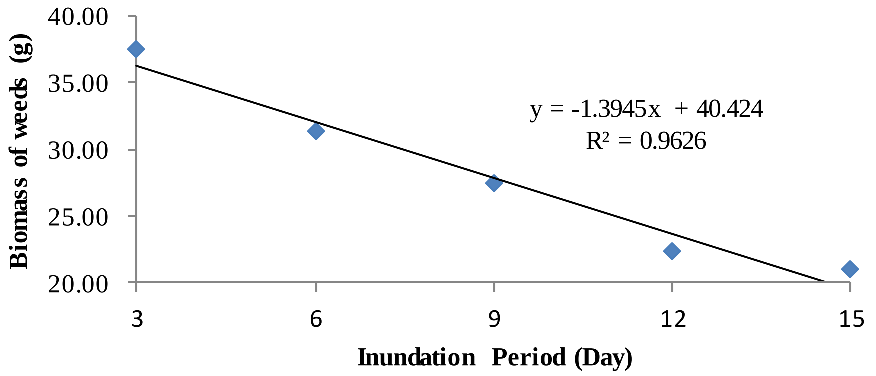

Fig.1: Decrease due of Biomass Weeds to addition Inundation Period

While flooding over 15 days caused death of weed seeds. If the number of weeds that grow up a bit and weeds that sprout growth is disturbed it will produce relatively lower biomass. This statement is supportedMujik (1970) in which the propagation material will be damaged and dead weeds if backup their food reserves reaction denaturation, coagulation proteins and the accumulation of toxic substances from the environment.

IV. CONCLUSION

Based on experiments that have been conducted found some conclusions that

1. Noxious weed in rice cultivation in Indonesia SRI method is *Cyperus rotundus*, Scirpus juncoides Roxb., Fimbristylis miliacea (L.) Vahl, Monochoria vaginalis and Richardia brasiliensis Gomez
2. Old flooding best able to control weeds in rice cultivation SRI method is long inundation 15 days.

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Effect of Several Ameliorants on the Chemical Properties Improvement of Toba Highlands Peat Soil in North Sumatera- Indonesia

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Abstract— Peatland is a potential land farming for increasing food abundance. This study aimed to determine the effect of ameliorants (sea water, volcanic ash, zeolite and $CaCO_3$) to improvement of Toba Highlands Peatlands chemical properties. This research used factorial complete randomized design with two factor treatments consist of ameliorant application and washing frequency, with four combination those are (A0) Sea water, (A1) volcanic dust plus sea water, (A2) zeolite plus sea water, (A3) $CaCO^{3+}$ sea water with 2 replications The results showed that application of ameliorant influenced significantly to increase soil pH, electric conductivity, carbon organic, N total, K-exchangeble and Ca-exchangeble. The frequency of washing increase of soil pH significantly.

Keywords— ameliorant, washing, sea water, volcanic ash, zeolite, peat soil

I. INTRODUCTION

Peatlands are marginal land for agriculture because of their low fertility, very acidic pH, and poor drainage conditions. Indonesia's peatland area is estimated to range between 17-21 million Ha. Accurate data on the extent of peatland is difficult to find because of the limited survey and mapping of peatland in Eastern Indonesia. With a large enough area which ranges from 9-11% of the whole land area in Indonesia, it is difficult to avoid the development of agriculture into this marginal land (Agus*et al*., 2008).

In Sumatera Utara Province, in addition to the lowlands, peatlands are also found in the highlands. This highland peatland is located in the Toba highlands located in three sub-districts, LintongNihuta Sub-district, Doloksanggul Sub-district and Pollung Sub-district, these three Sub-districts are in HumbangHasundutan District. This highland peatland is quite unique because it is in the highlands which are not affected by beaches or rivers. The total area of peatland in HumbangHasundutan District is 6289.08 ha spread in Pollung Sub-district 1663.73 ha, 1812.15 ha in Lintong Ni Huta and 2813.2 ha in DolokSanggul Sub-district. Types of peatland cover are forests, non-vegetation areas, etc. (Sitanggang*et al*., 2013).

The type of peat soil in HumbangHasundutan District includes topogen peat type with a depth of 60 - 100 cm which is used by the community as a cultivation area for horticulture and food crops. Research on highland peatlands in agriculture utilization is still very few. According to local farmers, farmers' production on peatlands is very low in line with slowing plant growth (Purba.2017).

Improving the productivity of peat soils, there are constraints such as soil acidity, cation exchange capacity (CEC) and a relatively high C / N ratio and a low number of bases exchange (Na +, K +, Ca2 +, Mg2 +) plus the presence of organic acids in soil solutions which are partially toxic to plants (Purba. 2017).

In the utilization of peatlands, it is necessary to apply intensification in the form of soil properties improvement so that the efficiency of land use can be increased. The efforts that can be made are by utilizing several types of soil ameliorant materials such as sea water, volcanic sand, lime and zeolite to increase the productivity of peat soil. Research on peatlands has shown that application of a combined treatment of volcanic sand, zeolite and seawater can increase tillers and paddy production in line with the increasing of soil acidity and soil electrical conductivity (Firlana *et al*., 2013).

Based on the description above, it is necessary to conduct a research on the effects of several ameliorants, namely volcanic ash, zeolite and lime (CaCO3) which are flowed by seawater on the chemical properties improvement of Toba highland peat soil.

II. MATERIALS AND METHODS

This research was carried out in screen house and analyzed at the Laboratory of Chemistry and Soil Fertility and Research and Technology Laboratory of the Faculty of Agriculture, University of North Sumatra Medan. The research was started from November 2017 to December 2017.

The material used in this research was peat soil from HumbangHasundutan District, LintongNihuta Sub-district as an object of observation, Amelioran used was Zeolite, volcanic ash from the area of Mount Sinabung, Karo district, lime ($CaCO_3$) and sea water taken at PantaiCermin, SerdangBedagai District as ameliorant material, PVC was used as soil medium, ion-free water was used to wash peat soil after incubation and other supporting materials. The tools used in this research were pH meter to measure the acidity of soil solution, electro conductivity meter to measure the electrical conductivity of soil solution, atomic absorption spectrophotometer (ASS) to measure bases exchange, sieve to sift volcanic sand, scales used to weigh materials, laboratory equipment and other supporting tools used during the research. This research used Factorial Completely Randomized Design (CRD) with two factors. Factor 1 was mixing peat soil with various sources of ameliorant consisting of 4 levels of treatment, namely; (A0) leachate of sea water (1 liter), (A1) volcanic sand 100 grams + leachate of sea water (1 liter), (A2) zeolite 100 grams + leachate of sea water (1 liter), (A3) lime CaCO3 100 grams + leachate sea water (1 liter). Factor 2 was the leaching frequency consisting of 3 levels of treatment, namely; P0 without leaching, P1 was washed with ion-free water 2 times (1 liter) and P2 was washed with ion-free water 4 times (1 liter). 12 combinations of treatments were obtained with 2 replications so that there were 24 experimental units.

The research media was made from a 4-inch Polyvinyl chloride (PVC) pipe, with a base made of gauze attached under a PVC pipe. Next, put a pebble measuring ± 2 cm below the gauze. Finally, peat soil which has been mixed with ameliorant material was added into PVC media. Furthermore, the soil that has been mixed with ameliorant material was put into the prepared PVC, then leached with 1 liter of sea water per treatment unit. Leached sea water was collected and leached several times until the remaining leach water that comes out below the PVC run out. After leaching with sea water, all treatment units were incubated for 4 weeks. After 4 weeks leaching was done with 3 levels of treatment factors, i.e. without leaching, 2 times and 4 times using ion-free water. After the leaching frequency process was finished, soil samples were taken for analysis.

III. RESULTS AND DISCUSSION

The results of the analysis of variance showed that there were effects of ameliorant application on some chemical properties of Toba highland peat soil. These were shown from the significant differences in the observed parameters.

Soil Acidity (pH)

Addition of ameliorant in the form of sea water, volcanic ash + sea water, zeolite + sea water and lime CaCO3 + sea water as a whole increased the pH compared to the initial soil pH of 3.48. Some ameliorant material application and leaching frequency also the interaction of both have a significant effect on soil pH. Ali and Sedaghat (2007) stated some benefits of mineral materials as ameliorant by previous researches, including steel slag and zeolite can serve to increase the soil pH as well as lime, providing elements of Ca, K and P, and can reduce the toxic effects of Al on sour soil. The frequency of leaching was able to wash organic acids during the decomposition process; Rini*et al* (2009) stated that peat water is very acid from the decomposition process that is happening on peatlands that produce organic acids.

Electrical Conductivity

Someameliorant materialapplicationhad a significanteffect on soil electrical conductivity. This is due to theamelioration of volcanic ash, zeolite and CaCO3can increasethe concentration of salt in the soil. Electrical Conductivity was increasing because salt concentration also increased. Electric current delivered by salt solution under standard conditions will increase if there is an increase in salt concentration in the soil solution (Rahmawati, *et al*., 2009). The effect of leaching frequency did not give a significant effect on the change in electrical conductivity. This was likely to occur because the accumulation of salt in the soil formed an organic peat compounds with the organic acids.

Table.1: The Average Value of Soil Acidity due to the provision of several ameliorants and leaching frequency

Treatments	Leaching			Average
	P0 (0 Times)	P1 (2 Times)	P2 (4 Times)	
A0 (Sea Water)	3.69 e	3.62 f	3.89 d	3.74 d
A1 (Volcanic Ash + Sea Water)	3.89 d	3.94 bcd	3.91 cd	3.91 bc
A2 (Zeolite + Sea Water)	3.89 d	3.91 cd	3.97 bc	3.92 b
A3 ($CaCO_3$ + Sea Water)	3.94 bcd	3.995 b	4.01 a	3.98 a
Average	3.85 b	3.87 b	3.95 a	3.89

Note: numbers followed by different letters are statistically different ($P<0.05$)

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Table.2: The Average Value of Electrical Conductivity due to Ameliorant application and Leaching Frequency

Treatment	Leaching			Average mmhos/cm
	P0 (0tmes)	P1 (2 times)	P2 (4 times)	
A0 (Sea Water)	0.12	0.12	0.14	0.13 b
A1 (Volcanic Ash + Sea Water)	0.16	0.15	0.15	0.15 a
A2 (Zeolite + Sea Water)	0.14	0.15	0.16	0.15 a
A3 ($CaCO_3$ + Sea Water)	0.17	0.15	0.14	0.15 a
Average	0.15	0.14	0.15	0.14

Note: numbers followed by different letters are statistically different (P<0.05)

Cation Exchange Capacity (CEC)

The application of ameliorant or its combination with the leaching frequency had no significant effect on the cation exchange capacity (CEC) of the soil. Previous land CECs were classified as very high based on BPPM (1982) criteria. Changes in the value of cation exchange capacity (CEC) of peat soils occur because the rate of decomposition of peat changes. The CEC value was also influenced by the reaction of ameliorant material given toward the changes in soil pH and negative charge on soil colloids. Ridho (2014) stated that changes in CEC values are caused by an increase in pH and a factor of fertility and soil productivity, namely the higher the CEC, the higher the base cation which is bound by the soil so that the fertility level is higher.

Table.3: The Average Value of Cation Exchange Capacity (CEC) due to Ameliorant Application and Leaching Frequency.

Treatment	Leaching			Average me/100g
	P0 (0 times)	P1 (2 times)	P2 (4 times)	
A0 (Sea Water)	21.27	21.28	20.90	21.15
A1 (Volcanic Ash + Sea Water)	21.52	21.01	21.04	21.19
A2 (Zeolite + Sea Water)	21.27	20.64	21.05	20.99
A3 ($CaCO_3$ + Sea Water)	22.58	25.94	24.26	24.26
Average	21.66	22.22	21.81	21.90

Note: numbers followed by different letters are statistically different (P<0.05)

C Organic, N total and C / N ratio

Table.4: The Average Value of C organic, N total and C / N ratio due to some ameliorants application and leaching frequency

Treatment	C organic	N total	C/N Ratio
A0 (Sea Water)	58.77 a	1.09 a	54.31
A1 (Volcanic Ash + Sea Water)	54.37 b	0.99 b	54.96
A2 (Zeolite + Sea Water)	52.74 c	0.95 c	55.54
A3 ($CaCO_3$ + Sea Water)	50.30 d	0.94 c	53.75

Note: numbers followed by different letters are statistically different (P<0.05)

Ameliorant application had a significant effect on C organic in the soil. Treatment of A0 (sea water), A1 (volcanic ash + sea water), A2 (zeolite + sea water), and A3 (CaCO3 + sea water) can reduce C organic in the soil which had an organic C content of 58.77% in A0 (sea water), but the C organic content was very high overall. The increase in the C-organic content indicates that the overhaul is not perfect because the decomposition process is so low that N immobilization occurs which increases the C-organic content (Nurhayati, 2008).

Nitrogen content in peat soil changes, namely a decrease in total N, but overall the total value of N is very high. The decreasing in nitrogen content occurs because ameliorant was able to increase the rate of peat decomposition so that changes in N organic to N inorganic (NH + 4 become NO-3) and leached or evaporated. In the process of decomposition, nitrogen in the soil decreases because it is used by microorganisms (Rajagukguk, 2001).

The C / N ratio of highland peat soil in this research ranged from 53.75% to 55.54% and was very high. Changes in the C / N ratio are strongly influenced by the

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duration of incubation and the rate of soil decomposition, also influenced by the characteristics of the peat itself, namely the change from anaerob to aerob allows a decrease in the C / N ratio (Buckman and Brady, 1982).

Bases Exchange (K, Ca, Na, Mg)

The application of ameliorant had a significant effect on K-exchange and Ca-exchange but did not give a significant effect on Na-exchange and Mg-exchange. The leaching treatment has no significant effect on the value of K, Ca, Na and Mg exchanges of peat soil.

The application of ameliorant treatment had a significant effect in increasing the value of K-exchange and Ca-exchange. The increasing was occurred because the ameliorant material administered contained bases exchange. Overall, the bases exchange content was still very low. Agus and Subiksa (2008) stated that the presence of cations in peat soil is easily replaced by other cations because the absorption complex in organic colloids is very weak and causes cations to be easily washed out. The effect of ameliorant treatment tends to increase base saturation. This occurred because of the addition of cations (Ca, Na, Mg and K) in the soil, compared to before the application of ameliorant in addition to a decrease in the value of soil CEC. Hanafiah (2005) stated that Ca available is very much related to base saturation and CEC, where if Ca is increased, the CEC and base saturation are also increased.

Table.5: The Average Value of Bases Exchange (K, Ca, Na, Mg) due to Some Ameliorant Application and Leaching Frequency.

Treatment	K exchange	Ca exchange	Na exchange	Mg exchange	Base Saturation
A0 (Sea Water)	1.05 bc	1.71 b	2.01	2.87	37.53
A1 (Volcanic Ash + Sea Water)	1.05 b	1.77 b	1.88	3.85	43.05
A2 (Zeolite + Sea Water)	1.32 a	1.76 b	1.67	3.39	42.49
A3 ($CaCO_3$ + Sea Water)	0.99 c	2.52 a	1.55	7.98	64.14

Note: numbers followed by different letters are statistically different (P<0.05)

CONCLUSION

1. Ameliorant application of CaCO3 plus sea water was able to increase pH, electricity conductivity and Ca-exchange of Toba highland peatland, while Zeolite plus sea water was able to increase K-exchange rate.
2. The application intensity of ion-free water as much as 4 times can increase the pH of Toba highland peat soil.
3. The administered Interaction of CaCO3 plus sea water with 4 times leaching was able to increase the pH of Toba highland peat soil.

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Antagonistic Effect of Eight Sri Lankan Isolates of *Pseudomonas fluorescens* on, *Meloidogyne incognita* in Tomato, *Lycopersicon esculentum*

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Abstract**—*****The study was conducted to determine the efficacy of Pseudomonas fluorescens isolates collected from eight locations in the Central Province of Sri Lanka against Meloidogyne incognita in tomato. Isolates were tested under laboratory conditions to determine the efficacy on egg hatchability and mortality of second stage juveniles. A planthouse experiment was conducted using potted tomato plants to determine the potential of P. fluorescens isolates and effective application technique. All tested isolates have significantly inhibited egg hatchability and increased the juvenile mortality after 72 hours. P. fluorescens isolate from Kangkung field in Pallekelle (PK) and tomato field in Udispattuwa (UT I) recorded 95% and 95.5% inhibition of egg hatchability after 72 hours. P. fluorescens isolates collected from tomato fields in Bopane (BT II) and Udispattuwa (UT II) and from Kangkung field in Pallekelle recorded the higher mortality of second stage juveniles 93%, 87% and 83.3% respectively. The highest reduction in the root knots (96.8%, 96.3%), egg masses (98.5%, 98.2%) and lower root galling index (1 and 1) were recorded in tomato plants treated as soil drench with UT II and PK isolates respectively.The root dipping technique gave higher reduction in the number of root knots (47.4%), egg masses (44.9%) and lower root galling index (3.75) were recorded from BT II, UT II and tomato fields in Nugethenna (NT) isolates respectively. UT II and PK found to be the most effective isolates and most effective application technique determined as soil drenching ten days after transplanting under plant house conditions.***

Keywords - Biological Control, Meloidogyne incognita, Pseudomonas fluorescens, Soil Drenching.

I. INTRODUCTION

Root Knot Nematodes (RKN), *Meloidogyne* spp., are widely distributed pests of several crops grown in Sri Lanka [6]. Almost 95% of food crops grown are susceptible to one or more species of RKN [2]. The yield loss due to the damage caused by *Meloidogyne* spp. is more prominent in vegetables, especially among Solanaceae and Cucurbitaceae crops than other crops [2]. The management of nematodes is challenging as they inhabit the soil and usually attack the underground parts of plants. Control of *Meloidogyne* spp. through synthetic nematicides is effective, easy to apply but are toxic to humans, animals and can cause soil and water pollution [11]. Biological control offers a good alternative to chemical control with a little hazard to the soil environment. A variety of microorganisms and natural enemies antagonistic to soil nematodes exist in the soil; these include bacteria, fungi, predatory nematodes and mites. The application of antagonistic soil microbes is considered as effective and eco-friendly for managing nematodes [7]. Bacteria are the most abundant organisms in soil and some of them, for example members of the genera *Pasteuria*, *Pseudomonas* and *Bacillus* have shown great potential for the biological control of nematodes. Aerobic endospore-forming bacteria *Pseudomonas* spp. are among the dominant populations in the rhizosphere that are able to antagonize nematodes. The antagonistic mechanisms include production of antibiotics and induction of systemic resistance to minimize the populations of plant parasitic nematodes [11].

Tomato is an attractive cash crop that provides a source of income to the rural population in the central region of Sri Lanka. Nematodes of the genus *Meloidogyne,* is known to cause more than 50% crop losses to tomato [4]. This study was conducted to determine the antagonistic properties of eight Sri Lankan isolates of *Pseudomonas fluorescens* against *Meloidogyne incognita* in Tomato (*L. esculentum*) *in vitro* and *in vivo* and to select the effective *P. fluorescens* isolate(s) for the control the *Meloidogyne* spp.

II. METHODOLOGY

2.1. Preparation of water cultures of *P. fluorescens*

Soil samples collected from a Kang kung crop from Pallekelle, tomato crops from Nugethenna (one sample), Bopane (2 samples) and Udhispaththuwa (3 samples) and from a maize crop from Sooriyawewa were used for the experiments. One gram each of the above 8 samples was diluted in 100 ml of sterilized phosphate buffer solution and shake for 2 h.

A series of 10-fold dilutions was prepared by repeating 6 times under aseptic condition. The diluted soil supernatants (0.1 ml) was spread on king's medium B agar plates and incubated at 28 °C for 48 h in an incubator. Culture plates were observed under ultraviolet trans-illuminator at 366 nm for few seconds and colonies with green fluorescence were streaked on King's medium B agar plates to get pure colonies. Well-grown 48 h old uncontaminated single colonies were used to prepare water cultures of *P. fluorescens* and cell density were estimated for all the isolates.

2.2. Effect of *P. fluorescens* on egg hatchability of *M. incognita*

Sterilized Petri dishes were filled with the eight *P. fluorescens* suspensions at the rate of one isolate per five Petri dishes. Similarly five Petri dishes were filled distilled water (as control). Egg masses of *M. incognita* were placed on the micro sieve (75-µm aperture, 20 mm diameter) at the rate of 10 egg mass per sieve. These micro sieves were placed in the Petri dishes to touch the egg masses with *P. fluorescens* isolates or water. The experimental set-up was kept at room temperature and number of emerged juveniles was counted at 24, 48 and 72 h after inoculation. At the end of the experiment, the egg masses were treated with 1% sodium hypochlorite to dissolve the gelatin matrix around the eggs and the un-hatched eggs were counted. Percentage egg hatchability: (mean number of emerged juveniles in each treatment / Total number of juveniles and eggs in treatment) x 100 were calculated.The treatments were replicated 5 times in a Randomized Complete Block Design.

2.3. Effect of *P. fluorescens* on mortality of juvenile *M. incognita*

Forty, sterilized 60 mm diameter watch glasses were filled separately with 3 ml of *P. fluorescens* isolates and similarly five watch glasses were filled with 3 ml distilled water. Newly hatched second-stage juveniles of *M. incognita* were added to the bacteria suspensions at the rate of ten per watch glass. After 24, 48 and 72 h the numbers of dead juveniles were counted under a stereomicroscope. The treatments were replicated 5 times in a Randomized Complete Block Design. Percentage mortality: (Mean number of dead juveniles in the treatment / Total number of juveniles in treatment) x 100 were calculated.

2.4. Efficacy of *P. fluorescens* isolates for the control of *M. incognita* on tomato

A pot experiment was conducted in the plant house using the tomato variety KWR, a variety susceptible to *Meloidogyne* spp., to determine the efficacy of *P. fluorescens* isolates on the root damage using two application techniques.

2.4.1. Soil drenching of *P. fluorescens* isolates to potted tomato plants

Two-week-old tomato plants potted in 15 cm dia. plastic pots at the rate of 1 plant per pot were used for the experiment. About 2 cm of top soil layer was removed near the root system and the soil were drench with 50 ml *P. fluorescens* isolates separately. In addition, two sets of plants were treated with distilled water as an untreated control. The plants were then covered with 2 cm sterilized soil layer. After 24 h each pot was inoculated with 1,000 juveniles except one set of plants treated with distilled water. The experiment was arranged in a Randomize Complete Block design with 5 replicates.

2.4.2. Root dipping of tomato plants with *P. fluorescens* isolates

Roots of another set of tomato plants were dipped separately with *P. fluorescens* isolates for one minute before planting in sterilized potting media. Another set of plants were treated only with the nematodes + distilled water. The experiment was arranged in Randomize Complete Block Design with 5 replicates.

Sixty days after inoculation of nematodes, tomato plants were uprooted and the nematode damage was assessed by the number of egg masses per root system. The intensity of root damage was determined through the diagrammatic root knot scoring chart (John and Sam, 1980). Plant height, shoot fresh weight, shoot dry weight, root fresh weight were also measured.

2.4. Data analysis

Proc Catmod was performed to check for normality and homogeneity, if the results were significant, numerical data were square root-transformed prior to analysis. The data were analyzed using analysis of variance and

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treatment means were compared by Duncan's Multiple Range Test at P<0.05 level. Data were subjected to analysis using Statistical Analysis Software (SAS) package version 8.2.

III. RESULTS

The densities of *P. fluorescens* isolates in the 8 samples ranged from 1.01 x 10^8 to 2.00 × 10^8 specifying that the bacterial colonies falled within a narrow range suitable for pathogenicity estimates (Table 1).

Table.1: Cell count of different P. fluorescens isolates used for the experiments

Notation of the isolate	*P. fluorescens* isolates: location/ crop source	*P. fluorescens* cell count / 1 ml
PK	Pallekele - Kangkung	1.87 × 10^8
NT	Nugethenna - Tomato	1.05 × 10^8
BT I	Bopane - Tomato I	2.00 × 10^8
BTII	Bopane - Tomato II	1.64 × 10^8
UT I	Udhispaththuwa - Tomato I	1.40 × 10^8
UT II	Udhispaththuwa -Tomato II	1.01 × 10^8
UT III	Udhispaththuwa- TomatoIII	1.01 × 10^8
SM	Sooriyawewa - Maize	1.03 × 10^8

3.1. Effect of *P. fluorescens* on egg hatchability of *M. incognita*

P. fluorescens isolates significantly reduced the egg hatchability of *M. incognita* at 24, 48, 72 h after inoculation as estimated by the chi-square < 0.05 level of probability according to Proc Catmod (Table 2). The lowest egg hatchability was observed in PK (Pallekele - Kangkung), NT (Nugethenna – Tomato) and UT 1 (Udhispaththuwa – Tomato) isolates

3.2. Effect of *P. fluorescens* on mortality of juvenile *M. incognita*

The mortality of *M. incognita* juveniles has shown significant effect compared to the controls from 24 to 72 h after treatment at chi-square < 0.05 level. The suppressive activity of *P. fluorescens* increases gradually with the increased exposure time. BT II (Udispattuwa isolate 2 from tomato crop) exhibited the highest mortality of juveniles after 72 h (Table 3).

Table 2. Hatchability percentages of M. incognita egg masses treated with P. fluorescens isolate at different exposure periods

***P. fluoresces* isolates**	**Mean cumulative egg hatchability % after different exposure time**		
	24 HAI*	48 HAI*	72 HAI*
PK	1.07 ^{c}	3.19 ^{cd}	4.55 ^{e}
NT	2.64 ^{bc}	3.40 ^{cd}	5.47 ^{e}
BT I	5.10 ^{ab}	8.75 ^{bc}	12.09 ^{cd}
BT II	2.37 ^{bc}	7.50 ^{bcd}	15.94 ^{bc}
UT I	1.56 ^{bc}	4.51 ^{cd}	4.99 ^{e}
UT II	1.11 ^{c}	5.64 ^{cd}	8.99 ^{d}
UT III	9.70 ^{a}	15.24 ^{ab}	20.87 ^{ab}
SM	2.86 ^{b}	6.95 ^{cd}	16.09 ^{bcd}
DW(Control)	11.13 ^{a}	29.71 ^{a}	32.12 ^{a}

* Mean values within a column followed by the same letter(s) are not significantly different at p<0.05 based on the Duncan's multiple range test.Key to cultures PK = Pallekele/ Kangkung; NT = Nugethenna /Tomato; BT1 and II = Bopane/ Tomato: UT I, II, III= Udhispaththuwa/ Tomato: SM = Sooriyawewa/ Maize: DW = Distilled water

Table 3. Mortality (%) of M. incognita juveniles when exposed different isolates of P. fluorescens for 24, 48 and 72h periods

***P. fluoresces* isolates**	**Juveniles (J2) mortality percentages after different exposure periods**		
	24 h*	**48 h***	**72 h***
PK	53.33 ^{ab}	70.00 ^{a}	83.33 ^{abc}
NT	50.00 ^{ab}	60.00 ^{b}	70.00 ^{abcd}
BT I	30.00 ^{b}	56.67 ^{ab}	63.33 ^{cd}
BT II	36.67 ^{ab}	60.00 ^{ab}	93.33 ^{a}
UT I	46.67 ^{ab}	53.33 ^{ab}	60.00 ^{d}
UT II	40.00 ^{ab}	50.00 ^{a}	86.67 ^{ab}
UT III	56.67 ^{a}	60.00 ^{ab}	66.67 ^{bcd}
SM	46.67 ^{ab}	60.00 ^{ab}	66.67 ^{bcd}
DW	0	3.33 ^{c}	13.33 ^{e}

* Mean values within a column followed by the same letter(s) are not significantly different at p<0.05 based on the Duncan's multiple range test.

Key to cultures PK = Pallekele/ Kangkung; NT = Nugethenna /Tomato; BT1 and II = Bopane/ Tomato: UT I, II, III= Udhispaththuwa/ Tomato: SM = Sooriyawewa/ Maize: DW = Distilled water

3.3. *In vivo* experiments to determine the efficacy *of P. fluorescens* isolates for the control of *M. incognita* on tomato

3.3.1. Efficacy *of P. fluorescens* isolates on root knot development:

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We observed that the tested *P. fluoresces* isolates and application technique significantly influenced on the root knots per root system and the number of egg masses per root; chi-square < 0.05 probability level according to Proc Catmod and significant difference between application methods at P< 0.05 level of probability according to Duncan's multiple range test except the NT and positive control (Fig 1 and 2). *P. fluorescens* isolates from PK (Pallekele/ Kangkung crop); UT II (Udhispaththuwa/ Tomato crop 2) and BT II (Bopane /tomato crop 2) recorded a significantly low number of root knots when the isolated were soil drenched. It was observed that root knot count per root significantly influenced by the application technique; and soil drenching as the most effective application technique for all tested isolates.

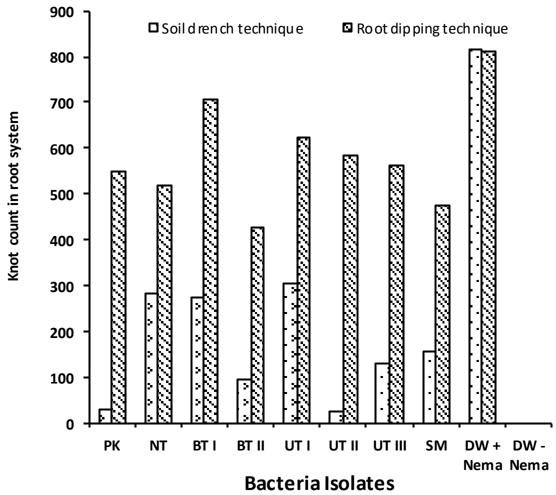

Fig 1:Root knot counts in tomato treated with different P. fluorescens isolates under different application techniques

3.3.2. Effect of *P. fluorescens* on egg laying of *M. incognita*:

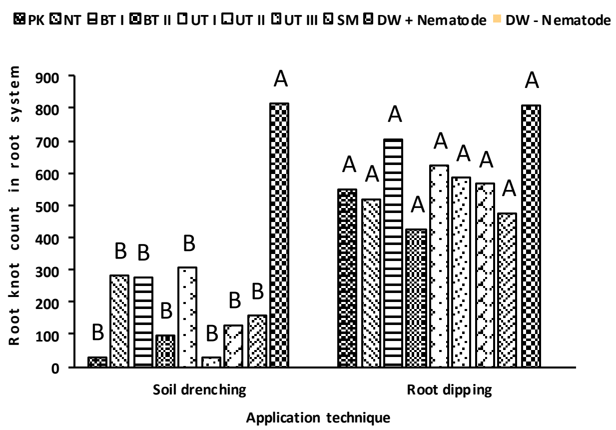

Fig.2: Rootknot counts per tomato root system treated with eight P. fluorescesusing two different application techniques (root drenching and root dipping) (n= 5)

Significant differences among the treatments were observed as shown by chi-square <0.05 probability level and application methods at P< 0.05 level of probability according to Proc Catmod and Duncan's multiple range test. The *P. fluorescens* isolates UT II (Udhispaththuwa Tomato crop 2) and PK (Pallekele Kangkung crop) showed the lowest number of *M. incognita* egg masses of when the treatments were soil drenched.

Soil drenching technique recorded the low number of *M. incognita* egg masses in all *P. fluorescens* isolates when compared to the root dipping technique. PK, NT, BT I, BT II, UT I, UT II, UT III, SM isolates recorded low number of egg masses in soil drench technique than root dipping technique.

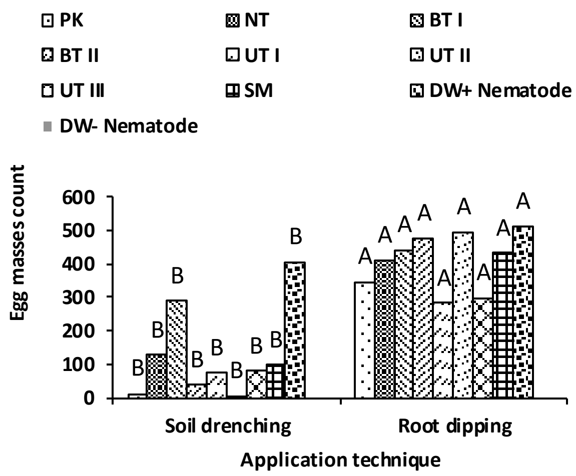

Fig.3: Egg masses count per tomato root system treated with eight bacterial isolates using two different application techniques (root drenching and root dipping) (n= 5)

3.3.3. Effect of *P. fluorescens* on root knot score on tomato:

The mean value of root knot scores in *P. fluorescens* isolates. Moreover, there is significant difference between control and all other isolates in soil drench techniques at chi-square < 0.05 probability level of according to Proc Catmod. There is no significant difference between two application techniques at P< 0.05 level of probability according to Duncan's multiple range test. According to table 5, Bacteria isolates of PK, UT II and shows the significant low root knot score (score =1) compared to control treatment in soil drenching technique. In root dipping technique, NT isolate showed the low mean number of root knot score (score =3.75).

Table 4. Root knot scores of tomato plants treated with different bacterial isolates as soil drenching and root dipping .

***P. fluoresces* isolates**	**Mean value of Root knot score ± SD**	
	Soil drench technique*	**Root dipping technique***
PK	1 ± 0 d	4.25 ± 0.95 abc
NT	3 ± 1.15 bc	3.75 ± 0.5 c
BT I	5 ± 0.95 a	4.75 ± 0.95 abc
BT II	1.25 ± 0.5 d	5 ± 0 ab
UT I	4 ± 1.15 ab	4.75 ± 0.5 abc
UT II	1 ± 0 d	4.75 ± 0.5 abc
UT III	2.25 ± 0.95 c	5.25 ± 0.57 a
SM	2.75 ± 1.5 bc	5 ± 1.15 ab
DW + *Nema*	5.25 ± 0.5 a	5 ± 0.81ab
DW only	0	0

*Mean values with in a column followed by simple letters are not significantly different at p<0.05 based on the Duncan's multiple range test according to treatments,

Key to cultures PK = Pallekele/ Kang Kung; NT = Nugethenna /Tomato; BT1 and II = Bopane/ Tomato: UT I, II, III= Udhispaththuwa/ Tomato: SM = Sooriyawewa/ Maize, DW = Distilled water

3.3.4. Effect of P. fluorescens on fresh root weight of tomato:

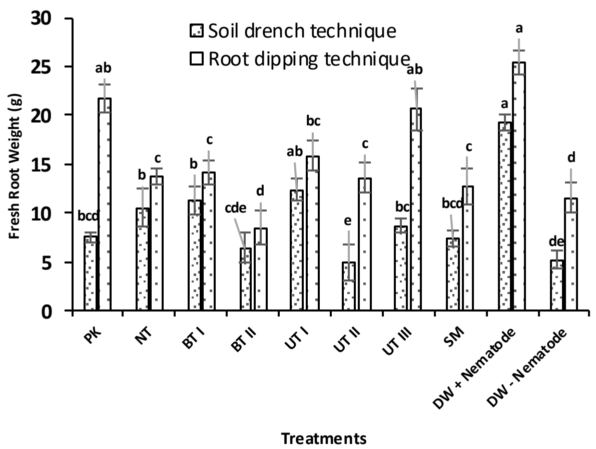

Fig.4: Root fresh weight in different P. fluorescesisolations applied with two different soil application techniques

Fresh root weight was significantly lower in bacterial isolates treated treatments than nematode present treatment at P< 0.05 level of probability. Highest fresh root weight was recorded in nematode present treatment in both soil application techniques. The lowest fresh root weight was recorded in UT II (5 g) bacterial isolate treatment in soil drenching technique and BT II (9 g) bacteria isolate treatment in root dipping technique respectively (Figure 5).Tomato plants treated with the isolates as soil drench technique recorded the lowest root fresh weight than root dipping technique.

3.3.5. Effect of *P. fluorescens* on plant growth parameters:

Tomato plants treated with the different isolates as soil drenching and root dipping, shows variations in shoot length, shoot fresh weight and shoot dry weight. There were no significant difference among treatments in dry shoot weight at P< 0.05 level of probability according to Duncan's multiple range test (Table 5 and 6).

Root knot nematodes are soil pathogen. They directly attack to the root system of plants and main symptoms were occurred in the below ground parts of the plant. Secondary symptoms will have occurred in the above ground plant parts. Alsothe plants were maintained under plant house conditions and because of that, the effect of bacterial treatments on above ground plant parameters were not clearly expressed.

Table 5. Growth parameters of tomato plants when soil drench with P. fluoresces isolates

P. fluoresces* *isolates	**Shoot Length (cm)***	**Shoot Fresh Weight(g)***	**Shoot Dry Weight(g)***
PK	91.45 c	68.48 d	13.23 ab
NT	105.8 ab	93.52 bc	17.01 ab
BT I	109.52 ab	105.70 ab	17.50 ab
BT II	104.52 b	91.08 bc	16.89 ab
UT I	108 ab	110.28 a	18.38 a
UT II	89.65 c	84.20 c	16.57 ab
UT III	113.07 a	95.62 abc	17.03 ab
SM	87.5 c	104.74 ab	16.70 ab
DW + Nematode	88.17 c	91.85 bc	14.77 ab
DW - Nematode	105.62 ab	92.47 bc	15.50 ab

*Mean values within a column followed by the same letter(s) are not significantly different at p<0.05 based on the Duncan's multiple range test.

Key to cultures PK = Pallekele/ Kangkung; NT = Nugethenna /Tomato; BT1 and II = Bopane/ Tomato: UT I, II, III= Udhispaththuwa/ Tomato: SM = Sooriyawewa/ Maize

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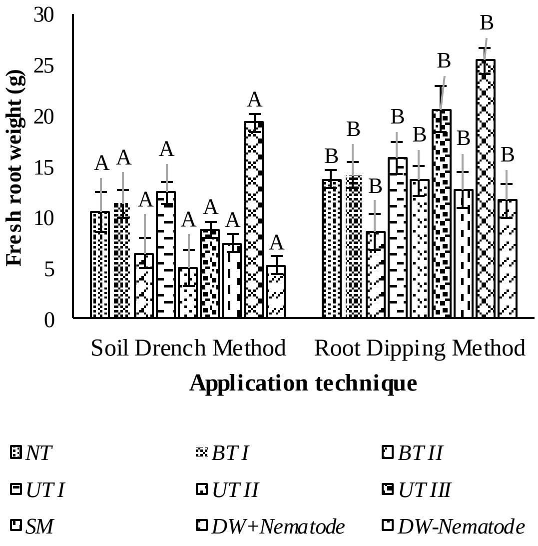

Fig.5: Root fresh weight in two different application techniques of eight P. fluoresces isolates

Table 6. Growth parameters of tomato plants when root dipped with P. fluorescesisolatesbefore planting

P. fluoresces isolates	Shoot Length (cm)*	Shoot Fresh Wt(g)*	Shoot Dry Wt(g)*
PK	95.1 b	114.12 a	19.57ab
NT	100.1b	100.18 bc	16.92 ab
BT1	99.8 b	100.02 bc	17.52 ab
BT2	110.2 a	86.15 de	15.37 b
UT1	96.6 b	90.38 cde	16.19 ab
UT2	96.6 b	85.01 e	16.96 ab
UT3	100.8 b	121.51 a	20.27 b
SM	101.4 b	90.87 cde	16.83 ab
DW + Nematode	84.05 c	95.59 bcd	18.55 ab
DW –Nem	0	0	0

*Means within a column followed by the same letter(s) are not significantly different at p<0.05 based on the Duncan's multiple range test.

Key to cultures PK = Pallekele/ Kangkung; NT = Nugethenna /Tomato; BT1 and II = Bopane/ Tomato: UT I, II, III= Udhispaththuwa/ Tomato: SM = Sooriyawewa/ Maize

IV. DISCUSSION

Some reports says that, *P. fluorescens* has nematicidal activity to root knot nematode, *M. javanica*, juveniles and nematicidal activity against potato cyst nematode, *Globodera rostochiensis* eggs as the same might contribute as mechanism of *M. incognita* mortality and egg hatchability [9].

P. fluorescens can produce large number of toxic secondary metabolites such as; phenazine, indole, compounds, phenyl-pyrroles and pterines [1]. These metabolites might also be toxic to *M. incognita* juveniles [1]. The production of the metabolite 2, 4-diacetylphloroglucinol (2, 4-DAPG) by *P. fluorescens* strain CHA0 induced mortality in juvenile of root-knot nematodes [13].

Some *P. fluorescens* strains are known to contain 1-aminocyclopropane-1carboxylic acid which inhibits ethylene production in roots and henceminimizes colonization of root knot nematodes and root knot development [9]. Also reported that application of *P. fluorescens* bacteria led to reduce the number of egg masses of nematodes [4].

Some articles described DAPG produced form *P. fluorescens* strains, reduced the mobility and survival the second stage juveniles, the infective stages of some plant-parasitic nematodes [10]. The production of this antibiotic in the rhizosphere of plants suppress nematode penetration of roots [12]. In addition, it is known that DAPG affect root morphology and such changes in root architecture that may alter the number of available infection sites and, therefore, lead to a complex response with regards to nematode suppression [10].

The percentage of gall formation and root gall index found to decrease when *P. fluorescens* were introduced prior to *M. incognita* infestationon tomato plants [1]. Similar results were observed that the highest reduction in the numbers of second-stage juveniles in soil, host root galls and egg mass indices when *P. fluorescens* was drenched before planting [5]. However, it was reported that, strains CHA805 and CHA89 had no significant impact on nematode population densities in soil and root-knots in tomato and soybean crops [10].

V. CONCLUSION

The *Pseudomonas fluorescens* isolated from tomato rhizosphere from Nugethenna (NT) and Udhispaththuwa (UT I) effectively minimize egg hatchability of *Meloidogyne incognita*. *P fluorescens* isolated from tomato rhizosphere from Bopane (BT II) and Udhispaththuwa (UT II) effectively controlled juveniles of *M. incognita* in tomato. The tomato plants treated with *P. fluorescens* isolated from Kang Kung from Pallekele (PK) and UT II had lower number of root knots and egg masses. These experiments indicated that the tomato rhizosphere from Udhispaththuwa and Kang-Kung rhizosphere from Pallekele contained effective *P. fluorescens* isolates that can be used for the management of *M. incognita*. The effective application technique determined as soil drenching ten days after transplanting under plant house conditions.

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Farmers' Perception and Adoption of Agroforestry Practices in Faridpur District of Bangladesh

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***Abstract*— *This study mainly focused on exploring perception of farmers' towards agroforestry practices and identifying the demographic factors influencing agroforestry adoption in Faridpur district. Field survey was conducted during November-December, 2016 using semi-structured questionnaire. Multi-stage random sampling was used to select upazillas, unions and villages. Snowball purposive sampling was applied to select 84 respondents in total for the questionnaire survey. Chi-square was used to test variables at 5% level of significance. Homestead agroforestry was found to be the most common agroforestry practice (39.28%), followed by fruit-based agroforestry (21.42%), woodlot plantation (13.09%) and so on. Agroforestry was perceived to increase farm productivity by 82.14% of the respondents, 73.8% opined that agroforestry increase household income, while 30.95% perceived it as a means to food security. On the contrary, 34.52% opined that agroforestry practices decrease cash crops production, 17.85% of the respondents stated agroforestry as a difficult practice. Chi-square test showed no significant association between the adoption of agroforestry practices and respondent's age ($P > 0.05$) or income range ($P > 0.05$) of the respondents. On the other hand, there is a positive significant association between the adoption of agroforestry practices and educational level ($p < 0.05$) as well as the farm size ($p < 0.05$) of the respondents. The study suggests raising awareness regarding the benefits of agroforestry practices as well as providing technical assistance.*

Keywords*— *Adoption, Agroforestry practices, Faridpur district, farmers' perception

I. INTRODUCTION

Agriculture has been the most prominent sector of Bangladesh economy contributing around 17% of GDP and also providing employment to 45% labor force (BBS, 2014). The area of the country is very small having a huge amount of population making it one of the densely populated countries in the world with the annual growth rate of 1.37 % (BBS, 2017). New pressure has been created on limited resources such as agriculture, forest and land resources due to rapid population growth. The forest coverage of Bangladesh is one of the lowest as 11% and at the same time the deforestation rate is the highest as 3.3% per year of any country in the world (Gain, 1995; FAO, 2010; Rahman *et al*., 2010). Finding the best possible way to produce more agricultural crops and forest products deploying these scarce resources is a dire need to meet the demand of increasing population.

Agroforestry systems are preferable to monocropping as they are able to generate income from agricultural crops, tree sales and carbon trading programmes, such as REDD+ schemes. Agroforestry can be the most effective way to reduce deforestation in Bangladesh which could bring 'win-win' solutions to meet both environment and development objectives (Rahman, 2012). Agroforestry can be recognized as potential solution to meet the needs of the society as well as sustainable development models due to its benefits not only to the economy and society but also to the ecosystem (Bargali *et al*., 2009; Thanh, 2005). Farmers can benefit from agroforestry technologies that give solutions to issues with soil productivity, product diversification, and economic problems (Franzel and Scherr, 2002). Haque (1993) mentioned that agroforestry as a means to meet the dimensional needs of the rural people in terms of food, fuel, timber, construction materials, thereby helping them to lead a self-sustained life. It is estimated that about 80-82% of forest products produced anually in the country come from this agroforestry farming system (GOB, 1992).

Agroforestry systems may provide efficient, productive, and/or sustainable land use but doesn't matter unless and until they are adopted and maintained over longer period of time (Scherr, 1992; Sanchez, 1995). Farmers invest in

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agroforestry practice only if the expected gains from this practice are higher than the alternatives for the use of their resources. Households tend to invest in uncertain and unproven technologies when they have more risk capital available in terms of land, labor, capital etc. (Mercer, 2004).
The main objective of this study was to investigate and analyze farmers' perceptions of different agroforestry practices and to determine the socio-economic factors influencing adoption of agroforestry practices in Faridpur district.

II. MATERIALS AND METHODS

2.1 Site description

Faridpur is a district in central Bangladesh. It is a part of the Dhaka Division. Faridpur District has a population of over 1.7 million people and is situated on the banks of the Padma river (Lower Ganges). It is about 2072.72 sq. km, located in between 23°17' and 23°40' north latitudes and in between 89°29' and 90°11' east longitudes. It is bounded by Rajbari and Manikganj districts on the north, Gopalganj district on the south, Dhaka, Munshiganj and Madaripur districts on the east, Narail and Magura districts on the west (Banglapedia, 2016). The rainy season duration is June to October and the winter season duration is November to February. The annual average temperature in this area varies maximum 37.40 ^{0}C to minimum 8.60 ^{0}C. The annual average rainfall is 1310 mm (BBS, 2015).

Fig. 1: Map of the study area

2.2 Sampling design

Faridpur district was purposively choosen as first sampling unit. Multistage random sampling was adopted in the selection of villages. In this study five upazilla out of nine were selected randomly as second sampling unit and then two unions from each of the five upazilla were taken randomly as third sampling unit. Again two villages from each union were selected in random manner as fourth sampling unit. Random sampling (Zhen *et al*., 2006) was used to select villages because the reconnaissance survey identified all villages where agroforestry practices had taken place and those without agroforestry. Finally four to five

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respondents were selected from each village using snowball purposive sampling and total of 84 respondents were contacted for the survey. Both random and purposive sampling can be combined to produce a good method of sampling (Albertin and Nair, 2004) as well as to add credibility to the result of a larger study (Teddlie and Tashakkori, 2009).

2.3 Data collection methods Two main sources were used to collect data, these were primary and secondary. Questionnaire, interviews and field observation methods were applied to collect detailed information on perception and the demographic features of the respondents. Rectified semi-structured questionnaire was used to obtain data on the demographic characteristics of the farmers. Data was gathered on farmers' household characteristics, occupational characteristics, perceptions of agroforestry and demographic factors that may influence farmers' decision of adopting agroforestry practices. The secondary sources of data were collected from journals, books, various publications, government department, extension officers, local leaders, published and unpublished reports, internet browsing etc.

2.4 Data analysis

Field data collected using semi-structured questionnaires was presented in Microsoft Excel, 2010 while information gathered through observation was presented descriptively. The data gathered was analyzed using descriptive statistics that include the use of percentages tables, column chart charts, pie charts etc. Chi- square test (goodness of fit) was followed (Adedayo and Oluronke, 2014) to test the nature of association between adoption of agroforestry practices and respondent's age, level of education, annual income and farm size.

III. RESULTS AND DISCUSSION

3.1 Demographic features of the respondents

The demographic features of the respondents in the study area are shown in Table 1. The age of the respondents is divided into four categories. Major respondents (47%) were young aged, 31% respondents were middle aged, 19% were old and 3% respondents were very young. The Table 1 indicates that a majority of the respondents (49%) studied secondary level followed by 32% to primary level, 13% to above secondary level and 6% to illiterate. The annual income of the farmers falls in four categories. The highest percentage (32%) is represented by farmers who earn from $ 1201-$1800 and appear to be in the middle income category. 16% of the respondents earn upto $1200 and 24% of the respondents earn from $1801-$2400 whereas about 28% of the respondents earn above $2400 per year. The land holding size was categorized in four groups i.e., small (16%), medium (26%), large (34%) and very large (24%). Demographic features of the respondents play an important role in determining their perception and attitude towards the adoption or rejection of new ideas (Ghauri and Qureshi, 1999). Different studies revealed that the socio-economic characteristics had much influence on the adoption behavior regarding new practices.

Table 1: Demographic profile of the respondents

Characteristics	Categories	Percentage of farmers (%)
	Very young (18-25 yrs.)	3
Age	Young (26-35 yrs.)	47
	Middle-aged (36-50 yrs.)	31
	Old (50+ yrs.)	19
	Illiterate	6
Education Level	Primary	32
	Secondary	49
	Above	13
	Low (Upto $1200)	16
Annual income	Medium ($1201-$1800)	32
	High ($1801-$2400)	24
	Very High (Above $2400)	28

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Farm size	Small (upto 0.33 acre)	16
	Medium (0.34- 0.66)	26
	Large (0.67- 0.99)	34
	Very Large (Above 1 acre)	24

3.2 Agroforestry practices in the study area

There are various types of agroforestry practices in Faridpur district. The study area mainly covers the following types of agroforestry practices with some other minor types. From Table 2, 40% of the respondents had homestead agroforestry followed by 12% to cropland agroforestry, 21% to fruit based agroforestry, 10% to boundary plantation, 13% to woodlot plantation and 4% to fish farm agroforestry.

Table.2: Agroforestry Practice by Respondents in the Study Area

Agroforestry Systems	No. of Respondents	Percentage of Respondents
Homestead Agroforestry	33	39.28%
Cropland Agroforestry	10	11.9%
Fruit-based Agroforestry	18	21.42%
Boundary Plantation	8	9.52%
Woodlot Plantation	11	13.09%
Fish farm Agroforestry	4	4.76%

3.3 Farmers' perception of agroforestry practices in the study area

Majority of the respondents in the study area were aware of the positive impact of agroforestry practices. The respondents were aware of the economic and productive benefits of agroforestry practices and had favorable perception towards those practices. Perception of agroforestry practices from Fig. 2 indicated that the productive values (82.14%) were considered most important among majority of the respondents. Because they understood agroforestry as a means to meeting their basic needs in terms of fuel wood, fruits, fodder, timber, vegetables etc. Similarly, a significant proportion (73.80%) of the respondents realized the economic aspects as most important.

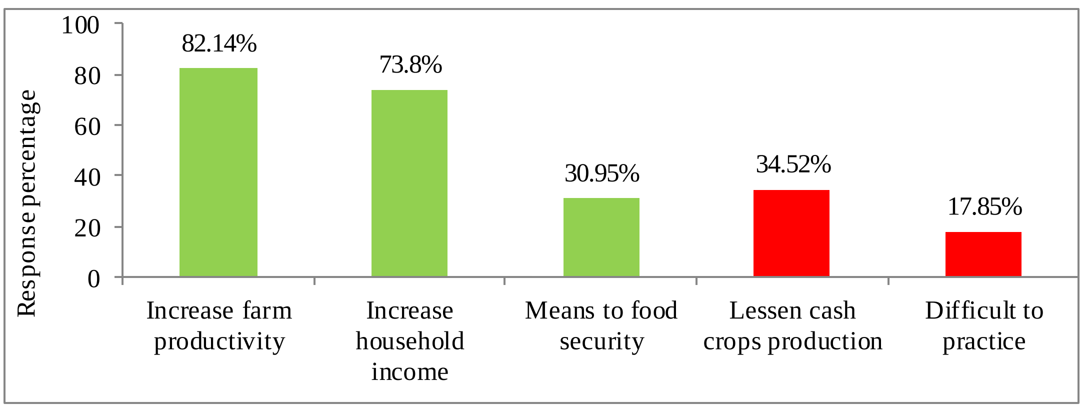

Fig. 2: Farmers' perception of agroforestry practices

This is because agroforestry increased family income, employment opportunities, decreased farm expenditure etc. Farmers' perceived some protective roles of agroforestry such as soil conservation, erosion control, flood control etc. It is noteworthy that, respondents opined that agroforestry is difficult (17.85%) to practice this is an indication of lack of knowledge. Besides, some of the surveyed farmers (34.52%) opined that crop yields are reduced when trees are grown in the fields.

3.4 Trees and agricultural crops in the study area

Various tree species as well as agricultural crops were found in the farmlands of the respondents. The Table 3 shows the crops in the agroforestry farmlands. Mahagoni, raintree, sissoo, neem, mango, jackfruit, rose apple, coconut, palm-tree etc. were found in the study area. On the other hand, papaya, turmeric, banana, eggplant, peas, jute, mustard, lentil etc. cash crops were grown in their fields.

Table 3: Crops found in the agroforestry farmlands

Practices	Tree species found	Agricultural crops found
Homestead Agroforestry	*Mangifera indica, Artocarpus heterophyllus, Syzygium cumini, Cocos nucifera, Azadirachta indica, Swietenia macrophylla, Manilkara zapota, Areca catechu, Citrus maxima*	*Basella alba, Lagenaria siceraria, Typhonicum trilobatum, Cucurbita moschata, Benincasa hispida, Vigna sesquipedalis, Carica papaya*
Cropland Agroforestry	*Phoenix sylvestris, Borassus flabellifer, acacia auriculiformis, Mangifera indica, Swietenia macrophylla, Citrus limon*	*Corchorus capsularies, Momordica charantia, Amaranthus lividus, Solanum melongena, Pisum sativum*
Fruit-based Agroforestry	*Mangifera indica, Manilkara zapota,, Citrus limon, Psidium guajava, Litchi chinensis*	*Zingiber officinale, Curcuma longa, Brassica nigra, Lens culinaris, Vigna unguiculata*
Boundary plantation	*Phoenix sylvestris, Borassus flabellifer, Cocos nucifera, Swietenia macrophylla, Samanea saman*	*Carica papaya, Musa sapientum, Moringa oleifera, Basella alba*
Woodlot	*Swietenia macrophylla, Samanea saman, Dalbergia sissoo, Albizia lebbeck*	×
Fish farm agroforestry	*Mangifera indica, Litchi chinensis, Psidium guajava, Azadirachta indica*	*Lablab niger, Basella alba, Vigna sesquipedalis etc.*

In spite of having some constraints agroforestry were perceived as advantageous practices. Table 4 shows several beneficial and harmful features of various agroforestry practices in the study area.

Table.4: Beneficial and harmful characteristics perceived by respondents

Agroforestry Practices	Beneficial features	Harmful features
Homestead Agroforestry	Household consumption (81%) Easy to manage as near to houses (43%) Protection from natural calamities (28%) Multiple products (67%)	Large trees may fall above house during storm (37%)
Cropland Agroforestry	Avoid single crop failure (60%) Profitable in the long run (40%) Provide cash in a continuous basis (30%)	Crops may not grow well after several years. (50%) Some plants may affect tree growth (e.g. banana) (30%)
Fruit-based Agroforestry	Very productive system (72.13%) Higher economic return per year (77.7%) Some fruit trees tolerate drought (22%) Some crops can be grown after tree canopy closure (28%)	Fruit trees will not live long (e.g. 10-12 years) (22%) Pest attack (16%) Higher initial investment (34%)
Boundary Plantation	Fencing (62.5%) Soil stabilization (62.5%)	May hamper adjacent crops (37.5%)

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Woodlot	Regular management is not required (54%)	Farmers' have to wait for a long time (72%)
	Less labor required (37%)	Higher initial input required (63%)
	Big amount of cash at a time (72%)	
Fish farm Agroforestry	Productive integrated system (25%)	Leaf fall into the water (50%)
	Diversified products (50%)	Shade problem (25%)
	Soil conservation (50%)	

3.5 Farmers' adoption of agroforestry practices in the study area

Agroforestry can provide the next step in sustainable agriculture by promoting and implementing integrated, bio-diverse processes (Wilson and Lovell, 2016). However, the success of agroforestry practices is determined by the level of adoption of agroforestry by the farmers. This study revealed that, fruit-based agroforestry has been adopted by 77.78% of the respective respondents followed by homestead agroforestry (69.7%), boundary plantation (62.5%) and so on. Adoption percentage was measured according to the respective practice. Here, average adoption percentage of agroforestry practice was 64.28%.

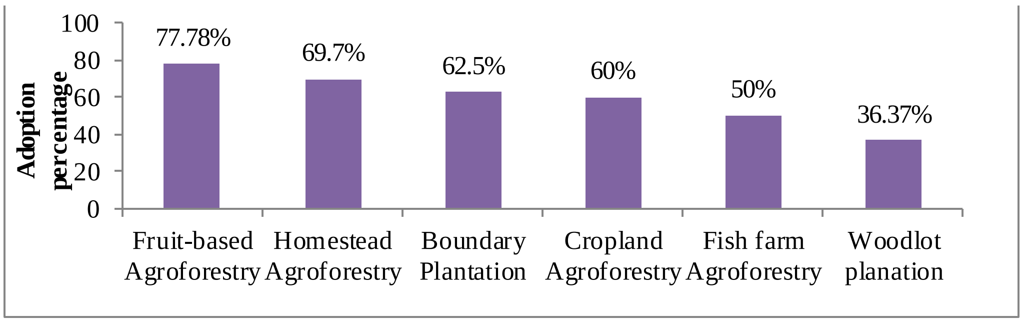

Fig. 3: Farmers' Adoption of agroforestry practices in the study area

Findings showed that, on an average significant proportion of farmers (64.28%) have adopted Agroforestry practice while 35.72% did not adopt the practice. The main reason for high level of adoption was may be because of multiple benefits gained by the farmers from the crop-tree combination and also because agroforestry has been an age-old practice among the local farmers not only in the study area but also in number of districts in the country.

3.6 Demographic features and adoption of agroforestry practices

Table 5 shows the association between demographic features and adoption of agroforestry practices in the study area. Chi-square test shows no significant ((P>0.05)) association between respondents' age and the adoption of agroforestry practices. This result is in line with Mwase *et al*., (2015), who found that age does not affect the adoption of agroforestry.

Table 5: Chi-square statistic for demographic features and adoption of agroforestry practices

Factors	Categories	Adoption Frequency	P-value
Age (years)	Very young (18-25 yrs.)	7	
	Young (26-35 yrs.)	20	
	Middle-aged (36-50 yrs.)	16	
	Old (50+ yrs.)	11	0.066
Education Level	Illiterate	3	
	Primary	18	
	Secondary	26	
	Above	7	0.00002

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Annual income (taka)	Low (Upto $1200)	8	
	Medium ($1201-$1800)	19	
	High ($1801-$2400)	13	
	Very High (Above $2400)	14	0.211
Farm size (acre)	Small (upto 0.33 acre)	11	
	Medium (0.34- 0.66)	25	
	Large (0.67- 0.99)	12	0.002
	Very Large (Above 1 acre)	6	

Chi-square statistic from the Table 5 showed a positive significant ($p<0.05$) association between the education level of the respondent and their awareness about the agroforestry practices.

Findings clearly indicated that educated farmers had more awareness and they are very keen to adopt agroforestry practices as compared to illiterate farmers. When farmers are educated they have better access to information and innovations which help farmers to quickly adopt new technology. However, this finding supports Mekoya *et al*., (2008) who found that agroforestry technologies are knowledge intensive and therefore require enough education in the adoption process. Farmers' income range is classified into four categories. They have various income ranges to lead their life. However, from Table 5 chi-square test indicated that respondents income range and adoption level is not significant ($P>0.05$) and therefore does not seem to affect the adoption of agroforestry in the study area.

Again, Chi- square statistic from Table 5 also indicated that there is significant association ($p<0.05$) between respondents farm size and the adoption of agroforestry practices in the study area. Thus, findings revealed that large landholders had more interest as compared to small landholders. Similar findings were given by Amsalu and Graaff (2007) that, in Ethiopia farmers with large farm sizes are more likely to invest in soil conservation measures as the farmers can take more risks, including relatively high investment, and survive crop failure. 40% of the respondents mentioned lower production rate of agricultural crops as a significant reason for planting trees on the croplands. Farmers' integrate trees and agro crops on the same piece of land to avoid uncertainty of agricultural crops production rate. Respondents stated that flood water comes and destroys the agricultural crops in the rainy season in some areas. Therefore, they don't want to waste their valuable resources and were reluctant to cultivate agricultural crops solely.

A large number of labors have been shifted outside the country in search of works thus giving rise to the labor shortage to cultivate agricultural crops. This labor shortage may be a reason for stopping agricultural crops cultivation alone and practicing Agroforestry thereby adopting it. Market facilities for agroforestry products were satisfactory to 88% of the farmers. Farmers stated clearly that they can sell their products without any significant difficulties which improve their living conditions and reduce poverty.

IV. CONCLUSIONS

Significant proportion of respondents (82.14% on the average) perceived agroforestry as a practice that can improve their farm productivity and overall income in comparison to monoculture. Besides, 73.8% of the respondents found agroforestry as household income raising practice while 30.95% mentioned agroforestry as a means of food security. In spite of this, 34.52% perceived it as methods that lessen cash crops production while some of them (17.85%) perceived it as a scientific method that is difficult to practice. Therefore, all the farmers in the study area did not adopted agroforestry practice. Finally, it can be concluded that the successful adoption of agroforestry to raise farm productivity and overall income of the respondents in the study area depends on raising awareness on benefits of agroforestry, providing adequate technical supports as well as ensuring the efficient use available farmlands of all types of landholders.

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Drought Tolerance in Some of Red Rice Line Based on Morphology at Vegetative Stage

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Abstract*— *Tests are carried out to obtain red rice lines that are tolerant to drought based on morphological characters in the vegetative phase (49 HSS). The lines used were genetic material from red rice lines which were the result of a cross between local red rice cultivars namely karajut and silopuk cultivars with Fatmawati varieties consisting of 10 lines namely KF42-2-3, KF42-4-2, KF42-7-3, KF42-9-3, KF42-10-2, KF42-13-2, SF122-3-16, SF122-3-30, SF5-25-8 and SF-25-25. This experiment was carried out from January to May 2018 in the greenhouse of the Faculty of Agriculture, Andalas University. This experiment used a Randomized Block Design (RBD) consisting of 3 groups and 10 hope lines that were given drought treatment. The level of damage based on winding, and leaf dryness of the vegetative phase of all lines included in the tolerant category except SF122-3-30 with a somewhat tolerant category. Based on the intensity of leaf rolling consisting of 2 groups, the tolerant group consisted of 2 lines and rather tolerant groups consisting of 8 lines. Based on the leaf drought intensity consisting of 2 groups, the tolerant group consisted of 7 lines and rather tolerant groups consisting of 3 lines.

Keywords*— *drought, tolerant, drying, red rice

I. INTRODUCTION

Rice (Oryza sativa L.) is the main food source of the Indonesian population, therefore an increase in rice production needs to be carried out in line with the increase in population. But a number of problems emerged, including the conversion of agricultural land to non-agriculture (especially paddy fields), pest and disease attacks. As well as the occurrence of global climate change that has a direct impact on the agricultural sector, for example an increase in temperature and carbon dioxide content, changes in rainfall and others (Prinz, 2004). These problems resulted in reduced fertile land for lowland rice cultivation so that rice production was low. Dry land development is one of the potential in increasing rice production in sub-optimal land. According to Kartawisastra et al., (2012) around 7,083,812 Ha of dry land is potentially untapped, therefore extensification to dry land is a potential option as an effort to meet the need for rice to develop the idea, the right rice cultivar applied to the land is rice drought resistance. Therefore, it is necessary to develop drought-tolerant rice cultivars to anticipate climate change so that it can be utilized maximally on dry land. Drought-tolerant rice can be obtained through a variety of breeding methods, one of them with ordinary crosses (artificial hybridization). Assembling rice in order to assemble and produce high yielding varieties, early maturing and high nutritional quality, through crossing or hybridization has been carried out by crossing Karajut cultivars which are local red rice in West Sumatra having high nutritional value with New Type of Superior Variety (VUTB) Fatmawati who is early maturing and has high production (Swasti and Putri, 2010). The process of forming VUTB is a series of continuous activities, ranging from the selection of germplasm, crossing, selection, yield testing, seeding, to the release of varieties (Tjokrowidjoyo et al., 2006).

The crossing from the parent produces several hope lines that need to be selected to get the candidate varieties that are tolerant to drought stress that are carried out in the fegetative and generative phases. According to Vankateswarlu and Visperas (1987) drought in the vegetative phase affects leaf growth and root growth, while according to Vergara (1995), generative phase drought will reduce yield and rice yield components. There are three stages in the generative phase which are very susceptible to drought, namely the panicle formation stage, pollination / fertilization and seed filling. If the plant experiences drought stress in one of the three stages it can be ascertained that there will be a decrease in grain yield. his study aims to determine the level of resistance of the 10 red rice hope lines in the vegetative and generative phases based on rolling, shoot dryness and leaf recovery.

II. MATERIALS AND METHODS

This research was carried out in a greenhouse of the Faculty of Agriculture, Andalas University, West Sumatra starting in October January - May 2018. The materials used were 10 lines of hope for red rice, Urea fertilizer (200 g / Ha), SP-36 (75 Kg / Ha), and KCL (75 Kg / Ha). The tools that will be used are buckets, hoes, knives, sickles, scissors, meters, seed beds, analytic scales, plastic blades and glasses. This experiment used a randomized block design (RBD) consisting of 3 groups and 10 hope lines which were given drought treatment so that 30 pots of plants were planted, each of which was planted with a clump / pot. Criteria for drought resistance are leaf rolling rate, leaf dryness level, and healing power with scale according to IRRI's Standard Evaluation System (SES).
Scoring sensitivity stress index for scores is calculated by the Fernandez method (Hanum et al, 2010) formula:
Drought-resistance criteria i.e. level scrolling leaves, leaves, dryness and power recuperation (Recovery) and the scale of the standard Evaluation System (SES) of IRRI.

$$P = \sum \frac{(n\ x\ V)}{Z\ X\ N}\ x\ 100\%$$

Description: P: The intensity of leaf damage; n: Number of leaves for each symptom category; V: crop scores for each symptom category; N: the number of leaves observed; Z: highest cropping score

III. RESULT AND DISCUSSION

3.1 Damage level based on leaf rolling

The results showed that in the vegetative phase the lines were divided into two groups with 9 lines included in the tolerant category and 1 line including the somewhat tolerant category. The results showed that there were variations in the level of damage in these lines. This is a different genetic response in each line causing differences in scores due to leaf rolling. However, all lines included in the tolerant category except SF122-3-30 which are categorized as somewhat tolerant. The highest damage value was obtained by the SF122-3-30 line which is a score of 3.7 with a rather tolerant category, while the lowest damage value was found in the lines of KF42-7-3, KF42-10-2 and SF122-3-16 which were 1.7 with tolerant category.
Physiologically different levels of damage in the results of this study are thought to be related to the response of each fan cell to each line tested. According to Zou et al. (2011) the curled leaves occur due to the shrinking of the bulliform cell or fan cell. Fan cells are a series of cells larger than other epidermal cells, thin walls, large vacuoles and water. The function of the fan cell itself is to protect the underlying tissue so that it does not experience damage due to greater water loss and opening and closing the leaves in the process of rolling the leaves (Zou et al. 2011). The difference in the level of damage caused by leaf rolling is thought to be related to the water content in the leaves. This is in line with the opinion of Tubur (2011) stating that there is a relationship between leaf rolling and leaf water content. The influence of diffusion conductance and leaf rolling is part of the mechanism of drought avoidance in several genotypes. This is related to the ability of plants to extract water from the soil, which is closely related to the root system. The ability to extract water from the soil also determines the status of water in the leaves, where lines that can maintain the potential of leaf water remain high can increase leaf conductance and reduce the level of leaf rolling. The variation between leaf rolling and leaf water potential of each line and possibly due to the influence of osmotic adjustment, lines with high osmotic adjustment tend to increase cell turgor potential in low leaf water potential conditions. Cattivelli *et al.*, (2008) states that this also occurs in other cereal crops.

3.2 **Damage level based on leaf dryness**

The results showed that the 10th vegetative phase of the line included tolerant group. The value of leaf damage in the vegetative phase ranged from 1.0-2.3 in the tolerant category. The highest damage value was found in SF122-3-30 and SF5-25-8 lines with a score of 2.3 and the lowest value was obtained in the KF42-2-3, KF42-4-2, KF42-7-3, KF42-9- 3, and KF42-10-2 with a score of 1.7. This shows that the lines tested can survive well with drought stress in the vegetative phase. Thus it can be said that all lines are tolerant to drought based on the level of leaf damage.
Based on observations in this study the lines given drought treatment showed that the leaf dryness level had a lower value than the leaf winding score. This is because the leaf rolling rate is more severe than the level of leaf dryness. The leaves first roll in response to the initial dryness, then experience dryness after losing the moisture content of the leaves. therefore it can be said that the level of leaf rolling is directly proportional to the level of leaf dryness. The same cause is thought to be because the water content in the line is lower than other lines so that it is easier to roll and dry the leaves experience severe damage shown by a high score.
Differences in the level of leaf dryness also occurred in the red rice lines tested. Differences in tolerance between lines to drought stress such as indications are expressions of the nature or genetic potential of these lines. According to Sopandie (2014) that each variety can give a different response to the same environmental factors. To express its full and full genetic potential, plants need optimum

environmental conditions. Then it was also stated that optimum environmental conditions could differ between types of plants depending on the diversity of their genetic makeup. Plant tolerance to certain stresses can be influenced by the nature of a variety, both morphology and physiology. Leaf rolling is the initial response of rice plants to drought stress followed by leaf desscation. According to Tubur (2011) factors that trigger drought that refers to abortion are stomatal closure, leaf rolling, decreased leaf area and light interception.

3.3 Recovery

During healing for 10 days some lines were seen in normal conditions for less than 10 days. Based on the assessment until the 10th day, the lines KF42-2-3, KF42-4-2, KF42-7-3, KF42-10-2 and KF42-13-2 require 9 days to return to normal conditions, while other lines returned to normal on the 10th day of testing. This means that, all lines can return to normal leaf conditions on the 10th day. However, recovery observation cannot be used as an indicator in determining the tolerance level of the line tested. This is because within 10 days the plant has returned to normal before the 10th day, so that the damage level can be observed for more than 10 days.

Based on observations of the level of recovery, showed that the lines tested had a constant response which was very tolerant to drought stress which was able to return to normal conditions within 10 days. This indicates that these lines have the ability to maintain growth in dense conditions (drought). Arrandeau (1989) states that the drought recovery mechanism is related to the ability of plants to restore growth after a certain period of drought. Arrandeau (1989) states that the drought recovery mechanism is related to the ability of plants to restore growth after a certain period of drought. Fukai and Cooper (1995) added that this mechanism is important when drought occurs at the beginning of plant growth and development, this shows in several genotypes that are able to produce more tillers and produce grain after a period of drought. The ability of plants to improve the metabolic system due to dryness is related to its ability to keep the leaves green during periods of drought. Maintaining the leaves remain green when drought stress occurs during panicle initiation is very important because leaves that remain green provide assimilation for the development of panicles so that the production of spikelet will increase (Tubur, 2011).

3.4 Damage intensity

The level of intensity of damage due to leaf rolling during the vegetative and generative phases can be seen in Table 7. The intensity of damage can be divided into 2 groups, the tolerant group consists of 2 lines and rather tolerant groups consisting of 8 lines. The highest winding intensity is found in SF122-3-30 line which is 41.11% with somewhat tolerant criteria, while the lowest winding intensity is found in KF42-7-3 and KF42-10-2 lines which are 18.89% with tolerant criteria. The intensity level of damage due to leaf drought is carried out during the vegetative phase can be seen in Table 8. The intensity of leaf drought damage in the vegetative phase can be grouped into 2 groups, namely the tolerant group consisting of 8 lines and rather tolerant groups consisting of 2 lines. The highest intensity is found in SF122-3-30 and SF5-25-8 lines which are 25.56% with somewhat tolerant criteria, while the lowest damage intensity is found in lines with 11.11% intensity. The value of drought damage intensity shows that some lines have different values this is due to differences in the response of each line tested so that there is a difference in damage intensity and criteria for drought stress. Line criteria based on the drought damage intensity of the vegetative phase ranged from 11.11-25.56% with tolerant to somewhat tolerant criteria. The value of the intensity of leaf damage due to leaf rolling and dryness shows that each line tested has a different value. The difference in the value of leaf damage intensity is suspected because differences in plant genetic responses to different water losses will cause different leaf damage intensity. This is also allegedly due to the water content in the line so that it is easier to experience winding which causes the leaves to experience heavy damage, which is indicated by high damage intensity 2 lines including rather tolerant groups. The highest intensity is found in SF122-3-30 and SF5-25-8 lines which are 25.56% with somewhat tolerant criteria (AT), while the lowest damage intensity is found in lines with 11.11% intensity. While the intensity of damage is due to the dryness of the leaves in the generatife phase can be grouped into 2 groups with 8 lines including the tolerant category (T) and 3 lines including the somewhat tolerant category (AT). The highest intensity level was found in SF122-3-30 and SF5-25-8 lines, namely 41.11%, the lowest damage intensity was found in SF5-25-25 lines which were 8.89%. The value of drought damage intensity shows that some lines have different values, this is due to differences in the response of each line tested so that there is a difference in damage intensity and criteria for drought stress. Line criteria based on drought damage intensity vegetative phase ranged from 11.11 to 25.56% with the criteria of resistance (T) to somewhat tolerant (AT), whereas in the generative phase ranged from 8.89 to 41.11% with the criteria of resistance (T) to somewhat tolerant (AT).

The value of the intensity of leaf damage due to leaf rolling and dryness shows that each line tested has a different value. The difference in the value of the intensity of leaf damage is suspected because differences in the plant's genetic response to different water losses

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will cause different leaf damage intensity. In addition, the SF122-3-16 line has a higher intensity value in the generative phase than the generative phase, this is presumably because the genetic response of the line is more sensitive to drought in the generative phase than the vegetative phase. This is also allegedly due to the water content in the line so that it is easier to experience winding which causes the leaves to experience heavy damage shown by high damage intensity.

Table 1: The scale level scrolling leaves, leaves, dryness and the power of healing according to the standard Evaluation System (IRRI, 2013) in the following table:

Scale	Leaf Rolling	Leaf Drying	*Recovery*	Kategori
0	Leaves healthy	No symptoms		Very Tolerant
1	Leaves start to fold (shallow)	Slight tip drying	90-100 %	Tolerant
3	Leaves folding (deep V-shape)	tip drying extended up to ¼	70-89%	Rather Tolerant
5	Leaves fully cupped (U-shape)	One-fourth to ½ of all leaves dried	40-69%	Moderate
7	Leaf margins touching (O-shape)	More than 2/3 of all leaves fully dried	20-39%	Rather Susceptable
9	Leaves tightly rolled (V-shape)	All plants apparently dead. Length in most leaves fully dried	0-19%	Susceptable

Table 2: The extent of the damage leaves strain-strain red rice hopes based on scrolling leaves of vegetative and generative phase

No	Lines	Leaf Rolling		Leaf Drying	
		Value	Tolerant level	Value	Tolerant level
1	KF42-2-3	2,3	Tolerant	1,0	Tolerant
2	KF42-4-2	2,3	Tolerant	1,0	Tolerant
3	KF42-7-3	1,7	Tolerant	1,0	Tolerant
4	KF42-9-3	2,3	Tolerant	1,0	Tolerant
5	KF42-10-2	1,7	Tolerant	1,7	Tolerant
6	KF42-13-2	2,3	Tolerant	1,0	Tolerant
7	SF122-3-16	1,7	Tolerant	3,0	Tolerant
8	SF122-3-30	3,7	Rather Tolerant	3,7	Rather Tolerant
9	SF5-25-8	2,3	Tolerant	3,7	Rather Susceptable
10	SF5-25-25	3,0	Tolerant	1,7	Tolerant

Table 3: The old days reached a level of healing until the return to normal conditions line-line of red rice in expectation of vegetative

No	Lines	Vegetative Stage	
		Day	Tolerant level
1	KF42-2-3	9	Very Tolerant
2	KF42-4-2	9	Very Tolerant
3	KF42-7-3	9	Very Tolerant
4	KF42-9-3	10	Very Tolerant
5	KF42-10-2	9	Very Tolerant
6	KF42-13-2	9	Very Tolerant
7	SF122-3-16	10	Very Tolerant

8	SF122-3-30	10	Very Tolerant
9	SF5-25-8	10	Very Tolerant
10	SF5-25-25	10	Very Tolerant

Table 4: recapitulation of the level of Robustness based on leaf rolling and leaf Drying of vegetative leaves

No	Lines	Leaf Rolling		Leaf Drying		Tolerant Level
1	KF42-2-3	2,3	T	1,0	T	Tolerant
2	KF42-4-2	2,3	T	1,0	T	Tolerant
3	KF42-7-3	1,7	T	1,0	T	Tolerant
4	KF42-9-3	2,3	T	1,0	T	Tolerant
5	KF42-10-2	1,7	T	1,0	T	Tolerant
6	KF42-13-2	2,3	T	1,7	T	Tolerant
7	SF122-3-16	1,7	T	1,0	T	Tolerant
8	SF122-3-30	3,7	RT	2,3	T	Rather Tolerant
9	SF5-25-8	2,3	T	2,3	T	Tolerant
10	SF5-25-25	3,0	T	1,7	T	Tolerant

Note : VT :very tolerant; T :tolerant; RT : rather tolerant

Table 5. The intensity of the leaf rolling and leaf drying on vegetative stage

No	Galur	Leaf Rolling		Leaf Drying	
		Damage intensity %	Tolerant Level	Damage intensity %	Tolerant Level
1	KF42-2-3	25,56	Rather Tolerant	11,11	Tolerant
2	KF42-4-2	25,56	Rather Tolerant	11,11	Tolerant
3	KF42-7-3	18,89	Tolerant	11,11	Tolerant
4	KF42-9-3	25,56	Rather Tolerant	11,11	Tolerant
5	KF42-10-2	18,89	Tolerant	11,11	Tolerant
6	KF42-13-2	25,56	Rather Tolerant	14,61	Tolerant
7	SF122-3-16	29,94	Rather Tolerant	11,11	Tolerant
8	SF122-3-30	41,11	Rather Tolerant	25,56	Rather Tolerant
9	SF5-25-8	25,56	Rather Tolerant	25,56	Rather Tolerant
10	SF5-25-25	33,33	Rather Tolerant	21,24	Tolerant

IV. CONCLUSION

The level of damage based on winding, and leaf dryness of the vegetative phase of all lines included in the tolerant category except SF122-3-30 with a somewhat tolerant category. Based on the intensity of leaf rolling consisting of 2 groups, the tolerant group consisted of 2 lines and rather tolerant groups consisting of 8 lines. Based on the leaf drought intensity consisting of 2 groups, the tolerant group consisted of 7 lines and rather tolerant groups consisting of 3 lines.

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Effect of Endophytic and Plant Growth Promoting Rhizobacteria against Foot Rot Disease of *Piper nigrum* L.

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***Abstract*— *Crop loss in black pepper (Piper nigrum L.) due to pathogenic diseases is mainly induced by soil borne fungi, bacteria, nematodes and viruses. Foot rot disease caused by Phytophthora capsici Leonian is a major production constraint in South India and other south East Asian countries. Combination of biocontrol agents that are compatible with each other is one of the emerging strategies to control plant disease and pest. The present study was designed to evaluate the protective effects of compatible endophytic fungal (Trichoderma harzianum Th16 and Th5) and rhizobacterial (Pseudomonas fluorescens Pf1) strains against pepper foot rot disease. Our results showed that T. harzianum (Th16 and Th5) and P. fluorescens (Pf1) were compatible and effectively inhibited the growth of P. capsici. The application of endophytic and rhizobacterial strains, alone and in combination in green house and field conditions were found to be effective in controlling the foot rot of pepper caused by P. capsici by inducing systemic resistance (ISR) as evidenced by enhanced activities of PO, PPO, PAL, β-1,3-glucanase, chitinase and total phenolics involved in the synthesis of phytoalexins thereby promoting the growth of plants. However, combinations of Th16 + Th5 + Pf1 were more effective than individual treatments. The findings suggest that synergistic interactions of biocontrol agents may be responsible for the management of foot rot of pepper caused by P. capsici.*

Keywords*— *Azadiracta indica, Endophytes, Foot rot of pepper, Phytophthora capsici Leonian, PGPR and PGPE bio-formulations.

I. INTRODUCTION

Black pepper (*Piper nigrum* L.) is a commercial spice crop cultivated in India. India ranks first in the world in terms of production, consumption and exports and the crop is is grown in an area of 131230 ha with an annual production of 55500 tonnes (Indian Spice Board, India, Feb 2017). Foot rot disease of black pepper caused by *Phytophthora capsici* is known to affect 90% of yield in India (Nair and Gupta, 2003; Krishnamoorthy and Parthasarathy 2011). The control of foot rot disease has been almost exclusively based on the application of chemical pesticides that effectively kill the *P. capsici*. Although several effective pesticides have been recommended for use against this pathogen, they are not considered to be long-term solutions due to concerns of expense, exposure risks, fungicide residues, toxicity to non-target organisms and other health and environmental hazards. Therefore, recent efforts have been focused on developing eco-friendly safe, long lasting and effective management strategies against plant pathogens.

Use of biocontrol agents has been shown to be eco-friendly and effective against many plant pathogens and pest. Several biocontrol agents have been documented to prevent foot rot disease by inducing systemic resistance of pepper plants against *P. capsici*. Induced systemic resistance (ISR) activates multiple defense mechanisms that include increased activity of pathogenesis related (PR) proteins like Chitinase, β-1,3-glucanase and peroxidase (PO) (Maurhofer *et al*., 1994; Xue *et al*., 1998), and also the accumulation of low molecular weight substances called phytoalexins (Van Peer and Schippers, 1992). Chitinases and β-1,3-glucanases are a structurally and functionally diverse group of hydrolytic enzymes involved in defense reactions of plants against pathogens (Jackson and Taylor, 1996), while PO and PAL are the key enzymes involved in phenylpropanoid metabolism (Vidhyasekaran *et al*., 1997).

Accumulating evidence suggest that the organisms under most scrutiny for potential use in biological control of pest and diseases are bacteria belonging to the genera *Pseudomonas* and *Bacillus* (Ramamoorthy *et al*., 2001). Further, plant growth promoting endophytic bacteria (PGPE), especially *Bacillus subtilis* (EPCO16 and EPC5) and plant growth promoting rhizobacteria (PGPR), especially *Pseudomonas fluorescens* (Pf1) strains have been developed commercially as a talc based formulation and tested against several crop diseases (Vivekananthan *et al*., 2004; Rajendran *et al*., 2007; Kavino *et al*., 2007 and Harish *et al*., 2008). Sundaramoorthy *et al*., 2011 reported that combination of *P. fluorescens* strains and *B. subtilis* strain together resulted in significant growth promotion that was correlated with induced resistance in *Capsicum annum* L. Several approaches have been made to manage the foot rot of pepper. However, no attempts have been made for the management of *P. capsici* disease using the mixtures of both PGPR and endophytes. Therefore, the present study was designed to evaluate protective effect of endophytic fungal strains, *T. harzianum* (Th16 and Th5) and rhizobacterial strain *P. fluorescens* (Pf1) against foot rot disease.

II. MATERIAL AND METHODS

2.1. Plant materials and pathogen

The black pepper samples were obtained from Pepper Research Center, Appangala, Mercara, Karnataka. The pathogen was isolated from the black pepper foot showing typical symptoms of *P. capsici* by using Oat meal agar (OMA) medium and the fungal culture was identified based on morphological, conidial and culture characterization using standard fungal manual was send to Department of Studies in Biotechnology, University of Mysore, Mysuru– India for identification purpose and it was identified as *P. capsici*.

2.2. Biocontrol agents

The two endophytic fungal strains of *T. harzianum* namely Th16 and Th15 were isolated from bark of *Azadiracta indica*. In addition, antagonistic strains of *P. fluorescens* Pf1 were collected from Department of Studies in Biotechnology, University of Mysore, Mysuru. Pure strains of endophytic *T. harzianum* strains (Th16 and Th15) were maintained on potato dextrose agar (PDA) slants and *P. fluorescens* strain (Pf1) was maintained on King's B (KB) agar slants at 4 °C.

2.3. Efficacy of individual and mixtures of biocontrol agents on radial growth of *P. capscici*

Pseudomonas fluorescens strain (Pf1) and *T. harzianum* (Th16 and ThC5) strains were tested individually and in combination against *P. capsici* by dual culture technique (Dennis and Webster, 1971). The mycelial disc (9 mm) from 7 days old culture of *P. capsici* was placed in one side of the Petri plate containing 15 ml of PDA medium. After three days of pathogen inoculation, 72 h of old bacterial strains *P. fluorescens* and *T. harzianum* strains were streaked on the opposite of the petri plate by the help of sterilized inoculation needle individually on each plate. Three replications were maintained for each treatment. The plates were incubated at room temperature (28 ± 2 °C) for three days and inhibition zone was measured. The radial growth of the pathogen and per cent reduction over control was calculated by using the following formula

$$\text{Per cent reduction over control} = \frac{\text{C} - \text{T}}{\text{C}} \text{X } 100$$

Where, C – Mycelial growth of the pathogen in control (mm) and T – Mycelial growth of the pathogen in dual plate (mm).

2.5. Preparation of individual and mixtures of PGPR and PGPE bio-formulations

For individual strains of *P. fluorescens* (Pf1) and *T. harzianum* (Th16 and Th5) were inoculated into the sterilized KB and Potato dextrose broth, respectively and incubated in a rotary shaker at 150 rpm for 48 h at room temperature (28 ± 2 °C). After 48 h and 7 days of incubation, the broth containing 9×10^8 cfu/ml was used for the preparation of talc-based formulation for bacterial culture. To the 400 ml of bacterial suspension, 1 kg of the talc powder (sterilized at 105 °C for 12 h), calcium carbonate 15 g (to adjust the pH to neutral) and Carboxymethyl cellulose (CMC) 10 g (adhesive) were mixed under sterile conditions, following the method described by (Nandakumar *et al*., 2001). After shade drying overnight, it was packed in polypropylene bag and sealed.

2.6. Greenhouse studies

2.6.1. Effects of bio-formulation mixtures on the incidence of foot rot disease

To study the induced systemic resistance (ISR) against *P. capsici* of pepper veins, a pot culture experiment was conducted with single and combination of rhizosphere bacteria and endophytic fungus. Veins are grown in earthen pots (Size-0.35 m diameter, 0.50 m height, volume of soil: 0.04 m^3) filled with sterilized potting soil containing the spore suspension (2×10^5 spores/g of soil) of *P. capsici*.

In all treatments, the talc-based bio-formulation mixture was applied as seedling root dip and soil application. The fungicide **RIDOMIL** GOLD® **MZ** was used as a positive control. For treatment, the pepper vine cv. Subhakara, hence the cultivar is susceptible to foot rot disease the same cultivar was used for further studies. After 25 days, the seedlings were pulled out from the pots and transplanted at the rate of five vine per pot (Size-0.35 m diameter, 0.50 m height, volume of soil: 0.04 m^3) containing sterilized soil mixture (cow dung: sand: soil in 1:1:1 ratio) inoculated with the spore suspension (2×10^5 spores/g of soil mixture) of *P. capsici* (Sundaramoorthy *et al*., 2012). For root dipping, pepper veins were dipped in 250 ml of *Trichoderma* suspension (9×10^8 cfu/ml) for 2 h, ensuring that roots alone were immersed in the inoculum and planted in pots. In soil application, 25 ml of *Trichoderma* suspension (9 × 10^8 cfu/ml) per pot was poured 30 and 60 days after planting (40–45 cm height). Vine treated with **RIDOMIL** GOLD® **MZ** (2 g/litre) as well as soil drench (0.1%) at 30 and 60 days after planting served as a positive control.

The pepper vine inoculated with the pathogen alone served as inoculated control. The observation on development of *P. capsici* symptoms was recorded at the time of harvest. Each treatment was replicated thrice in Completely Randomized Block Design (CRD). The percent disease index (PDI) was estimated using the formula suggested by Mckinney (1923).

Induction of defense-related protein and experimental design

Pseudomonas fluorescens and endophytic (*T. harzianum*) fungal strains in single and in combinations (Treatments T1-Th16, T2-Th15, T3-Pf1, T4-Th16 + Th15, T5-Th15 + Pf1, T6-Pf1 + Th16, T7-Th16 + Th5 + Pf1, T8-Ridomil gold, T9-inoculated control, T10-healthy control) were used in the induction of defense reactions in pepper. The bio-formulations treated vine were sown at the rate of one veins per pot (Size-0.35 m diameter, 0.50 m height, volume of soil: 0.04 m^3) filled with sterilized potting soil containing the spore suspension (2 × 10^5 spores/g of soil) of *P. capsici*. Bio-formulation treated plants were challenge inoculated with *P. capsici*, while the other set were not challenge inoculated. The plants neither treated with bio-formulation nor challenged by the pathogen were kept as a control. Three replications were maintained in each treatment. Each replicate consisted of five pots and in each pot one vine were maintained. The experiments were conducted using CRD in greenhouse. The humidity in the greenhouse was maintained at around RH 70%. The temperature was adjusted to 26 °C (day)/20 °C (night).

2.6.3. Sample collection and assay of defense-related proteins

Vine leaf tissues were collected at different time intervals (0, 4, 8, 16, 24, 48 and 72 hours after pathogen inoculation). Four pepper vines were sampled from each replication of the treatment separately and were maintained for biochemical analysis. Leaf samples were homogenized with liquid nitrogen in a pre-chilled mortar and pestle. One gram of leaf sample was homogenized with 2 ml of 0.1 M sodium phosphate buffer (pH 7.0) at 4 °C. The homogenate was centrifuged for 20 min at 10,000 rpm. The supernatant was used as a crude enzyme extract for assaying PO (Hammerschmidt *et al*., 1982), polyphenol oxidase (PPO) (Mayer *et al*. 1965) and PAL (Dickerson *et al*., 1984). Enzyme extracted in 0.1 M sodium citrate buffer (pH 5.0) was used for the estimation of chitinase (Boller and Mauch 1988) and β-1,3-glucanase (Pan *et al*., 1991). The total phenol content was estimated as per the procedure given by (Zieslin and Ben-Zaken 1993).

2.6.4. Native polyacrylamide gel electrophoresis analysis

The isoform profiles of PO and PPO were studied by discontinuous Native polyacrylamide gel electrophoresis analysis (PAGE) (Laemmli 1970). The protein extract was prepared by homogenizing 1 g of leaf sample in 2 ml of 0.1 M sodium phosphate buffer (pH 7.0) and centrifuged at 18,000 rpm for 20 min at 4 °C. The protein content of the sample was determined (Bradford 1976) and samples (50 µg protein) were loaded into 8% polyacrylamide gels (Sigma, USA). After electrophoresis, PO isoforms were visualized by soaking the gels in staining solution containing 0.05% benzidine (Sigma–Aldrich, Mumbai, India) and 0.03% H_2O_2 in acetate buffer (20 mM, pH 4.2) (Nadolny and Sequeira 1980). For assessing the PPO isoform profiles, the gels were equilibrated for 30 min in 0.1% *p*-phenylene diamine, followed by the addition of 10 mM catechol in the same buffer (Jayaraman et al., 1987).

2.7. Statistical analysis

The data on effect of the treatments on the growth of pathogens, severity of diseases and activity of enzymes in pepper vine were analyzed by analysis of variance (ANOVA), and treatment means were compared by Duncan's Multiple Range Test (DMRT). The data on disease severity was arcsine transformed before undergoing statistical analysis (Gomez and Gomez 1984).

III. RESULTS

3.1. Compatibility among bacterial strains

PGPR strain of *P. fluorescens* (Pf1) and PGPE strains of *T. harzianum* (Th16 and Th15) were tested for their compatibility *in vitro*. None of the antagonistic bacteria were inhibited by each other, So the absence of inhibition zone suggesting that these three biocontrol agents were compatible with each other.

3.2. Effect of biocontrol agents on radial growth of *P. capsici*

One strain of *P. fluorescens* (Pf1) and two strains of *T. harzianum* (Th16 and Th15) were tested individually and in combination to assess the effect of biocontrol agents on radial growth of *P. capsici*. All the treatments were effective in reducing the mycelial growth of the pathogen. However, the combined application of Th16 + Th15 + Pf1, Th16 + Th15 and Th16 + Pf1 had resulted in the least mycelial growth with 49.0, 54.0 and 54.1 mm, respectively. Combined application of Th16 + Th15 + Pf1 and Th16 + Th15 and Th16 + Pf1 recorded the maximum inhibition zone of 26.0, 23.5 and 19.5 mm, respectively. The control plates recorded the highest mycelial growth of 90.00 mm (Table 1).

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Table.1: Effect of biocontrol agents on the mycelial growth of P. capsici

Sl. No	**Treatments**	**Mycelial growth (mm)**	**Inhibition zone (mm)**	**Percent inhibition over control (mm)**
1	Th16	61.00[de]	10.00[f]	32.22[de]
2	Th5	63.50[ef]	8.70[g]	29.44[ef]
3	Pf1	70.40[g]	7.00[h]	21.77[g]
4	Th16 + Th5	54.00[b]	23.50[b]	40.00[b]
5	Th5 + Th5	56.20[bc]	15.20[d]	37.55[bc]
6	Pf1 + Th16	54.10[b]	19.50[c]	39.89[b]
7	Th16 + Th5 + Pf1	49.00[a]	26.00[a]	45.55[a]
8	**RIDOMIL** GOLD	58.00b[cd]	13.10[e]	35.55[cd]
9	Control	90.00[h]	0.00	0.00

Values are mean of three replications. In a column, mean followed by a common letter (s) are not significantly different at the 5% level by DMRT.

3.3. Efficacy of PGPR and PGPE strains on foot rot incidence under greenhouse conditions

Talc-based bio-formulation of *P. fluorescens* (Pf1) and *T. harzianum* (Th16 and Th15) strains individually or in combination were tested for their efficacy against *P. capsici* under pot culture conditions, along with **RIDOMIL** GOLD as a chemical check. Both individual and strain mixtures significantly reduced the foot rot incidence (by 21–35%) compared to untreated plants upon challenge inoculation of *P. capsici* (Fig. 1). Conspicuously, a combination of Th16 + Th15 + Pf1 together resulted in a significantly lower foot rot disease index (PDI) than any of the strains individually, as well as better germination (96%) and plant height (73.62 cm) (Fig. 2). The results indicated that disease reduction by a combination of antagonistic bacterial and endophytic strains was comparable with the fungicide control, which recorded the PDI of 22% and 18%, respectively.

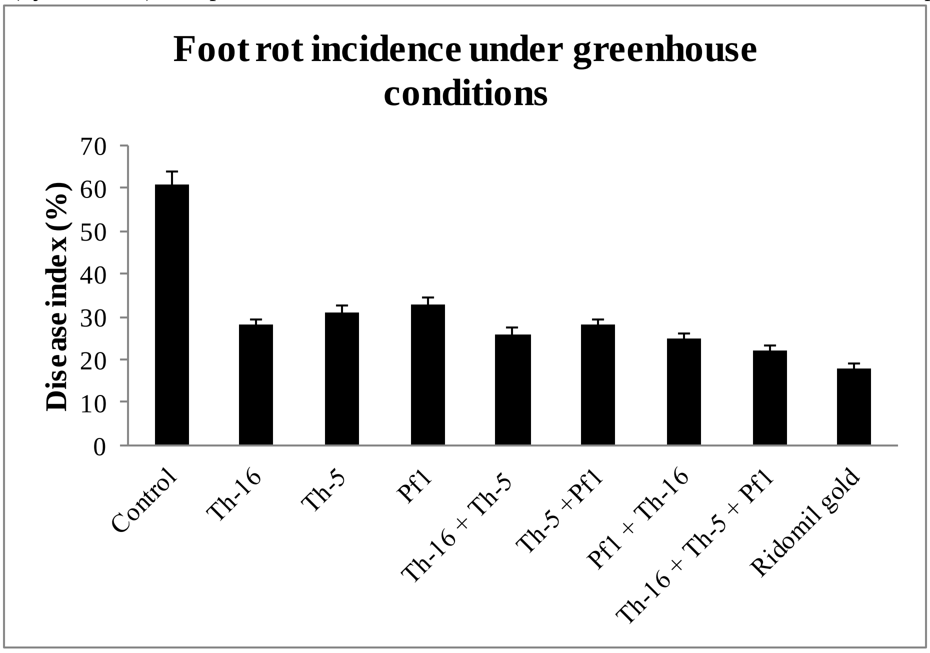

Fig.1: Efficacy of individual and mixture of biocontrol agents on foot rot incidence in black pepper under greenhouse conditions. Values are mean of three replications. The line on each bar represents ±SE and the values in the bars are not significantly different at the 5% level according to DMRT.

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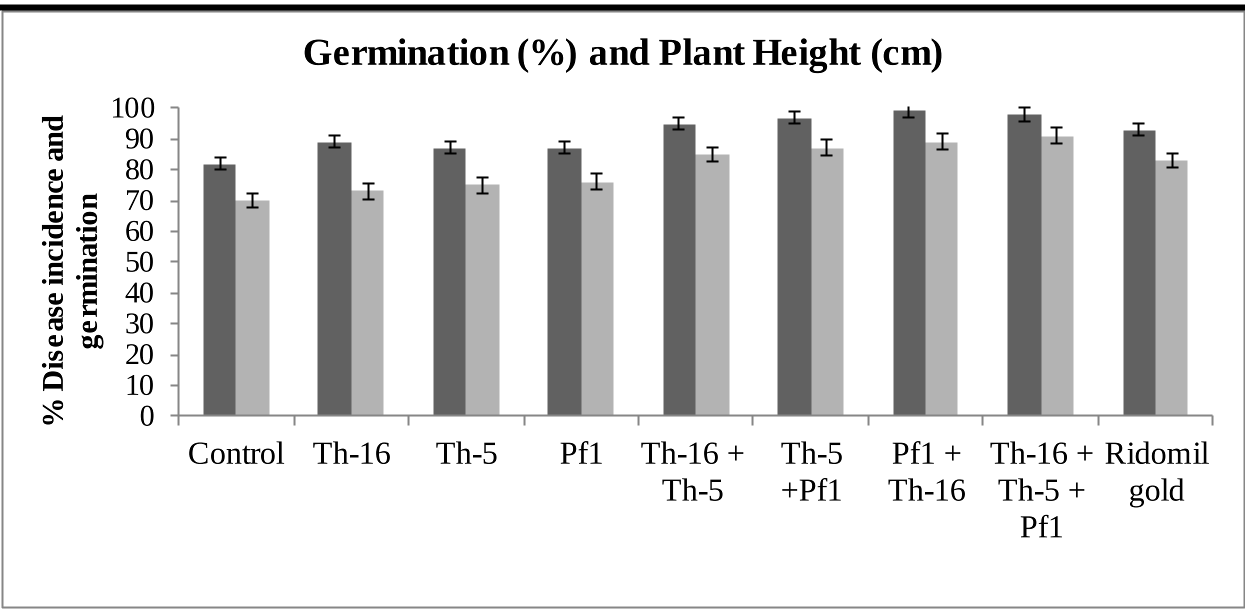

Fig.2: Effect of individual and mixture of biocontrol agents on growth promoting activity in black pepper under greenhouse condition. Values are mean of three replications. The line on each bar represents ±SE and the values in the bars followed by the common letter(s) are not significantly different at the 5% level according to DMRT.

3.4. Activity of defense enzymes and pathogenesis-related (PR) proteins

Induction of defense enzymes and pathogenesis-related (PR) proteins was studied in the rhizobacteria and endophytes treated pepper veins. The results revealed higher expression of defense-related proteins upon challenge inoculation with *P. capsici*. *P. fluorescens* and *T. harzianum* strains individually and in a mixture differ in the ability to stimulate PO and PPO in pepper veins challenge inoculated with *P. capsici*. The results of the study revealed that there was an increase PO and PPO activities in Th16 + Th15 + Pf1 mixtures treated plants compared to untreated control plants upon challenge inoculation. The activities (Th16 + Th15 + Pf1) were found to increase110 units of protein at 48 hours after inoculation, compared to all other treatments with drastic reduction in enzyme activities in later time points. The pathogen inoculation in untreated control plants also stimulated the enzymes but the level was less than that of mixture of *P. fluorescens* and *T. harzianum* pretreated plants (Fig. 3 and Fig. 4).

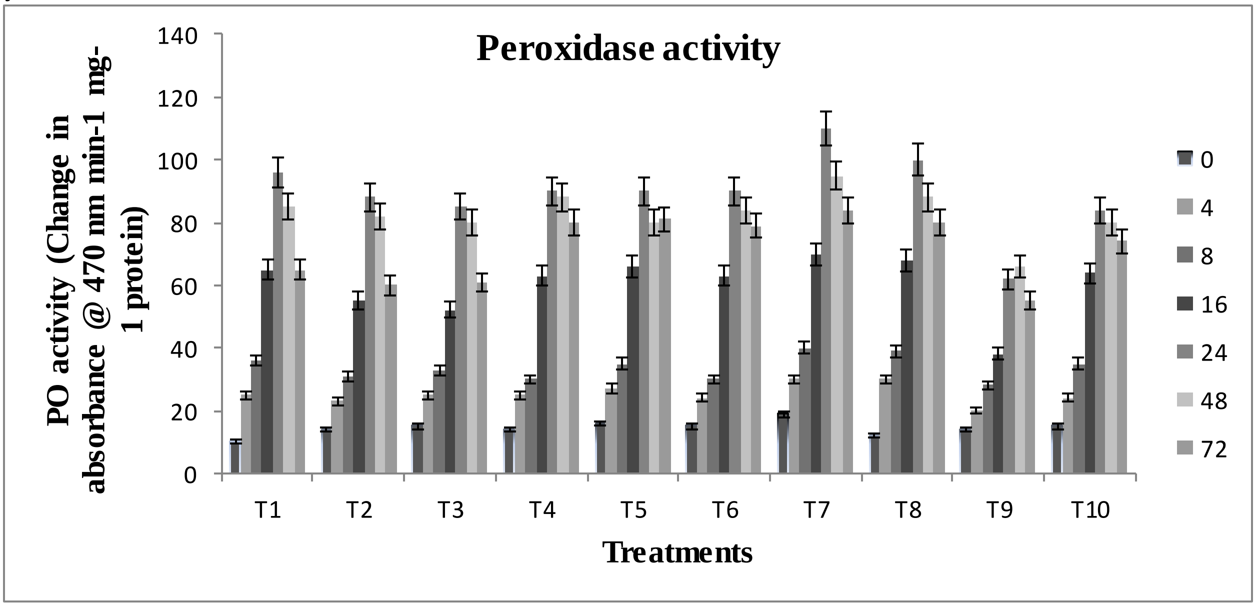

Fig.3: Induction of peroxidase activity in pepper veins treated with biocontrol agents against P. capsici. The vertical bar indicate the SE at 5% level according to DMRT. Treatments T1-Th16, T2-Th15, T3-Pf1, T4-Th16 + Th15, T5-Th15 + Pf1, T6-Pf1 + Th16, T7-Th16 + Th5 + Pf1, T8-Ridomil gold, T9-inoculated control, T10-healthy control

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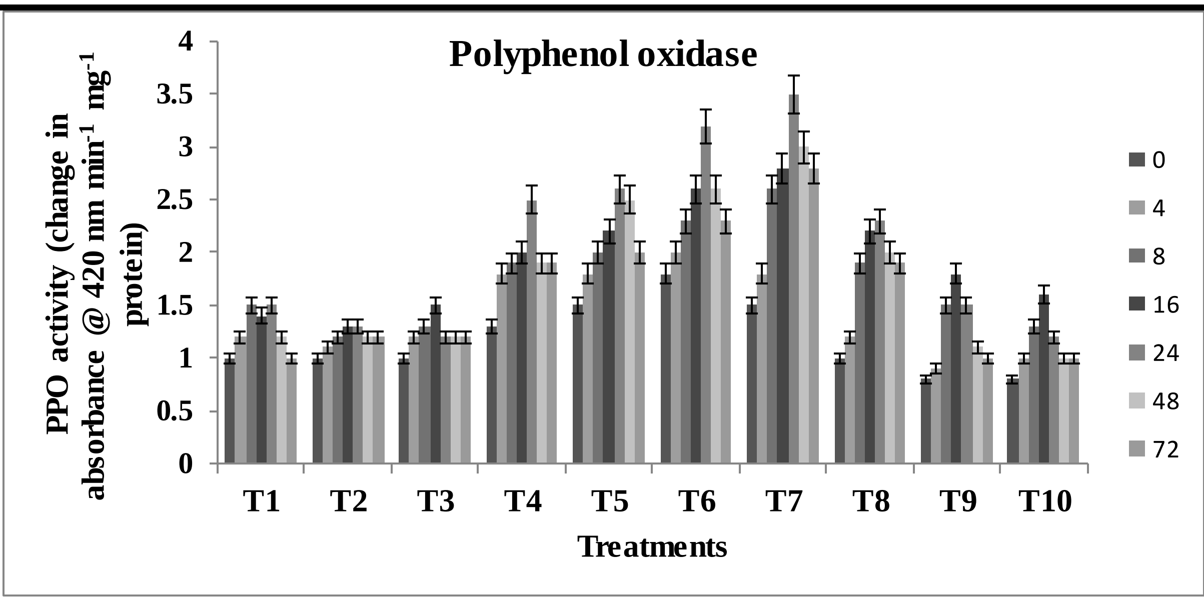

Fig.4: Induction of polyphenol oxidase activity in pepper veins treated with biocontrol agents against P. capsici. The vertical bar indicate the SE at 5% level according to DMRT. Treatments T1-Th16, T2-Th15, T3-Pf1, T4-Th16 + Th15, T5-Th15 + Pf1, T6-Pf1 + Th16, T7-Th16 + Th15 + Pf1, T8- Ridomil gold, T9-inoculated control, T10-healthy control

PAL activity was significantly higher in Th16 + Th15 + Pf1 mixture treated pepper veins inoculated with *P. capsici* than in untreated controls. PAL accumulation reached a maximum of 3.5 units of protein at 24 hours after inoculation in Th16 + Th15 + Pf1 treatment group when compared to all other treatment groups. Untreated pepper veins inoculated with *P. capsici* recorded the least induction of 1.4 units of protein and showed drastic decline at 48 hours after inoculation (Fig. 5).

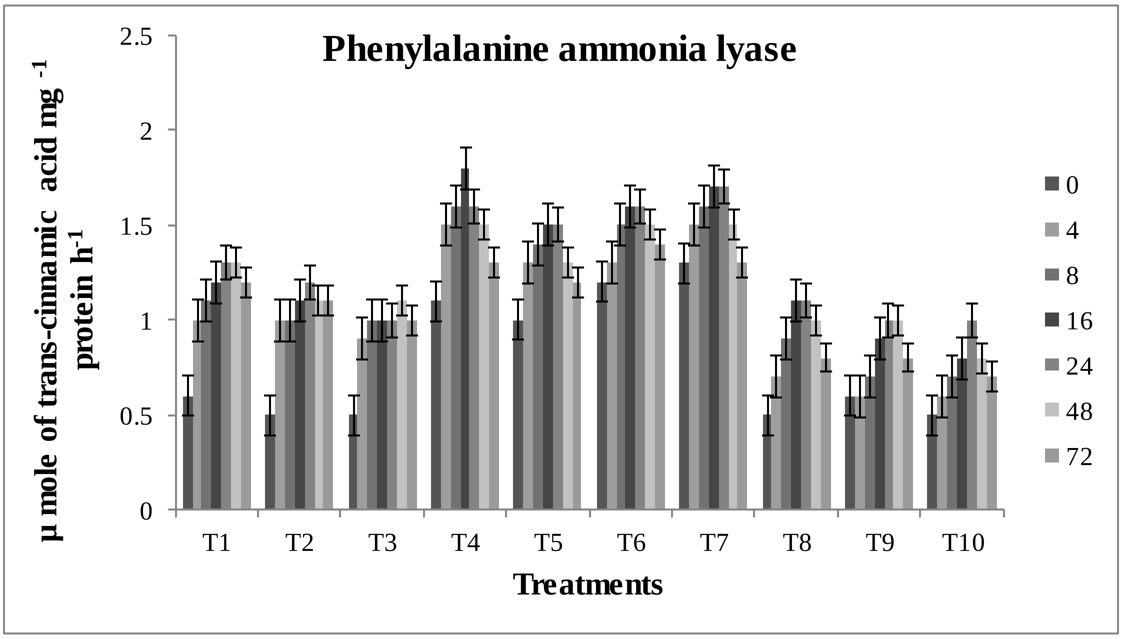

Fig.5: Induction of phenylalanine ammonia-lyase activity in pepper veins treated with biocontrol agents against P. capsici, the vertical bar indicate the SE at 5% level according to DMRT. Treatments T1-Th16, T2-Th15, T3-Pf1, T4-Th16 + Th15, T5-Th15 + Pf1, T6-Pf1 + Th16, T7-Th16 + Th15 + Pf1, T8- Ridomil gold, T9-inoculated control, T10-healthy control

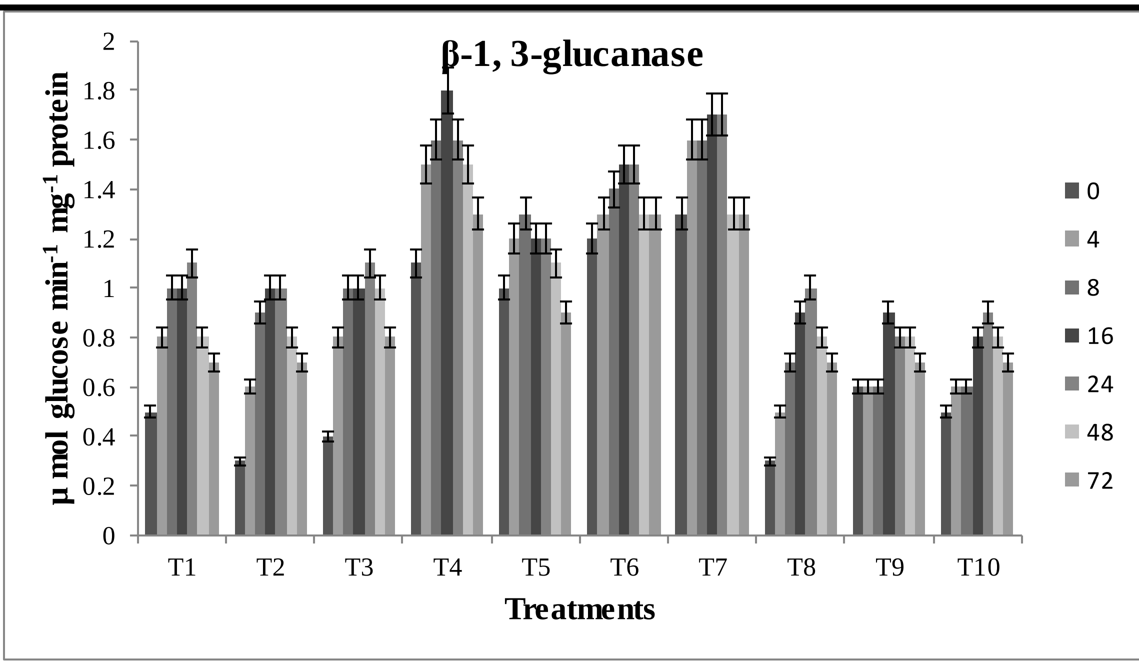

*Fig.6: Induction of β-1,3-glucanase activity in pepper veins treated with biocontrol agents and endophytes against P. capsici, the vertical bar indicate the SE at 5% level according to DMRT. Treatments T1-Th16, T2-Th15, T3-Pf1, T4-Th16 + Th15, T5-Th15 + Pf1, T6-Pf1 + Th16, T7-Th16 + Th5 + Pf1, T8- Ridomil gold, T9-inoculated control, T10-healthy control*β-

1,3-glucanase (Th16 + Th15 + Pf1) mixture treated plants inoculated with *P. capsici*. Showed an enhanced activity of 1.7 units of protein at 16 hours after inoculation when compared to untreated control plants which showed 0.8 units of protein. The activities of β-1,3-glucanase increased in plants treated with bio-formulation mixture (Th16 + Th15 + Pf1) up to 3 days after *P. capsici* inoculation, and declined thereafter as shown in (Fig. 6). Maximum accumulation of total phenol content was also observed in the combination treatments ofTh16 + Th5 + Pf1 followed by Th16 + Th15 and Th16 + Pf1 (Fig. 7). Untreated control, or inoculated with the pathogen alone did not show any remarkable change in the activity of phenolic substances. These results clearly indicate that the defense enzymes and PR proteins were more activated in the mixtures of bacterial bio-formulations treated plants thus strengthening the pepper veins against the abiotic stress.

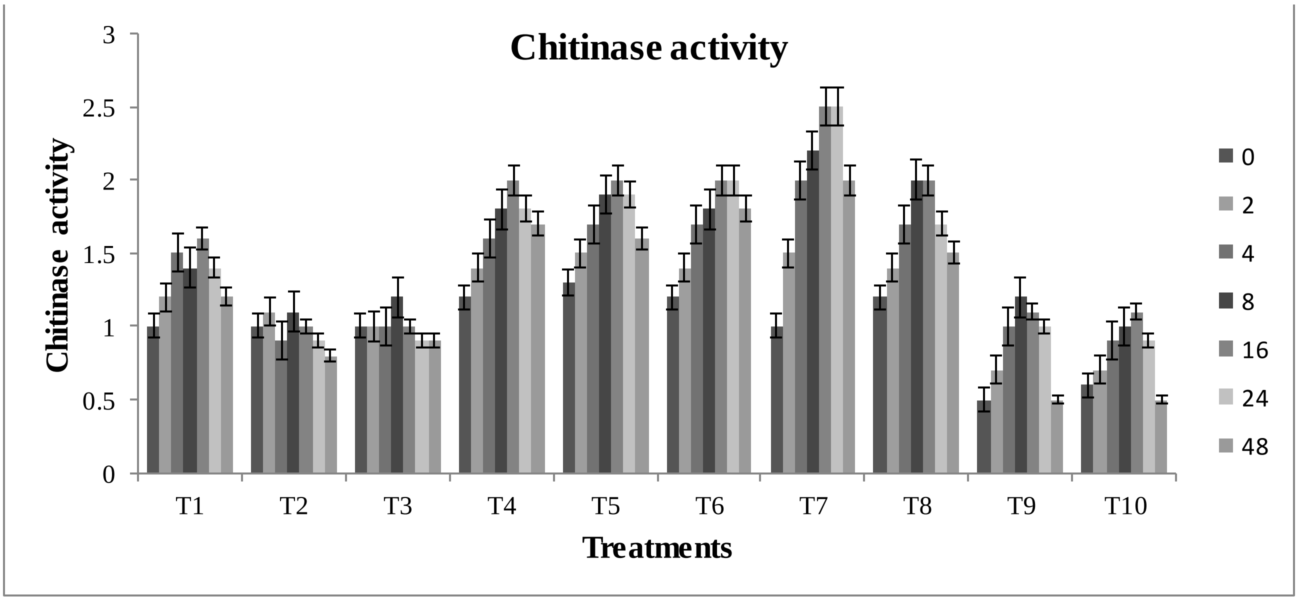

Fig..7: Induction of chitinase activity in pepper veins treated with biocontrol agents and endophytes against P. capsici, the vertical bar indicate the SE at 5% level according to DMRT. Treatments T1-Th16, T2-Th15, T3-Pf1, T4-Th16 + Th15, T5-Th15 + Pf1, T6-Pf1 + Th16, T7-Th16 + Th5 + Pf1, T8- Ridomil gold, T9-inoculated control, T10-healthy control

The chitinase activity was found high in Th16 + Th5 + Pf1 and Ridomil treated (T8) veins showed 2.5 and 2.0 at 16 hpi and 24 hpi. The activities of chitinase activity increased in plants treated with bio-formulation mixture (Th16 + Th15 + Pf1) up to 3 days after *P. capsici* inoculation, and declined thereafter as shown in (Fig. 7).

Untreated control, or inoculated with the pathogen alone did not show any remarkable change in the activity as shown in the figure.

IV. DISCUSSION

Accumulating evidence from literature has shown that compatible multiple strains appear to be an important pre-requisite for the desired effectiveness of strains and more consistent disease suppression (Young Cheol *et al*., 2008;Latha *et al*., 2009). The results of the present study provide evidence that the compatibility of *P. fluorescens* (Pf1) and *T. harzianum* (Th16 and Th15) effectively inhibited the growth of *P. capsici*. Several studies have documented that *Pseudomonas*, *B. subtilis* (CA32) and *Trichoderma harzianum* (RU01) significantly reduced the mycelial growth and conidial production of *P. capsici* (Abeysingne 2007) by producing the wide array of antibiotics such as 2,4-diacetylphloroglucionl, oligomycin, phenazine, pyoleteorin, pyrolnitrin, pyocyanin, lturin, bacillomycin, zwittermycin-A and surfactin responsible for antifungal activities (Yu *et al*., 2002).

Inhibitory effect of biocontrol agents observed in dual culture technique is correlated with the management of wilt disease of foot rot caused by *P. capsici* under green house as well as field conditions. The results of the present study revealed that the talc based bio-formulations prepared by using individual and in combination of Th16 + Th15 + Pf1 strains significantly reduced the wilt disease incidence in pepper. This effect may be due to its stimulatory effects on ISR as evidenced by increased activities of defense enzymes such as PO, PPO and PAL involved in the synthesis of phytoalexins thereby induce systemic resistance against foot rot disease and promote the growth of plants. Our results substantiate the inhibition of various plant pathogen and disease management by using several biocontrol agents through the induction of ISR in plants reported by (Van Peer *et al*., 1991; Kloepper, 1993; Van Loon, 1997; Chen *et al*., 2000). Thus, our findings provide evidence that the induction of defense enzymes and PR proteins by application of endophytic fungi and rhizosphere bacterial strains may strengthen the plants against various biotic stresses.

V. CONCLUSION

The present study demonstrated that the combinations of endophytic fungi Th16 + Th15 + Pf1 bacterial strains consistently reduced the radial mycelial growth of *P. capsici* by producing various antibiotics and reduced the foot rot of pepper under green house and field conditions by inducing ISR compared to individual agents. Combination of biocontrol agents is a strategic approach to control the plant disease and pest (Nandakumar *et al*., 2001a and Saravanakumar *et al*., 2007). Furthermore, interactions among the bacterial strains may have synergistic effects that could induce ISR and promote the growth of the plants (Sundaramoorthy *et al*., 2007). Several literature have documented that the use of biocontrol agents in combination was more effective for management of plant diseases and pathogens compared to individual agents (Sivakumar, 2012).

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Analysis of Maize Value Addition among Entrepreneurs in Taraba State, Nigeria

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Abstract— *This study analyzed maize value addition among maize entrepreneurs in Taraba State, Nigeria. A multi-stage sampling procedure was used to collect primary data from two hundred and twelve respondents (212), using structured questionnaire. Data were analyzed using descriptive statistics, Value addition model, ANOVA, multinomial logistic regression, log likelihood test ratio and factor analysis. The result of the study revealed that most (62.3%) respondents were males. 61.3% were within the productive age of 21-40 years. Majority (71.1%) were married with household sizes of 6-10. The total of (32.8%) respondents of them had secondary school education, (46.6%) had processing experience of between 6-10 years in processing as their major occupation. proportionate (49.2%) of total respondents had non-farm income of ₦150,001 per annum. Results of the value addition analysis showed that maize processed as boiled maize is more profitable with a mean of ₦130, 900 per annum. The result from the multinomial logistic regression on choice of maize processing enterprises revealed that sex had negative coefficient, which implied that male respondents preferred grain production enterprise rather than processing into akamu, corn flour, massa and boiled maize. Also age had negative coefficient, implying that age increase tends to favour grain production than processing. In relation to processing constraints, the maize processing value chain was hampered by the following: inadequate processing facilities, inadequate credit/funds, high cost of transport and inadequate access to inputs. The study concluded that maize value addition is a profitable enterprise and entrepreneurs should be encouraged to venture into it. Also the Agricultural Development Project Programme should send extension agents to processors to encourage processing diversification especially into poultry feeds.*

Keyword— Value addition, entrepreneurs, maize, processing, enterprise.

I. INTRODUCTION

1.1 Background to the Study

Maize is a very important food crop for human beings and livestock. It provides energy, vitamins and negligible amount of protein. Output of maize has generally continued to increase in Nigeria. For instance maize production increased from 10,813,980 tonnes in 2016 to 12,107,580 tonnes in 2017 representing 11.96 percent increase National Agricultural Extension and Research Liaison Services (NAERLS, 2017). Africa produces just 6.5 percent of the worlds maize with Nigeria being the largest African producer. Output of maize in Nigeria has continued to increase, however its contribution to Gross Domestic Product is still low as observed by (FAO, 2008). This is so, because a negligible part of the produce is formally exported while a good proportion is consumed locally with negligible value addition (Food and Agriculture Organization (FAO, 2012).

Maize is an important grain cereal in Nigeria, is wildly cultivated by almost all farmers because of its high economic value and high adaptability in the ecological zones of the rainforest and the derived Savannah zones of Nigeria. In addition, maize has been in the diet of Nigerians for centuries. It started as a subsistence crop and has gradually become a more important crop, and has now risen to be a major commercial crop on which many agro-based industries depend for raw materials (Iken and Amusa, 2016).

About 28 food items or dishes and 6 medical values of maize were identified by (Abdulrahaman and Kolawole., 2008). Some of these include hot and cold pap, '*tuwo*', '*massa*', '*couscous*', '*gwate*', '*nakia*', '*dambu*','*dakuwa*', 'Popcorn', cooked and roasted maize. These authors Abdulrahaman and Kolawole (2008) opined that analysis of maize value chain involves all factors of production including land, labor, capital, technology, and inputs as well as all economic activities including input supply, production, transformation, handling, transport, marketing, and distribution necessary to create, sell, and deliver a

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product to a certain destination. Value chain studies are important because the results yield interested stakeholders and company's ability to understand and optimize the activities that lead to its competitiveness and high profit levels (Keyser, 2006). Maize is a multipurpose crop because every part of its plant has economic value. The stems and leaves are used for feeding cattle and the seeds are used for food, livestock feeding and pharmaceuticals.

1.2 Problem Statement

Over the years in Taraba State precisely entrepreneurs of maize production enterprise and other stakeholders in maize industry have continued to be poor with low income, as observed in the works of Gani and Adeoti (2011). These authors identified the cause of these low level of income and poverty on government negligence of the industry as well as the extreme poverty of the stakeholders who could not participate in effective marketing to turn around economic fortune to their favour. Thus leading to consumption of almost all of the produce year round with little or no processing activities. Where related relevant local research could have provided an insight into the situation, there scarcely exist any.

Although a lot of research has been conducted on maize production and marketing in some States of the Federation, however little work has been done on maize value addition in Nigeria. For instance, adoption of cassava value added innovation and its implication in rural livelihood in Abia State (Chidozie, 2014). Capacity building on Cocoyam value addition training for rural women in Abia State (Onuekwusi *et al*., (2016). Yam value chain, constraints and opportunities for small scale farmers in the middle belt Nigeria (Damulak, 2012). This and many related studies have been conducted in Nigeria; however, there is a gap of information on analysis of maize value addition among maize entrepreneurs in Taraba State. The need for the conduct of this research becomes an obvious necessity in filling the existing gap.

1.3 Aim and Objectives of the Study

The main objective of this study is to analyze maize value addition among maize entrepreneurs in Taraba State, Nigeria.

1.4 The specific objectives of the study are to:

i. describe the socioeconomic characteristics of the respondents.
ii. identify the different forms of processed maize.
iii. determine the profitability of value added on maize.
iv. analyze the factors influencing choice of maize value added enterprise
v. identify the constraints associated with maize value addition.

The following hypotheses were tested:

i. The maize processing value chain in Taraba State is not profitable.
ii. Socio-economic characteristics of maize processors do not have significant effect on their choice of maize value added enterprise.

II. METHODOLOGY

2.1 Study Area

This study was conducted in Taraba State, Nigeria. Taraba State is situated in the North Eastern part of Nigeria and it lies between latitude $6^0$25'N and $9^0$30'N and longitude $9^0$30'E and $11^0$45'E. The State has a land mass of 54,428km^2 and population estimate of 2,294,800 million (National Bureau of Statistics., 2016). It is bounded by Bauchi and Gombe States in the North- East and Adamawa on the East, and Plateau State in the North- West. The State is further bounded to the west by both Nasarawa and Benue States, while it shares an international boundary with the Republic of Cameroun to the South and South-East (Oruonye and Ahmed, 2017). Taraba State consists of Sixteen (16) Local Government Areas.

2.2 Sampling and Sample Size Selection

The state comprises three agricultural zones, the Northern, Central and Southern zones. A multi-stage sampling procedure was adopted. Producers, marketers, processors and transporters enterprises were the target for this study. Firstly, purposive sampling was adopted, to select two agricultural zones, the Central and Northern zones, noted for high level of maize production. The second stage involved purposive selection of five Local Governments Areas from the two zones, involved in high level of maize production. These were Gashaka, Gassol and Bali from the Central zone, Jalingo and Ardo-kola from the Northern zone. Thirdly communities from each Local Government Area were selected by simple random sampling technique. Fourthly, a sampling frame was developed for each of the rural communities using proportional allocation of 5% (0.05) across board, a total of 212 respondents were selected as a sample size.

Primary data were collected for the study. Data were obtained through administration of a well structured questionnaire and administered by the researcher and trained enumerators to maize producers, transporters, processors and marketers. Descriptive statistics which involves the use of frequencies, percentages and means were used to analyze objectives i and ii, Value addition model was used to analyze objective iii, Multinomial logistic regression was used to analyze objective iv, Factor analysis was used to achieve objective v, ANOVA was used to test hypotheses one (i), Log Likelihood test ratio was used to test hypotheses two (ii).

2.2 Model Specification: The following models were adopted for data analysis

Multinomial Logistic Regression model

The Multinomial logistic regression model is generally specified in equation 1

$$P_i(A_i=j) = \frac{\exp(X_i\beta_j)}{\sum_{k=0}^{i} \exp(X_i\beta_i)} \quad 1$$

where:

(i=0, 1…j)

A_i = random variable representing choice of a particular maize stakeholder enterprise

$X_1 - X_{10}$= explanatory variable

X_1............. Age

X_2.............. Sex

X_3............... Marital status

X_4............Level of education

X_5.......... Household size

X_6...........Access to credit

X_7..........Membership of cooperative society

X_8.........Non farm income

X_9..........Experience in processing

X_{10}.........Value addition

A_1 = random variable representing choice of a particular marketing channel, and

X_1 = explanatory variables such as socio economic, institutional and marketing factors.

2.3 Value Addition model

Value Addition model was used to examine the most profitable maize processing value chain, which is simply the difference between the total revenue receipts and the total variable cost as expressed in equation 2,

i.e VA=TRR-TVC … 2

Where, VA=Value Added

TRR=Total Revenue Receipts and

TVC=Total Variable Cost

2.4 Analysis of variance (ANOVA)

The analysis of variance technique enables the determination of the number of relevant factors (or causes) of variation and the logical significance of each one of them. This is specified in equation 3.

F ratio =

$$F_{ratio} = \frac{V_b}{V_w} \quad …3$$

Where

V_b = the difference between the variance

V_w = the mean value of the variance

2.5 Factor Analysis

Factor analysis is a method for investigating whether a number of variables of interest Y_1, Y_2 ……., Y_l, are linearly related to a smaller number of unobservable factors F_1, F_2,……..., F_k .

The factor analysis model expresses the variation and co-variation in a set of observed continuous variables y (j = 1 to p)

As a function of factors η (k = 1 to m) and residuals ε (j = 1 to p).

For person i,

$$y_{i1} = v_1 + \lambda_{11}\,\eta i_1 + \lambda_{12}\,\eta i_2 + \ldots + \lambda_1\,k\eta_1 k + \ldots + \lambda_1 m\,\eta im + \varepsilon i_1$$

$$yij = vj + \lambda j_1\,\eta i_1 + \lambda j_2\,\eta i_2 + \ldots + \lambda jk\,\eta ik + \ldots + \lambda jm\,\eta im + \varepsilon ij \quad ….4$$

$$yip = vp + \lambda p_1\,\eta i_1 + \lambda p_2\,\eta i_2 + \ldots + \lambda pk\,\eta ik + \ldots + \lambda pm\,\eta im + \varepsilon ip$$

where,

vj are intercepts

λjk are factor loadings

ηik are factor values

εij are residuals with zero means and correlations of zero with the factors

III. RESULTS AND DISCUSSIONS

3.1 Socio-Economic Characteristics of the Respondents

Table 1 shows that majority (61.3%) of the respondents fell within the age bracket of 21-40 years while (36.8%) of the respondents fell within the age bracket of 41-60 years. The mean age was 37.78 years. This indicates that most of the respondents were young, active and of productive age. Table 1 also indicated that 62.3% of the respondents were males, while 37.7% of the respondents were females. This implies that majority of the respondents were males. This agrees with the findings of Ogunniyi and Omotesho (2011) and Osondu *et al*., (2014) who reported that most of the respondents were males. Majority (71.1%) of the respondents were married, 20.6% of the respondents were single, 6.4% of the respondents were widowed and 2.0% of the respondents were divorced. This implies that the area under study was dominated by married people. It was also found that 32.8% of the respondents had secondary school education, 20.6% of the respondents had primary school education. This implies that majority of respondents were

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literate. This agrees with the findings of Ogunniyi and Omotesho (2011) that literacy of respondents was high, table 1 further indicated that 40.7% of the respondents had a household size of 6-10, (31.4%) had a household size 11-15. This implies that respondents had large household size which could serve as a source of labour for maize value added activities. The mean of the household size was 9.98. This agrees with the findings of Abdeleteif and Siegfried (2015) who stated that large household size may translate to higher usage of family labour. The result also shows that 49.2% of the respondents had non-farm income of ₦150001, 16.2% of the respondents had a non-farm income of ₦500, 000, likewise 16.2% of respondents had a non-farm income of between ₦5000-₦10000. This shows that maize processors are low income earners and that is why most respondents operate on a low scale of maize processing. The mean of non-farm income of the respondents stood at ₦187553.4. This agrees to the findings of Bakari (2016) that respondents are low income earners, hence they may not possess the financial muscle required to expand the enterprise. About (47%) of the respondents had processing experience of between 6 and 10 years, 24% of the respondents had experience of between 11-15 years, 19.1% of the respondent had experience of <5 years. This shows that the respondents are experienced and can improve with more financial support. This agrees with findings of Dauda and Ndanitsa (2009) that the length of experience of a working population in any occupation determines its performance and enables managers to overcome problems previously encountered in the production process. Majority (91.7%) of the respondents had no access to formal credit while just 8.3% had access to formal credit which indicates the reason for the low level of processing as lack of access to formal credit, thus stakeholders can improve when supported. This agrees with the findings of Oladejo and Adetunji (2012) that only 3.7% of respondents have access to formal credit. It also agrees with the findings of Abdeleteif and Siegfried (2009) that only 14% have access to formal credit. Table 2 also shows that 88.3% of the respondents did not belong to any cooperative society. It was found that only 11.8% belong to cooperative societies. This clearly indicates that most of them do not have any useful other source of credit and information that can help them improve their productivity. This agrees with the findings of Bakari (2016) that most respondents do not belong to a cooperative society, so they could miss out on the opportunity to participate in any government programmes which is communicated through cooperative societies.

Table.1: Distribution of Respondents According to Socio-economic Characteristics (n=204)

Variables	Frequency	Percentage (%)	Mean
Sex			
Male	127	62.3	102.0
Female	77	37.7	
Total	204	100.0	
Age(Years)			
≤20	4	2.0	
21-40	125	61.3	
41-60	75	36.8	68.0
Total	204	100.0	
Marital Status			
Single	42	20.6	
Married	145	71.1	51.0
Widowed	13	6.4	
Divorced	4	2.0	
Total	204	100.0	
Level of Education			
Non formal education	28	13.7	

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Primary	42	20.6	
Secondary	67	32.8	39.6
Tertiary	30	14.7	
Degree	31	15.2	
Total	204	100.0	
Household size			
≤ 5	32	15.7	
6-10	83	40.7	
11-15	64	31.4	51
16 and above	25	12.3	
Total	204	100.0	

Source: Field Survey(2017)

3.2 Value Addition of Maize Processed into Different Products Annually

Non farm income (Naira)			
≤ 50000	33	20.5	
50001-10000	33	20.5	
100001-150000	15	9.3	40.3
150001 +	80	49.2	
Total	161	100.0	
Experience in processing and Marketing (years)			
≤ 5	39	19.3	
6-10	95	47.0	
11-15	49	24.3	50.5
16 and above	19	9.4	
Total	202	100.0	
Access to formal credit			
Yes	17	8.3	
No	187	91.7	102
Cooperative society			
Yes	24	11.8	
No	180	83.3	
Source of inputs			
Middlemen	116	56.9	
Retailers	69	33.8	
Wholesalers	19	9.3	

Table 2 shows that maize processed into *akamu* has a mean of ₦127,714.63, maize processed into corn flour has an annual mean of ₦112,609.677, maize processed into *massa* has an annual mean of ₦119,283.333, maize processed into boiled corn annually has a mean of ₦130,900.00, maize processed into roasted maize annually has a mean of ₦121,160.00. This indicates that boiled maize is more profitable compared to the other products annually in the study area. However, these annual means are generally low monetarily. This agrees with the findings of Umeh *et al*., (2011) that the income of small scale enterprises are low, so government should encourage the growth of small business by giving them the necessary assistance as regards to fund raising and equally advice them on how to utilize it effectively.

Table.2: Value Addition of Maize Annually (Naira)

Description	Number	Mini	Max	Mean	Std dev
Akamu	41	43000.0	1237200	12771463	183323.35
Corn flour	31	48000.0	225000	112609.677	41948.25
Massa	30	13700.00	170000	119283.33	42119.8788
Boiled	6	72000.00	224000	130900	59316.979
Roasted	30	1000.00	365000	121160	72717.3

Source: Field Survey (2017)

3.3 Forms in Which Maize is Processed into in the Study Area

Table 3 indicates that 32.8% of the respondent process their maize into corn flour, 19.1% process their maize into *massa*, 18.1% process their maize into *akamu*, 18.7% process their maize into roasted corn, 11.3% of the respondent process their maize into grains and 5.9% process their maize into boiled maize. This shows that most of the maize is processed into corn flour in making *tuwo* because majority of the households consume *tuwo* as their major meal in the study area. This study agrees with the finding of Thomas (2010) who reported that maize are mostly used for processing into flour, maize are roasted or boiled and eaten as a snack.

Table.3: Forms Maize is Processed into in the Study Area

Products	Frequency(f)	Percentage (%)
Akamu	37	18.1
Cornflour	67	32.8
Massa	39	19.1
Boiled	12	5.9
Roasted	26	12.7
Grains	23	11.3
Total	204	100.0

Source: Field Survey (2017)

3.4 Multinomial Logistic Regression of Selected Socio Economic Variables of Respondents.

The result of the multinomial logistic regression is presented in table 4 and the corresponding marginal effects in table 5. The result indicates a likelihood ratio (χ^2) value of 204 which was significantly different from zero (P<0.01) at 1% level. This confirmed that, the slope of the coefficient of the independent variables is significantly different from zero. This implies that the socio-economic characteristics included in the regression equation are significantly related to the choice of maize value addition enterprises by the processors. This result rejected the null hypothesis that socio-economic characteristics of maize processors have no significant influence on the choice of maize value added enterprise. The sign of their coefficient have important influence on the type of enterprise related to the reference category which is grain production enterprise in this respect. Increase in the coefficient with positive signs favored their choice as against the alternative non processing reference category. While increase in the variable with negative coefficient favored the choice of the reference category against the variable in question. In accordance to prior expectation the coefficient of sex was negative and statistically significant with *akamu* (-4.42), corn flour (-2.12), *massa* (-3.31) and boiled maize (-1.77) at 5% level. This implies that male participation in processing unfavored maize processing like *akamu*, corn flour, *massa* and boiled maize. It means that female processors are involved in processing these products more than their male counterparts. This agrees with the findings of FAO. (2000) that women are basically responsible for processing most food for storage and it also agrees with the programme Strategies for increasing food production and food security in Nigeria that traditionally women have been the custodian of most primary on farm processing operation and post harvest operations. The marginal effects of these products were -0.276, -0.09, -0.163 and -0.008 respectively. This implies that a 1% increase in male participation reduced their choice of processing *akamu*, corn flour, *massa* and boiled maize by 0.276%, 0.09%, 0.163 and 0.008% respectively. The coefficient of age was negative and statistically significant with *akamu* (-0.09) and *massa* (-0.122). This implies that increase in age of processors favored grain production as against processing it into *akamu* and *massa*. The marginal effects for these variables were (-0.09) and (-0.018). This means that at 1% increase in age of processors reduced their choice of processing maize into *akamu* and *massa* by 0.09 and 0.018% respectively.The coefficient for level of educational level is positive and statistically significant with a*kamu* (0.48) at 5% level. This implies that the level of education favored processing into a*kamu* as against grain production. The marginal effect for the variable was 0.071. This means that a 1% increase in

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level of education increase their choice of processing maize into a*kamu* by 0.07%. The coefficient of household size is positive and statistically significant with a*kamu* (0.15) and (0.192) corn flour against grain production. The marginal effects for these variables were (0.023) and (0.427) respectively. This means 1% increase in household size increase their choice of processing maize into *akamu* and corn flour by 0.023% and 0.42% respectively. This is because increased household size provides cheap family labour for the intensive tasks needed for *akamu* and corn flour processing at small scale level. The coefficient of net farm income is negative and statistically significant with *akamu* (-6.39) and corn flour (-8.45). This implies that increase in Net farm income favored grain production as against processing maize into *akamu* and corn flour. Following that sequence, the marginal effects for these variables were (-9.34) and (-5.07). This implied that increase in Net farm income of processors reduced their choice of processing *akamu* and corn flour, by 9.34% and 5.07% respectively. This conforms to the findings of Jay. (2018) that if an enterprise is continually unprofitable, then get rid of it and carefully consider options.

Table.4: Multinomial Logistic Regression Showing Socio-Economic Factors Influencing Choice of Maize Processing Enterprise

Variables	Akamu 1	Cornflour 2	Massa 3	Boiled 4	Roasted 5
Sex	-4.42*	-2.12*	-3.31*	-1.77*	-17.72
	(-5.63)	(-3.08)	(-5.04)	(-2.36)	(0.03)
Age	-.090**	0.03	-0.122*	0.018	-0.018
	(-2.18)	(0.78)	(-2.84)	(0.37)	(-0.43)
Education	0.48**	-0.462	0.299	-0.102	0.393
	(2.05)	(-1.63)	(1.28)	(-0.37)	(1.50)
Household size	0.15**	0.192**	-0.95	0.090	-0.068
	(1.99)	(2.36)	(-1.16)	(1.00)	(0.74)
Access to credit	-1.92	-1.67	-1.134	-0.234	-1.47
		(-1.10)	(-1.11)	(-0.20)	(-1.35)
Membership of	0.14	0.841	-0.146	0.723	0.255
cooperative	(0.14)	(0.73)	(-0.17)	(0.73)	(0.28)
NFI	-6.39*	-8.45**	2.21e-0.6	-2.05e-06	-2.45e-06
	(-2.53)	(-2.30)	(1.13)	(-0.73)	(-0.98)
Exp pro	-0.114)	-0.130	-0.014	-0.147	-0.132
	(-1.51)	(-1.53)	(-0.16)	(-1.57)	(-1.58
Constant	3.47	-0.249	5.15	-0.412	2.56
	(2.27)	(-0.13)	(3.53)	(-0.21)	(1.54)

Source: Field Survey (2017)
*dy/dx is for discrete change of diary variable from 0 to 1
Reference category is 6 which is grain production Number of observation 204
LR Chi-chi square 206.99
Prob > Chi square 0.0000, Pseudo R^2 0.304
**, * significant at 1% and 5% levels respectively (…) Represents various t -ratio

Table.5: Marginal Effects for Socio Economic Factors Influencing Choice of Maize Processing Enterprise

Variable	1 (dy/dx)	2 (dy/dx)	3 (dy/dx)	4 (dy/dx)	5 (dy/dx)
Sex	-0.276	-0.009	-0.163	0.008	-0.254
Age	-0.009	0.005	-0.018	0.006	0.000
Education	0.071	-0.427	0.039	-0.022	0.000
Household	0.023	0.0118	-0.027	0.006	-0.000
Access to credit	-0.161	-0.054	-0.098	0.35	-0.000
Membership of	0.008	0.053	-0.059	0.060	0.000

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cooperative					
NFI	-9.34e-07	-5.07e-07	8.18e-07	-4.38e-08	-9.71e-10
Exp	-0.126	-0.006	0.007	-0.009	-0.000
Constant					

Source: Field Survey (2017)

3.5 Constraints to Maize Value Addition

Table 6 presents factor analysis of constraints to maize value addition in the study area. The analysis reveals two major constraints namely: 1, socio-economic infrastructural constraints) and 2 (Marketing constraints). These were derived from loadings of 0.400 and above, while those with loadings less than 0.400 were ignored. This agrees with the findings of Abiyong (2017), who derived variable loadings of 0.400 and above, while those with loading less than 0.400 were not considered. The variables that (loaded high under factor 1) socio-economic infrastructural constraints were dominated by inadequate provision of processing equipment (0.419), inadequate availability of funds (0.669), high cost of products (0.661), poor transportation system (0.409), high cost of transportation (0.455). This was revealed by Olayemi (1982) that government places emphasis on increased food production without commensurate attention to food distribution in regards to funding. The variables that loaded high under factor 2 (marketing constraints) were high cost of inputs (-578), high cost of onloading/offloading (0.640) and access to input (0.714). The result agrees with Ajala and Adesehinwa (2007) who also reported high cost of transportation as constraints that may lead to market inefficiency.

Table.6: Factor Analysis of Constraints Associated with Maize Value Addition

Variables	Factor 1	Factor 2
Inadequate provision of processing facilities	0.419*	0.204
Inadequate availability of funds	0.669*	-0.187
High cost of products	0.661*	-0.336
Cost of inputs	0.358	-0.578**
Poor transport system	0.409*	0.077
High cost of transport	0.455*	0.062
High cost of loading/offloadig	0.414E0 2	0.640*
Access to inputs	0.020	0.714*

Source: Field Survey (2017)

Method : Varimax

*Factor 1: Socio-economic infrastructural constraints

*Factor 2: Marketing constraints

IV. CONCLUSION AND RECOMMENDATIONS

The study examined analysis of maize value addition among entrepreneurs in Taraba State and concluded that maize value addition is a profitable enterprise which entrepreneurs are encouraged to venture into and it is revealed that value addition is essential to maize entrepreneurs in the study area. On the basis of results of the study, it was concluded that maize value addition among entrepreneurs in the study area was hampered by constraints. This can be improved when infrastructure are put in place.

Based on the results of the study and conclusion drawn, the following recommendations were made:

1. The result revealed that processors have low level of educational qualification. Education is very important in achieving any development; to achieve this there should be effective educational training to strengthen the processing enterprise.
2. Extension agents to be sent to processors to encourage processing into more products, like processing into animal feed. It is important that processing should follow modern trends revealed from research.
3. Maize processors should be guided by Extension agents to register themselves into cooperative societies in order to harness the benefit of such

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group, one of which is the ease of getting access to credit facilities from both formal and informal financial institutions.

4. Government should provide infrastructure such as roads, transport and Storage facilities for processors to have ease of transportation, low cost of products and also getting access to the products

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The Effect of Gamma Cobalt-60 Ray Irradiation on Cultivar Growth in Taro White (*Xhanthosoma Sagittifolium* L.)

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Abstract— *The purpose of this study was to determine the effect of cobalt-60 gamma ray irradiation which could expand the genetic security of white taro cultivars (Xhanthosoma sagittifolium (L)). This research has been carried out in June - September 2018 at the Center for Isotope and Radiation Applications, the National Atomic Agency (BATAN) Jakarta, and the Experimental Garden of the Faculty of Agriculture, Andalas University, Padang. Experimental method of gamma cobalt-60 ray irradiation with 0 gray dose; 30; 60; 90; and 120 gray, observations with Single Plant using Student test t test at level 5%. The results showed that the Ld 50 (Lethal dose 50) value, at the level of Gammacell 220 light irradiation (Cobalt-60) occurred in 60 gray, leaf color variation only occurred at irradiation rates of 30 and 90 gray while for plant heights occur at all levels of irradiation.*

Keywords—*Taro plants, growth, radiation.*

I. INTRODUCTION

Along with the development of the population, problems arise in the limitations of food production (staple food in Indonesia is rice). It is not impossible that in the future there will be an imbalance between population growth which is getting faster and requires the consumption of large staple foods, but limited food production. Therefore, it is necessary to diversify consumption of food other than staple foods with other food products from agricultural commodities other than rice (Hafsah et al, 2014).

Carbohydrate needs from year to year continue to increase, serelia carbohydrate supply is not enough, so the role of carbohydrate-producing plants that have a strategic role can be used as a source of local foodstuffs (Arifin, 2015). In Permenhut P.35 / 2007 concerning Non-Timber Forest Products / NTFPs, taro food crops are grouped into pati-patian plants which state that tubers such as taro are very potential to meet food needs because they have a large enough taro production potential (Sudomo and Aditya, 2014) Taro tuber is one of the tubers that has important prospects and has high economic value compared to other types of tubers. Judging from its nutritional content, taro tubers include healthy and safe food commodities, the level of safety lies in the low carbohydrate content (27.25%), reducing sugar (0.87%) and starch content (24.11%) (Rudyatmi and Enni, 2014) Taro has a lower glycemic index (GI) compared to rice, potatoes and other carbohydrate sources. The glycemic index is the level of food according to its effect on blood sugar levels. In other words the glycemic index is the blood glucose response to food. The glycemic index is useful for determining the blood glucose response to the type and amount of food consumed, besides that taro is one of the functional food crops because in taro tubers contain bioactive ingredients that are efficacious for health, but the use of taro tubers cannot be used directly by society because of the length of the vegetative phase (Sundari et al, 2014).

Mutation induction using irradiation produces the most mutants (around 75%) when compared to using other treatments such as chemical mutagens. Gamma rays are short electromagnetic waves with high energy interacting with atoms or molecules to produce free radicals in cells. These free radicals will induce mutations in the plant because they will produce cellular damage or an important influence on plant cell components (Kovacs and Keresztes, 2002).The dose of radiation given to get mutants depends on the type of plant, the phase of growth, size, hardness, and material to be transferred. The results showed that gamma ray radiation with a dose of 100 Gy on chrysanthemum can change the color of the white flower of the purple edge to yellow, while the maximum dose for grains and cereals is 5 Gy (Gehring, 1985).

Given the importance of food diversification and food security it is time to use tubers that can support daily food needs, the content of taro tubers can be a source of carbohydrate substitute for rice which is rich in nutrients, low GI and low in calcium oxalate. Taro consumption can also prevent the risk of heart problems and high blood pressure. In addition, taro also increases alkaline levels in the mouth so that it can make teeth stronger (Bryan et al., 2014).In this study will try to treat the mutation method by physically mutating cobalt-60 in taro genus plant tubers (Xhanthosoma sagittofolium (L)) which is expected to damage the genetic DNA structure of taro plants that encode the production of calcium oxalate.

The purpose of this study was to determine the effect of cobalt-60 gamma ray irradiation capable of expanding the genetic security of white taro cultivars (Xhanthosoma sagittifoilm (L)).

II. MATERIALS AND METHODS

This research was carried out in June - September 2018 gamma ray irradiation treatment was carried out at the Center for Isotope and Radiation Applications, National Atomic Body (BATAN) Jakarta. Tuber nursery and moving the field were carried out at the Agricultural Faculty Experimental Garden of Andalas University, Padang.

This research is using experimental method. Treatment of gamma cobalt-60 irradiation with 0 gray doses; 30; 60; 90; and 120 gray, each gray dose contained 40 samples of taro tubers, bringing the total to 200 tubers. Observation method that is carried out is Single Plant. The test uses the Student test t test at the 5% level (Little and Jackson, 1978). Sampling of taro plants derived from taro farmers in Nagari Limo Kaum Tanah Datar District with the criteria of shoots buds have appeared buds ± 2 cm long and not attacked by pests and diseases.

III. RESULTS AND DISCUSSIONS

LD 50 (Lethal dose 50)

The Ld 50 (lethal dose 50) value, which is the dose level (gray) which causes the death of 50% of the irradiated plant population. Optimal graying in mutation induction that causes diversity and produces the most mutants usually occurs around Ld 50. Calculation of Ld 50 values uses the Thomson and Weil (1952) method. Ld 50 (lethal dose 50) data can be seen in table 1.

Based on observations in the field after irradiation of tubers with Gammacell 220 light (Cobalt-60), there was a difference in the growth rate of tubers in some gray, at 0 gray showed the tubers had grown and began to remove leaves at the age of 1 MST while 30 gray, 60 gray, 90 gray and 120 gray show bulbs grow and start removing leaf strands at the age of 2 MST. Gamma ray irradiation that causes random mutations results in physiological damage in the metabolism of cell development, so that its growth potential can be faster or slower (Aisyah, 2013).

The optimal gray dose in mutation induction that causes diversity and produces the most mutants usually occurs around Ld 50, the result of the Ld 50 calculation using the Thomson and Weil (1952) method. shows that the approach is 60 gray 54.98% while the highest is 120 gray 123.87%. Aisyah (2006) revealed that generally the desired mutation would lie in the Ld 50 dose range.

The administration of gamma ray irradiation on taro tubers is very influential on the growth of taro tubers indicating that the increase in irradiation gray decreases the rate of growth of taro tubers. This indicates that high gamma ray irradiation can inhibit the growth rate of taro tubers. This is in accordance with research conducted by Pramono (2011), which uses gamma rays and is applied to iles-iles plants resulting in plant death. Changes in phenotypes resulting from mutations vary, ranging from minor changes that are only detected by biochemical analysis methods to the drastic changes that occur in essential metabolic processes that cause the death of cells or organisms.

In some tubers that do not grow, the tuber skin conditions like burning, the buds grow brown, then the decay occurs in the eyes of shoots, besides the condition of the bulbs is soft when the tuber is cut open and the color of the reddish tuber (browning) looks. Somatic cell death due to irradiation can occur directly and indirectly. Direct consequences, in addition to the degradation of enzymes that play a role in IAA biosynthesis, also occur due to damage to DNA and chromosomes whose damage will increase along with the increase in irradiation doses (Kim et al., 2004). The appearance of taro plants after Gammacell 220 cobalt- (60) ray irradiation can be seen in Figure 1 below.

Ld50 value can be obtained by knowing the response pattern of plant growth power to various irradiation doses. Figure 1 shows the various responses to the growing power of taro plants.

The deterministic effect arises when the gray received by the plant is above the threshold gray and generally arises shortly after irradiation. The severity of the deterministic effect will increase if the received gray is greater than the threshold gray. Ld 50 in the above tubers is generally high, this indicates that the tubers have low radiosensitivity. This is suspected because the water content in the tuber is very high. The more levels of oxygen and water molecules (H2O) in irradiated material, the more free radicals will be formed so that plants

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become more sensitive (Herison, et al., 2008). Ionization due to irradiation can cause the grouping of molecules along the path of the ion left behind due to irradiation which can cause gene mutation or chromosomal dredging (Aisyah, 2006). Indirect effects, namely the presence of toxic effects from free radicals H2O2 and OH - which are produced from water radiolysis (Soeranto, 2003). The most irradiated material is water which then decomposes into H2O + and e-. In the next reaction free radicals are formed which then combine with peroxide. If peroxide and free radicals react with other molecules, compounds will be formed that will affect the plant biology system (Van Harten, 1998).

Leaf color

Observation of the appearance of leaf color is a descriptive observation by looking at the color changes in the leaves if there is a change in the effect of the mutation.

Based on observations in the field after Gammacell 220 (Cobalt-60) light bulb irradiation was found there was a difference in leaf color at the age of 16 MST. Picture of leaf color can be seen in table 3.

The treatment that has been done shows the difference in leaf color at 30 gray, 90 gray and 0 gray. At 0 gray shows the normal leaf shape where the leaf is a solid green color and the type of leaf color is a common type in white taro, 30 gray shows a slightly yellowish green leaf shape where the yellow color is visible on the edges of the leaf , 90 gray shows the dominant white green leaf color shape, while 60 and 120 gray shows the same leaf color at 0 gray.

Mutation is a process in which genes undergo changes or all types of changes in hereditary material that cause phenotypic changes inherited from one generation to the next. Research conducted by Royani (2012), induction of physical mutations with gamma ray irradiation has influenced changes in the morphological character of sambiloto plants, especially on leaves. Grosch and Hapwood (1979) add that irradiation in plants can cause different leaf shapes including growth inhibition (dwarf), fusion of leaves, and mosaic (change in color).

In this study, there was an expression of taro leaves from mutations in chloroplast DNA (cp DNA) which resulted in less plastide in some tissues or could not produce chlorophyll, while others produced normal chlorophyll, so the leaves were partly green and white or yellow. Changes in the character of chloroplasts can affect the biosynthesis of curcumin. Heldt (1997) states that leaves can absorb nitrogen in the form of nitrates, then chloroplasts change it in the form of ammonium and then become phenylalanine amino acids through a cyclic path. Markham (1998) adds that these amino acids are precursor amino acids for the phenylpropanoid pathway in flavonoid biosynthesis. Curcumin is a type of flavonoid secondary metabolite. Research conducted by Ling et al. (2008) in the form of gamma ray irradiation on the Citrus sinensis plantlets resulting in an increase in protein content, but the resulting chlorophyll content was not higher compared to plantlets without irradiation. In general, changes in the genetic structure will cause changes in their expression (protein form). These changes continue to cause changes in metabolism.

Physiological damage is also able to change metabolism without any changes in genetic material. Metabolic changes will cause changes in chemical content (proteins, enzymes, metabolites), morphological changes (shape and color), changes in adaptability (due to changes in morphology and metabolism), and conditional mutants.

Plant height

Plant height measurement is done by measuring the height of each plant from the end of the standard pole to the longest leaf tip, observations made using a meter. Plant height data can be seen in table 2.

Based on observations of plant height showed that high doses (gray) greatly affect the height of the taro plant, the higher the dose (gray) is given the lower the height of the taro plant.

A high decrease in plants or plants becomes stunted due to the influence of high doses due to physiological disorders or chromosomal damage caused by mutagen (gamma ray radiation) given. Gamma rays belong to pegionic radiation and interact with atoms or molecules to produce free radicals (losing one electron from the free electron pair) in the cell. These radicals can damage or modify very important components in plant cells and cause a partial change of morphology, anatomy, biochemistry and plant physiology depending on the level of radiation. This shows that mutation breeding can create genetic diversity in quantitative characters (Al Safadi et al., 2009). Taro plant height after Gammacell 220 cobalt-(60) ray irradiation can be seen in Figure 3 below.

Adding doses of gamma radiation causes a decrease in plant height. Allegedly caused by gamma rays that damage the plant chromosome composition, so that it affects the growth of plants. This is in accordance with the statement of Ritonga and Wulansari (2010), namely the higher the radiation dose, the lower the plant height; the decrease in plant height occurs because irradiation can damage the plant chromosomes, resulting in disruption of the plant.

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IV. FIGURES AND TABLES

Table.1: Data on the calculation of Ld 50 (lethal dose 50) in taro plants aged 4 MST

Gammacell 220 (Cobalt-60) ray irradiation rate					
Gray	0 (gray)	30 (gray)	60 (gray)	90 (gray)	120 (gray)
Value Ld 50 %	4	25,23	54,98	81,75	123,87

Table.2: High yield data on taro plants aged 16 MST.

Gammacell 220 (Cobalt-60) ray irradiation rate					
Gray	0 (gray)	30 (gray)	60 (gray)	90 (gray)	120 (gray)
Plant height (cm)	50,04	33,8	33,92	36,7	30,16

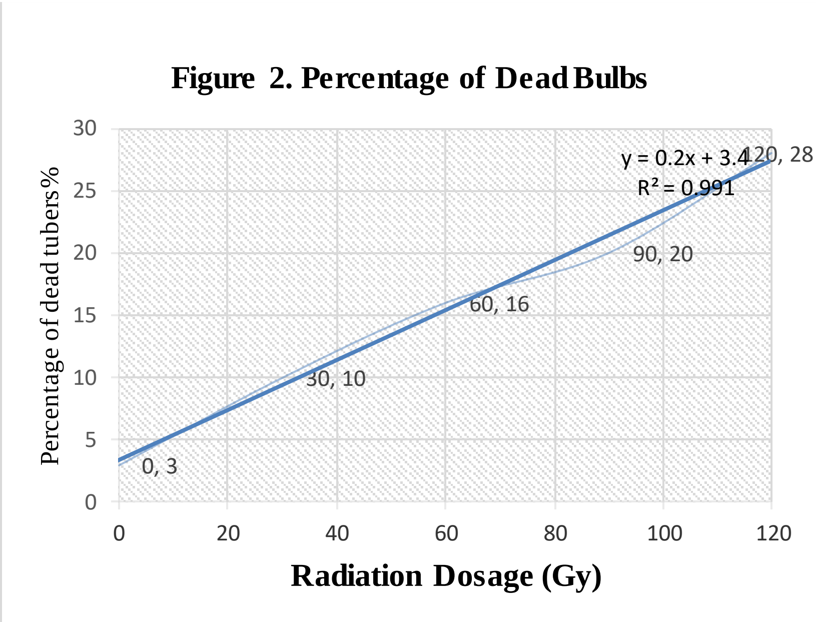

Fig.2: Percentage of dead tubers after being treated with Gammacell 220 cobalt- (60) ray irradiation, namely: 0 Gy, 30 Gy, 60 Gy, 90 Gy and 120 Gy.

Fig.1: Taro plant tubers, A: burnt tuber skin, B: rotten bulb eye, C: rotten tubers

Table 3. Display of leaf color at age 16 MST.

		
A. 0 Gray Solid green	B. 30 Gray Yellowish green	C. 90 Gray Dominant white green

Fig.3: Height of taro plants, 0 gray, 30 gray, 60 gray, 90 gray and 120 gray.

V. CONCLUSION

Based on the results of the research that has been done it can be concluded that the value of Ld 50 (Lethal dose 50), at the level of Gammacell 220 (Cobalt-60) light irradiation occurs in 60 gray, leaf color variations only occur at irradiation levels of 30 and 90 gray while for plant height occurs at all levels of irradiation.It is recommended that further research be carried out regarding the content of calcium oxalate and proximate acid

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Comparative Effect of Different Combinations of Animal Manures and Humic acid on selected soil biochemical properties

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***Abstract*— *The main objectives of this study were to evaluate the effect of animal manures combinations and humic acid on some soil biochemical properties. The laboratory incubation experiment was conducted using a completely randomized design with three replicates. The animal manures included chicken manure (ChM) and cow manure (CoM). The treatments of humic acid (HA), chicken manure (ChM) and cow manure (CoM) were applied on clay soil at a rate of 10 t. ha-1. The treatments used were: Control (T1), HA (T2), HA + ChM (T3) and HA + CoM (T4). The soil samples were incubated for 15, 30, 45 and 60 days at 28 °C and was analyzed for soil pH, the electrical conductivity (EC), total nitrogen, available phosphorus, potassium content, soil organic carbon percentages (SOC) and soil respiration (CO2). In general, the results showed a significant difference between all treatments and the control. Also, the applications of treatments have lowered the soil pH and significant increase in EC was observed as days of incubation. While, the N, P, K, SOC and soil respiration (CO2) were significant increased and reached its peak at 45 days of incubation and decreased thereafter with time. The results showed that applications of organic matter had significant effect on soil biochemical properties and treatment 4 T4 (HA+ CoM) showed a significant superiority compare with other treatments.*

Keywords*— *Animal Manures, Humic acid, soil respiration, soil chemical Properties.

I. INTRODUCTION

The addition of organic materials has the aim to improve soil fertility and increase agricultural production. When applied for a long time can impair certain soil properties. The mineralization of organic matter application into soils increases nutrient contents such as nitrogen, phosphorus, sulfur and smaller amount of micronutrients [1], but also increase soil acidity- pH [2], and there has been increasing of soil salinity [3]. The humic matter is formed through the chemical and biological humification of plant and animal matter and through the biological activities of microorganisms. Humic acids (HAs) are the main fractions of humic substances (HS) and it plays a vital role in soil fertility and plant nutrition. The addition of humic acid (HAs) into the soil can affect some soil properties such as enrichment in soil nutrients, an increase of microbial population, enzyme activities, higher cation exchange capacity (CEC), and improvement of soil structure [4]. Incorporation of HAs into soils stimulated root growth, branching and initiation of root hairs and could partially be attributed to enhanced nutrient uptake [5]. Animal manures (such as chicken and cow manures) can be potentially beneficial for soil properties [6]. The organic manures are excellent fertilizers for the plant, because of the beneficial effects of releasing nutrients to the soil upon their decomposition periods such as nitrogen, phosphorus, potassium and a smaller amount of micronutrients. They can be considered an excellent source of combinations of nutrients [7].

1.1 Objective

The objective of the study was to determine the effect of the combination of humic acid; chicken manure and cow manure on some soil biochemical properties.

II. MATERIALS AND METHODS

2.1 Soil, treatments and experimental design

The soil used in this study was taken from Ankara University - faculty of agriculture -Soil Science research field at depth of 0-30 cm. The soil was classified as aridisol based on Soil Taxonomy [8]. Humic acids was added to soil as powder and brought from Ankara, Turkey. The chicken manure and cow manure were applied to soil after fermentation for 6 months. The combinations of these materials were prepared and mixed with soil on oven dry weight basis at a rate of 10 ton/ha. A laboratory incubation experiment was carried out in complete randomize design (CRD) with three replicates in four different incubation periods (15, 30, 45 and 60 day). The soil weight was 100 g air dry in plastic containers. The treatments were as follows: T1: Control (no addition); T2: Humic acid (10 ton/ha); T3: humic acid (5 ton/ha) + chicken manure (5 ton/ha); T4: humic acid (5 ton/ha) + cow manure (5 ton/ha). The soil samples were incubated at 28 ˚C. The soil moisture was kept at field capacity condition (34.33%) by using distilled water. At the end of each incubation period soil samples were collected.

2.2 Soil analyses:

Soil samples were air-dried, ground and passed through a 2 mm sieve prior to chemical analysis. Soil EC and pH were extracted with 1:5 soil: water ratio and measured potentiometrically using EC-meter (Model JENWAY 4510 date of Mani: Sep, 05 serial No 01892) and glass pH meter electrodes (Model JENWAY 3510 date of Manf. Jan, 09 serial No 05864), respectively, [9]. The total N, phosphorus, and potassium content were determined according to the methods described by [10]. Organic carbon (OC) content was determined by Walkley–Black method [11]. The soil respiration (CO2) was calculated as ml CO2/kg/hr [12-13].

2.3 Soil analyses

Statistical analysis for means comparison was performed using Tukey's test in SAS version 9 [14].

III. RESULTS AND DISCUSSION

3.1 Soil use of study

The data presented in Table (1) showed some biochemical analysis of the soil used in this study. The soil was moderately alkaline, the electrical conductivity (EC) was 0.341(dS/m) classified as non-saline.

Table.1: Some biochemical properties of soil used in this study

Materials	pH	EC (dS/m)	N (%)	P (%)	K (%)	O.C (%)	CO_2 (mg kg^{-1})
Soil	8.15	0.341	0.088	3.48	37.2	0.89	78.8

3.2 Soil pH

Significant differences were observed in the soil pH between the control and all of the treatments throughout the incubation period. The control treatment (T1) was the highest (8.29) and treatment T3 (HA + CHM) was the lowest (7.88). That is because the decomposed organic matter released organic acids that lowered the pH. Regardless of organic matter, soil pH gradually decreased with the increase of incubation time (Fig. 1). Generally, treatment T3 (HA + ChM) was slightly acidic compared with other treatments. These results are in line with [15-16], who showed that pH of cow manure is significantly greater than chicken manure treatment.

3.3 Electrical conductivity (EC)

The results indicated that the treatments significantly affected the electrical conductivity (EC) compared to the control. The control treatment (T1) was the lowest (0.340 dSm1-) and treatment T3 (HA + ChM) was the highest (0.442 dSm1-) (Fig. 2). Generally, soil EC increased significantly with incubation time and reached its peak at 45 days. At 60 days of incubation soil, EC was decreased. In general, the result showed, treatment T4 (HA + CoM) was the best (0.401 dSm1-) compared with other treatments. This could be explained by the fact that the application of a combination of humic acid and cow manure will improve the physical condition of the soil that facilitate the water movement and hence salt leaching. Similar results were obtained by [17-18] who showed that the EC significantly increases with the application of chicken, cow manures and the potential of manure-induced soil salinization was very high in chicken manure compared with cow manure. This is may be due to the concentrations of nutrients released after decomposition.

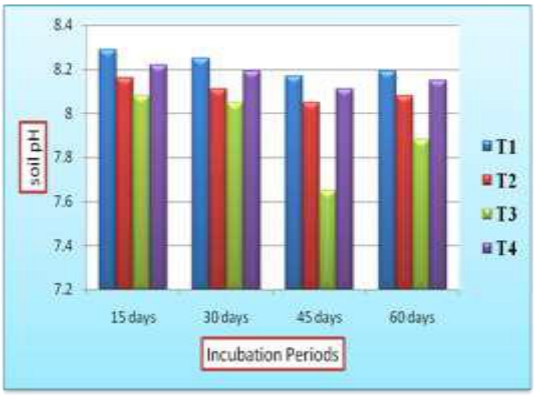

Fig.1: Effect of treatments on soil pH

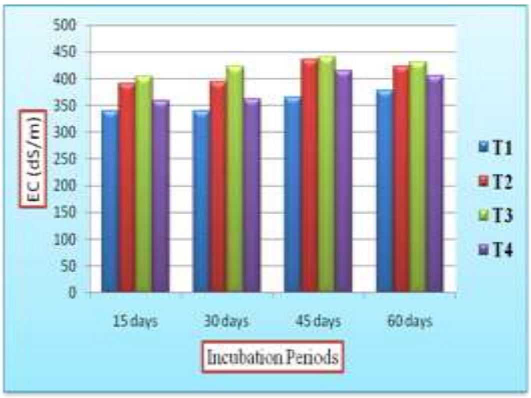

Fig.2: Effect of treatments on electrical conductivity (EC)

http://dx.doi.org/10.22161/ijeab/3.6.10 ISSN: 2456-1878

3.4 Total nitrogen (N)

The soil nitrogen content showed a significant increase by treatments compared with the control. The values of total N ranged from (0.101 mg kg1-) in control T1 to (0.215 mg kg1-) in treatment T3 (HA + ChM). This is natural because applications of manure release nitrogen upon decomposition. Generally, soil nitrogen content was increased significantly with incubation time and reached its peak at 45 days. But in the case of treatment T2 (HA), it was observed that the total nitrogen decreased from (0.162 mg kg1-) at 30 days to (0.134 mg kg1-) at 60 days of the incubation period (Fig. 3). It was observed that treatment T3 (HA + ChM) was higher compared with treatment T4 (HA + CoM). However, treatment T4 (HA + CoM) was the best treatment compared with the other treatments, that is because there was no significant difference between 45 and 60 days of incubation time. [19], who found that organic manure increases total N.

3.5 Phosphorus (%)

The analysis of variance showed significant effects on phosphorous content by all treatments during the incubation time. The control treatment T1 was the lowest (3.65 %) and treatment T4 (HA + CoM) was the highest (14.64 %). In general, the phosphorus content was increased by incubation time and reached its peak at 45 days. The value of P was found to be 6.5% in T2 (HA), while in treatment T3 (HA + ChM) the value was 12.54% (Fig. 4). Treatment T4 (HA + CoM) was the best compared with others treatments. That is because the decomposed cow manure released more organic acids and that lowers the pH. Therefore, the decrease in soil pH will lead to an increase in phosphorus availability. Similar results were obtained by [20] who found that application of manure or compost increased the phosphorus content of the soil.

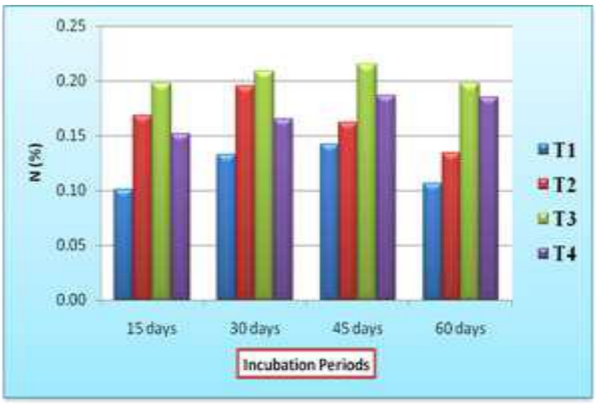

Fig.3: Effect of treatments on total nitrogen (%)

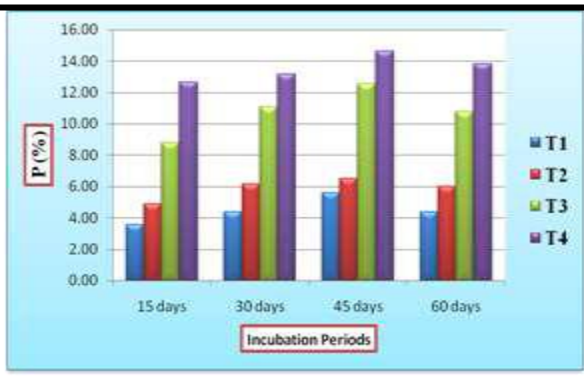

Fig.4: Effect of treatments on phosphorus content (%)

3.5 Potassium (%)

The application of organic matter caused significant differences in potassium content between all treatments and the control. Generally, at 45 days of incubation, potassium content was the highest. The control treatment T1 was the lowest (38.17 mg kg1-) and treatment T2 (HA) was the highest (69.39 mg kg1-). Comparing treatments T3 (HA + ChM) and T4 (HA + CoM), one can observe that the values of K content was 66.33 mg kg1- in treatment T3 (HA + ChM), while in T4 (HA + CoM) it was 59.13 mg kg1-. But the treatment T3 (HA + ChM) was the best compared with others (Fig. 5). The addition of organic matter increased the availability of potassium content in soil due the release of potassium upon organic matter decomposition. Similar results were obtained by [21], who found that application of manure increase the soil potassium.

3.6 Soil organic carbon (%)

The addition of organic material has a significant effect on soil organic matter content (SOM) during the incubation period. The soil organic matter content was highest in treatment T4 (HA + CoM) (1.98 %) and lowest in the control treatment T1 (1.25 %). That is due to the addition of cow manure to soils can improve some soil properties such as organic matter content. Generally, the organic matter content ranged from 1.25%, 1.89%, 1.64% and 1.98% for T1, T2 (HA), T3 (HA + ChM) and T4 (HA + CoM) respectively (Fig. 6). It was observed in this study treatment T4 (HA + CoM) was the best treatment compared with others. That could be explained by the fact that cow manure is a source of organic carbon. Similar results were obtained by [22-23], who showed an increase in soil organic carbon with increased cow manure application.

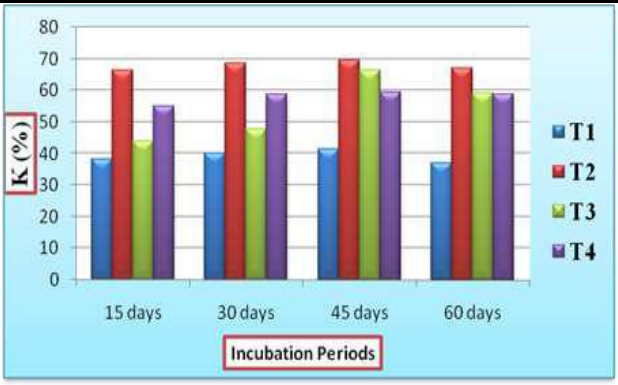

Fig.5: Effect of treatments on potassium content (%)

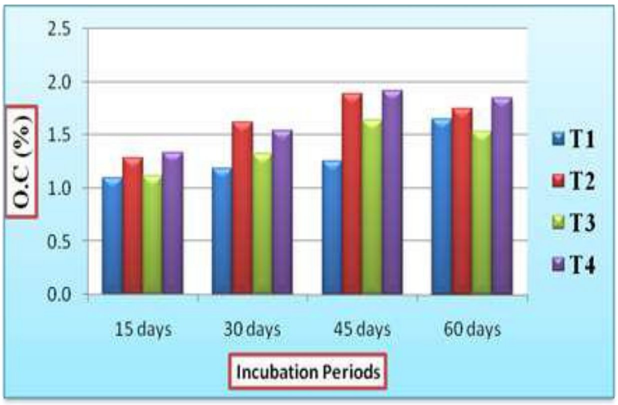

Fig. 6: Effect of treatments on soil organic matter content (SOM)

3.7 Soil respiration (CO_2)

The results indicated that addition of organic material has an effect on CO_2 emission throughout the incubation period. İn general, statistical analysis showed that the highest carbon dioxide (CO_2) was at 45 days of incubation period and decreased by time. This is natural becuase of the decrease of the organic material and hence, the decrease of the decomposing orgnisms. The control treatment T1 was the lowest (114.54 mg kg^{-1}) and treatment T4 (HA + CoM) was the highest (178.56 mg kg^{-1}) (Fig. 7) because the decomposition of cow manure released more CO_2 by soil microbes and that is an indicator of soil health (the level of microbial activity). These results were approximately in line with the findings of [24], who reported that application of manure can increase microbial populations by up to 1000-fold.

Fig. 7: Effect of treatments on soil CO2 emission (mg kg^{-1})

IV. CONCLUSION

In general, the results of the laboratory incubation experiments indicated that application of organic matter had significant effect on soil biochemical properties and treatment 4 T4 (HA+ CoM) showed a significant superiority compared with other treatments.

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Evaluation of safety of *Azdirachta indica* seed oil on Albino rat through haematological and some antioxidants by the rotatable central composite design (RCCD) of the response surface methodology (RSM)

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***Abstract*— *Raw Azdirachta indica seed oil is gradually adopted by local farmers as a protector of stored grains and legumes against the common insects, but with some reservations on its safety. The study investigated the safety A. indica on mammalian objects using haematological and antioxidant indixes. A. indica seed was obtained from the trees in the same location in Utu Ikot Ukpong, Essien Udim Local Government Area, Nigeria. The Albino rats were obtained from the Animal House of Biochemistry Department of the University of Calabar, Nigeria. The animals were treated with varied A. indica seed oil at varied concentrations, periods of exposure and age. Haematological analyses revealed that models of packed cell volume (PCV), red blood cell (RBC), white cell count (WCC) and hemoglobin content (Hb) were not significant. Catalase (CAT), superoxide dismutase (SOD), and glutathione (GSH) were also not significant (p>0.05). Linearity coefficients of the models however appeared to be significant ($R^2 \leq 0.8000$). The mathematical and pictorial models showed slight influence of the test substance on the parameters. The investigation revealed that A. indica seed oil showed no adverse effect on the haematological and antioxidant profile of the animal models at the level of administration, the slight statistical significance could be attributed to other experimental values. A. indica oil seems to be safe on mammalian subjects. More work is recommended on the topic using higher levels of the plant materials at a longer period of exposure.*

Keywords*— *Azdirachta indica, response surface methodology, rotatable central composite design, haematological indices, enzymes.

I. INTRODUCTION

Insecticides are organic and inorganic substances which are used to kill or inactivate insects to check damaging effects of their activities, application is useful in agriculture, medicine, industry and in the homes (Coats, 1999). Deployment of synthetic chemical insecticides in agriculture is claimed to be a major factor behind the increase in the 21st-Century's agricultural productivity (Gerald, 2006). Long-term applications of synthetic insecticides have resulted in residues accumulating in different environmental components of water, food, air and soil (Lorendo-Pino *et al.*, 2014). In order to circumvent their ill effects, ideal insecticides which are not toxic and more environmentally friendly are sought from the plant kingdom (Ojimelukwe, 2008; Lorendo-Pino *et al.*, 2014).

. Botanical insecticides in integrated insect management program have greatly reduced environmental pollution, toxicity to users, reduce cost of medical treatment of insecticide related diseases. Safety to farmers and consumers of treated foods has also been demonstrated. Efforts to develop and apply botanicals as alternatives to the synthetic chemical insecticides have been reported by many researchers, for instance, (Ojimelukwe and Adler, (1999) reported on the potential of zimtaldehyde, 4-Allyl-anisol, linalool, terpinol in the control of confused flour beetle, *Tribolium confusum*. Okpereke and Bunmi, (2006), Okpereke, (2007) reported effectiveness of *Xylopia aethopia* products against the common maize weevil, Huang and Ho, (1998) demonstrated effectiveness of *Piper guneense* powder against *Tribolium castaneum* (Herbst), *Sitophilus* *zeamais* Motsch. Mikhaiel, (2011) showed that some volatile oils of plants could protect packages of irradiated wheat flour against *Ephestia kuheniella* and *Tribolium castaneum*. Insecticidal activities of aromatic plant extracts and essential oils against *Sitophilus oryzae* and *Callosobruchus chinensis* had been demonstrated by (El-Wakil, 2013). Commercial *neem* seed oil is currently in use in the integrated insect management programme (Chaudhary, 2017). *A. indica* is native to Asia, but has now naturalized in Nigeria. *A. indica* is an important item in the traditional medicinal practice in the area of study, according to Pallav *et al.,* (2014) every part of the plant is claimed to posses some medicinal and insecticidal properties, but the seed is grossly underutilized (Schmutterer, 1990). Igbokwe (2017) opined that it is the presence of some biologically active principles like azdirachtin meliacin, gedunin, salanin, nimbin, valasin and their derivatives that confers the anti-inflammatory, anti-hyper glycemic, anti-ulcers, anti-malarial, anti-fungal, anti-bacterial, anti-oxidant, anti-mutargenic, and immunomodulatory properties of *neem* seed oil in mammalian models including anti-feedant, repellent, effect in insects (Ndodo, 2013).

Oil of *A. indica* seed is sprayed on grains/legumes for protection against the damaging effect of the common insects. Protected products are either used for food or feed or replanting. Oily nature of *A. indica* seed oil prevents its total removal from the stored product and therefore may contain residue at levels high enough to elicit health problems in susceptible individuals of the population, the oil may become rancid and develop mycotoxin (Yin *et al.,* 2003), which is a known carcinogen especially at high level of accumulation. As a new product, *A. indica* seed oil deserves safety evaluation on mammalian models before injected into the market for human consumption.

In this study, the Rotatable Central Composite Design (RCCD) of the Response Surface Methodology (RSM) was employed to test the linear, combined and quadratic effects of graded levels of age, dose and exposure time on haematological indices and antioxidants of blood of Albino rats. Response surface methodology tests effect of many variables on parameters of interest at the same time, therefore the method is robust, reliable and predictable, the design saves time and cost (Kwak *et al*., 2015). According to Kanu *et al.,* (2016), chronic diseases affect blood cells adversely, therefore haematological data provides the most important information in the determination of biochemical and physiological state of animal models (Jorum *et al*, 2016). Damage mediated by free radicals results in high rate of disruption of membrane fluidity, protein denaturation, lipid peroxidation, oxidative deoxyribonucleic acid (DNA) and alteration of platelet functions, the molecular damages have been linked with diabetes, cancers, inflammation, aging and atherosclerosis (Kanu *et al*., 2016).

From literature, many works have been done on the safety or toxicity of *A. indica* seed oil products but to the best of our knowledge, few data is available on the effect of *A. indica* seed oil on haematological and antioxidant levels using the rotatable central composite design of the response surface methodology.

Therefore the work evaluated the safety of *A. indica* seed oil through levels of haematological and enzyme indices of Albino rats using the RCCD of the RSM. Data from the work is expected to enhance food security and low cost of insect pest management, cultivation and utilization of *neem* seed can provide employment.

II. MATERIALS AND METHODS

Forty-five (45) Albino rats of 14 - 40 days were obtained from the animal house of the Department of Biochemistry, University of Calabar, Cross River State, Nigeria. The commercial rodent meal was bought from Pfizer, Lagos. *A. indica* seed was obtained from Essien Udim Local Government Area in Akwa Ibom State. All reagents used for the study were of analar grade, double distilled water was used for their preparation.

Preparation of *A. indica* seed powder

Preparation of *A. indica* seed was sorted, decorted, washed and dried in the sun for 24 hours. It was then dried in hot air oven at 50°C for 24 hours to a moisture content of about 12%. The dried seed was milled to pass through 0.2-0.5 mm sieve (Fritsch GMBH, Germany BRD-6580), packaged and stored in moisture proof container for subsequent use.

Preparation of *A. indica* seed oil

Preparation of *A. indica* seed oil was carried out according to the method adopted by Okigbo, (2008). Five hundred (500) grams of *A. indica* seed powder was soaked in 1000ml of 95% ethanol in a round-bottomed flask and allowed to stand at room temperature for 24 hours. The filtrate was evaporated with a rotary evaporator (Buch Laboratorriums Technic, AG CH - 9230), to free sample from the solvent leaving a dark slurry as the oil.

Animal models

The animal models were handled according to CLSI (2000). They were stabilized for 5 days with water and fed *ad lib*. A dose of ampicillin was administered through the drinking water to check possible infection, they were housed in separate cages, the housing guaranteed adequate lighting, ventilation and standard humidity.

Administration of *A. indica* seed oil

Treatment of Albino rats was done according to the method of (Adewale *et al.,* (2014) with slight

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modification to fit the experimental design. Animals with similar blood and antioxidants parameters were randomly assigned to the experimental units; (15 laboratory animal cages) (Table 1, 2), watered with commercial table water (ARSAN Water) and fed standard rodent diet (Pfitzer, Lagos) *ad lib* between 0 to 40 days. Graded levels of *A. indica* oil was administered orally at concentrations according to the experimental design in Table 1. At the end of each experimental run, animals in the experimental unit were anesthetized with diethyl ether, blood samples were taken from the heart and preserved with EDTA to prevent clotting. Samples were centrifuged at 3,000 rpm for 10 min to obtain the plasma.

Estimation of haemoglobin and antioxidant assay of blood of treated Albino rats

Pack cell volume (PVC), red blood cell (RBC), white cell count (WCC), haemoglobin content (HB) according to the method of Adebayo *et al.* (2005) using automated haematology analizer (ERMA) (Model PCE 210 Japan). Catalase was assayed spectrophotometrically according to the method of Aebi *et al*., (1983), estimation of superoxide dismutse was done according to the method of Aebi *et al*., (1983), estimation of reduced glutathione was determined by the method of Kwak *et al*., (2016).

Background of experimental design and statistical analysis

RSM enables evaluation of effects of multiple independent variables singly or in combination simultaneously on dependent variables (Meyers *et al*., 2002). Design Expert Version 10 (Statease Inc., Minneapolis, MN, USA) was deployed for the design and analysis of the experimental data. Age of animal model, dose of the test substance, and exposure time of the animal model to the test substance were chosen from experimental experience (Table 1). The Rotatable Central Composite Design assumes equation 1.

$$Y_i = \boldsymbol{\beta}_\theta = \sum_{l=1}^{3} \beta i Xi + \sum_{l=1}^{3} \beta ii\ x^2 i + \sum_{j=i+1}^{3} \beta ij\ Xi\ Xj + e \quad \ldots \quad (1)$$

where Y_i is any response, β_θ = intercept, β_i = first order model coefficients, β_{ii} = quadratic coefficient for the i^{th} variable, β_{ij} = interaction coefficients for the interaction variables i and j, X_i = any independent variable. Second order coefficient was generated by regression analysis with backward elimination. Responses were first fitted for the factors by the coefficients of determination, R^2.

Table.1: Experimental design and levels of independents variables

Variable	Units	-α	-1	0	1	+ α
Age	Days	8.6152	14	13.5	40	45.3848
Dose	mg/100g	5.8578	10	20	30	34.1421
Time of exposure	Days	-4.1421	0	10	20	24.1421

α = 1.4142 for RCCD

III. RESULTS

Levels of the independent variables, age (X_1) 14-40 days, dose (X_2) 10-30 mg, and exposure time (X_3) 0-20 days were assigned to the experiment by experience and done according to RCCD in Table 1. Effect of the variables on packed cell volume (PCV), red blood cell (RBC), white cell count (WCC), haemoglobin content (Hb), catalase (CAT), superoxide dismutase (SOD) and glutathione (GSH) of the blood samples of the animal models are presented in Table 2. From the table, PCV ranged from 20-39%, RBC ranged fron 7.92 to 9.92x106/ml, WCC ranged from 7110-8221x10^6/ml, Hb ranged from 12.01-13.17g/100g and means of 33.38%, 8.86x10^6/ml, 7745.23 x10^6/ml, 12.69 g/100ml respectively. CAT, SOD and GSH ranged from 328.9-954.90 IU/gHb, 5478-6917 IU/gHb and 2.35-3.99 IU/gHb and mean of 441 IU/gHb, 6164 IU/gHb, and 3.50 IU/gHb respectively. Standard deviations of the parameters were 4.59%, 0.52%, 454.20%, 12.69%, 166.90%, 416.07% and 0.493% respectively. The low standard deviation of the parameters indicated low variability in the observation as can be seen in Table 2 except SOD and GSH which showed higher values than the control. Run 14 was not included in the calculation due the extraordinarily low values.

Table.2: Experimental runs, results and standard values of the parameters

Run	Age Days	Dose mg/100g	Exposure Days	PCV %	RBC x10^6/ml	WCC x10^6/ml	Hb g/100g	CAT IU/gHb	SOD IU/gHb	GSH μM/gHb
12	27	20	10	39	9.52	7830	13.17	394.1	5981	3.53
5	8	20	10	38	9.21	8001	12.01	593.5	6098	2.35
10	27	24	24	37	9.51	7911	13.21	394.9	6182	3.75
6	45	20	10	35	9.22	7851	12.91	374.7	5519	3.11
2	40	10	20	37	9.11	7907	13.22	392.3	6917	3.99

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4	14	10	0	30	9.25	8110	12.10	389.9	6391	3.34
8	27	34	10	32	9.22	7110	13.00	389.6	6551	3.91
13	27	34	10	35	9.17	8113	12.21	954.9	6276	3.56
7	27	6	10	32	8.97	7917	13.11	377.8	6088	3.98
3	14	30	30	20	9.04	8211	12.01	328.9	5617	3.90
14	**27**	**20**	**34**	**9**	**8.90**	**8221**	**12.01**	**328.9**	**5617**	**3.21**
1	40	30	0	35	7.92	7117	12.22	389.7	6315	2.66
9	27	20	-4	35	8.21	8220	13.00	399.2	6277	3.77
11	27	20	10	34	8.22	7110	13.00	349.9	6616	3.65
15	27	20	10	34	8.22	7110	13.00	398.3	5478	3.55

PVC = packed cell volume, RBC = red blood count, WCC = white cell count, Hb = haemoglobin, CAT = catalase value, GSH = superoxide dismutase, GSH = glutathione level.

Table.3: Analysis of variance (ANOVA) of the experimental data

	PVC	RBC	WCC	Hb	CAT	SOD	GSH
Model	0.5112	0.4634	0.5540	0.1780	N/A	0.3382	0.0050
Linear effect							
Age (X_1)	04299	0.9882	0.8074	0.0684	N/A	0.3060	0.0198
Dose (X_2)	1.0000	0.7135	0.2253	0.3545	N/A	0.4073	0.7687
Exposure time (X_3)	0.5919	0.0992	0.6191	0.3691	N/A	0.8621	0.9327
Interaction							
Age x Dose (X_1X_2)	0.6690	0.5341	0.3068	N/A	N/A	0.9725	0.0080
Age x Exposure (X_1X_3)	0.7863	0.2310	0.7143	N/A	N/A	0.0914	0.1968
Dose x Exposre (X_2X_3)	0.1403	0.3674	0.3953	N/A	N/A	0.0898	0.0141
Quadratic							
Age^2 (X_{11}^2)	0.4649	0.7105	0.8688	N/A	N/A	N/A	0.0011
Dose^2 (X_{22}^2)	0.1427	0.9798	0.2788	N/A	N/A	N/A	0.0120
Exposure^2 (X_{33}^2)	0.6318	0.5203	0.5484	N/A	N/A	N/A	0.0755
R^2	0.6519	0.6741	0.6317	0.3488	0.0000	0.5030	0.9611
Adjusted R^2	0.0254	0.0874	-0.0313	0.1712	0.0000	0.1302	0.8911
Mean	33.38	8.86	7745.23	12.69	441.04	6164	3.50
Lack of Fit	0.6907	0.5066	0.9441	0.6786	0.9996	0.6797	0.9539

Table 2 shows random order of the experimental runs, coeficient of estimate, coefficient of determination, and control values of the parameters. Table 3 shows statistic of analysis of variance (ANOVA) of the experimental data. The model for PCV was not significant ($p>0.05$). The coefficient of determination, $R^2=0.6519$, and the Adjusted coefficient of determination, Adj. $R^2= 0.0524$ confirmed a weak statistical confidence of the model. Linear, interaction and quadratic terms of age, dose, and exposure time were not significant ($p>0.05$). Variation of the parameter is represented by Fig. 1 and equation 1. According to Fig. 1 and Equation 2, the value of the parameters deviated very slightly with age, dose and exposure time. According to the equation, terms of age, dose and exposure time were synergistic, while interactive terms showed antagonistic effects, quadratic terms were very low but postive.

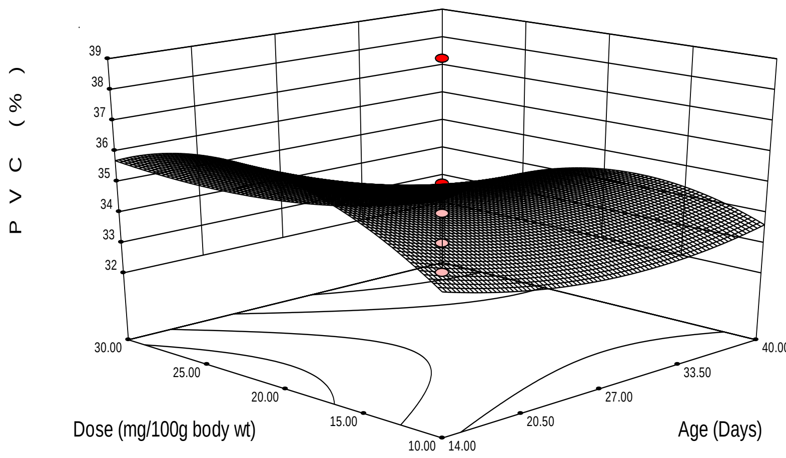

Fig.1: Response surface-contour plot of dose of test substance and age of model animal on pack cell volume of model animal blood

PVC = 23.10 - 0.146(X_1) + 1.09(X_2) + 0.70(X_3) - 6.099(X_1 X_2) -0.03(X_2 X_3) ... (2)

The model of RBC was not significant (p>0.05), the coefficient of determination, R^2 =0.6741 indicated weak confidence on the model. The linear, interaction, and quadratic terms of the model were not significant (p>0.05) except time (X_3) with which appeared to be significant p=0.0992. The model is represented by Fig. 2 which shows that red blood cells increased with age of the animal model and not as a function of dose and time (not shown here) and was corroborated by Equation 3.

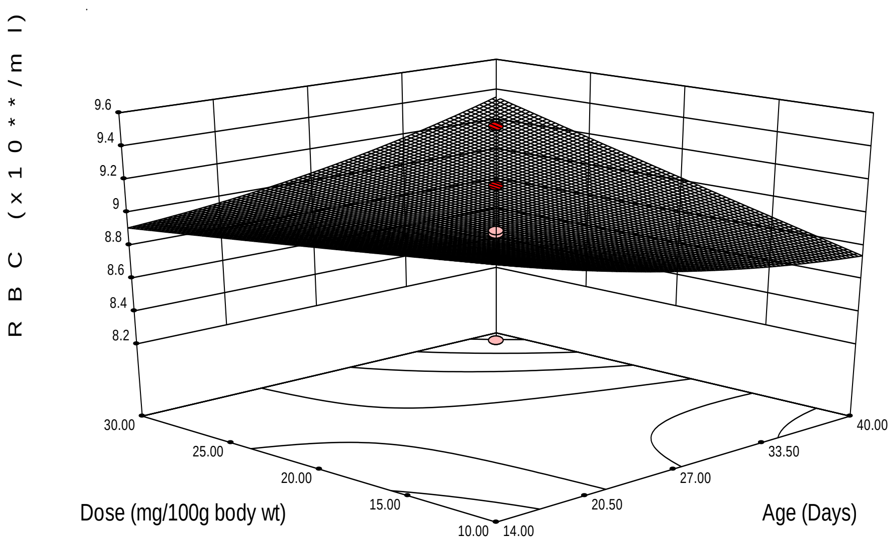

Fig.2: Response surface-contour plot of dose of test substance and age of model animals on red blood cell content

RBC =10.10 - 0.09(X_1) - 0.07(X_2) - 0.07(X_3) ... (3)

The model for WCC was not significant (p>0.05). The coefficient of determination (R^2 =0.6317), the linear, interaction, and quadratic terms of the model were not significant (p>0.05), with mean value of 34.53x10^6m/l. The model is represented by Fig. 3 and Equation 3.

WCC =7088 + 47.44(X_1) + 85.47(X_2) - 60.79(X_3) - 2.55(X_1X_2) - 0.87(X_1X_3) + 2.71(X_2X_3) + 0.15(X_{11}^2) - 1.80(X_{22}^2) + 0.95(X_{33}^2) .. (4)

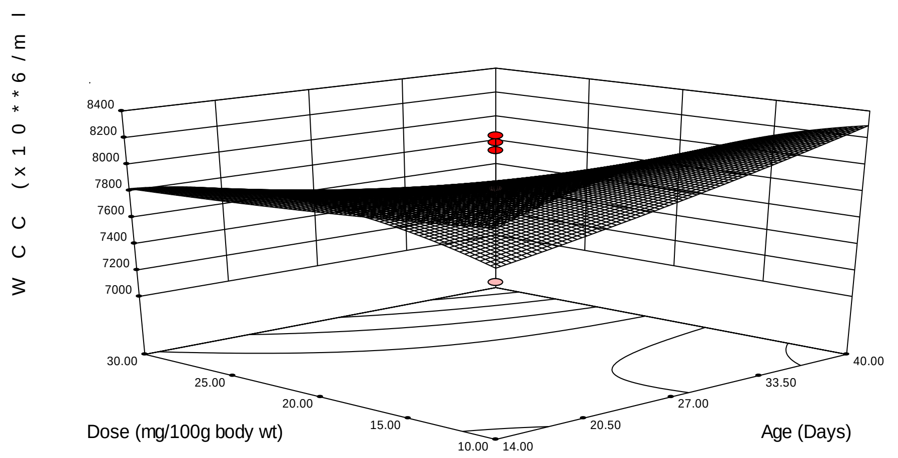

Fig.3: Response surface-contour plot of dose of test substance and age of model animals on white cell count.

WCC $=70.88 - 64.150(X_1) + 85.47(X_2) - 60.80(X_3) - 2.55(X_1X_2) - 0.87(X_1X_3) + 2.71(X_2X_3) + 0.16(X_{11}^2) - 1.80(X_{22}^2) + 0.96(X_{33}^2)$ ... (4)

The model of Hb was not significant ($p>0.05$), the coefficient of determination ($R^2 = 0.3488$) and Adj. $R^2 = 0.1712$ confirmed weakness of prediction of the model. The linear, interaction, and quadratic terms of the model were not significant ($p>0.05$), except age which appeared to be significant, $p=0.0684$. The model for Hb estimation is given in Equation 5. The model of CAT was not significant and could not be calculated, the linear, interaction, and quadratic terms of the model could not be calculated due to low range of the data (N/A), while the mean value was (420.37 IU/gHb). The model is represented by Equation 5. The model for SOD was not significant ($p>0.05$), the coefficient of determination $R^2 = 0.5030$ confirmed lack of confidence of the model. The linear, interaction and quadratic terms of the model were not significant ($p>0.05$). The model was represented by Equation 6.

SOD = $6363 - 1.56(X_1) - 56.24 + 65.49(X_2) - 6.661(X_3)$
$0.0724(X_1X_2) + 3.9053(X_1X_2) - 5.10(X_1X_3)$

The model for GSH was not significant ($p>0.05$). The coefficient of determination ($R^2 = 0.9611$, Adj $R^2 = 0.8911$) showed some confidence on the model. The linear, interaction and quadratic terms of age, dose and exposure time were not significant ($p>0.05$). The model is represented by equation 7 and a response surface plot (not shown).

GSH $= 1.54 + 0.205(X_1) - 0.032(X_2) - 0.145(X_3)$ ...

IV. DISCUSSION

Many people in the local community where the study was undertaken believed that the oil of *A. indica* seed at the level they apply to stored grains and legumes could retain the oil residues at a levels high enough to induce toxicity in mammalian system especially if consumed at high doses at an extended period of time. It is well known that the oil contains some bioactive components like alkaloids, polyphenols and flavonoids which have convinced proofs of influence on good biochemical processes in mammals. This is why they are used for as 'drugs' and nutrients (Wararut *et al*., 2012). In spite of proven assurances of safety of some botanical oils in nutrition and health, information on every plant material to be introduced into the food chain must be made available (Ojimelukwe *et al*., 2008) to the consumer population. Fear of toxicity of *A. indica* seed oil could originate from previous reports of toxicity of *Galega officialis, Agentum conyzoles* L., *Calendula officicinalis, Cedrus deodara* (Adebayo, *et al*., 2010). In our work, the major haematological parameters and organic enzymes were provided on the health status of the animal models, this method is used as a preliminary or decisive step in medical diagnosis before treatment (Wasser *et al*., 2004). Mean percentage PCV of the blood samples of 15 Albino rats treated with oil of *A. indica* seed was within the control value. The value obtained was in agreement with that reported by Wasser *et al*., (2004) on the effect of *Gonderma spp* on haematological parameter of mice model, but different from that reported by Shamaki *et al*., (2014) but using the same plant material on Albino rat. The variation in the values of the parameter reported could be attributed to the high dosage of the plant material which was administered, time of exposure, sex, age of the animal models and other experimental conditions. In real life situation, high residues of the *A. indica* seed oil are rare in processed foods (8) after washing and boiling, therefore treated foods may not contain residual concentration high enough to alter blood parameters above the control values. Therefore results of our study showed no significant variations in pack cell volume (PCV), red blood cell (RBC), white cell count (WCC), and haemoglobin content (Hb), very slight variations were noticed with increasing age of the animals except in run 14 which did not show reasonable values, this was in agreement with the observation of Adel *et al*., (2015). The observation suggest that the *A. indica* seed oil failed to alter most biochemical processes in the animal models to detectable level at the levels and time administered. Catalase (CAT), superoxide dismutase (SOD) and glutathione (GSH) are some of the important endogenous antioxidants (Geta *et al.,* 2002) which counteract the damaging effects of free radicals in living system, the marginal variation among the animal models did not suggest toxic effect of the plant material. This is not surprising because *A. indica* plant has a good history of remedying liver cirrhosis, inflammation and cancer (el-Shazyl *et al*., 2000), and is expected to control oxidative stress at the level of administration (Tables 2, 3).

In the study, it could be concluded that the of *A. indica* seed oil which was administered orally to the animal models did not alter haematological indices and antioxidant values significantly from the control. The slight changes observed did not mean that the animals were sick but could be attributed to experimental errors. Therefore, the use of *A. indica* oil as an alternative to some chemical synthetic insecticides should be considered.

V. CONCLUSION

Azdirachta indica seed oil may be a safe alternative to the synthetic chemical insecticides. Because the plant material failed to elicit appreciable alteration on the haematological indices and antioxidant levels in Albino rats at the conditions of administration. The use of the plant material as an alternative to the synthetic chemical insecticides should be encouraged, but more work should be carried out on higher levels of other independent variables.

Conflicts of interest: The authors declare no conflict of interest.

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Effect of Global Warming Scenarios on Carotenoid Pigments *Gracilaria changii*

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Abstract*— *The phenomenon of global warming is an increase in the earth's temperature due to the greenhouse effect where 50% of the main contributors to the greenhouse effect are carbon dioxide (CO_2). Carbon dioxide is one of the ingredients needed for photosynthesis. Photosynthesis is carried out by plants that have chloroplasts. Plants in the waters are Seaweed. Gracilaria changii is a type of red seaweed (Rhodophyceae). The dominant pigment from Gracilaria changii is carotenoids. Carotenoid serves as a light energy absorbent for photosynthesis and serves to protect chlorophyll from light damage. Seeing the important role of carotenoids in Gracilaria changii so that this study aims to determine the effect of increasing temperature and carbon dioxide on carotenoid pigments. Research on the scenario of global warming in this region was first carried out on a laboratory scale, many previous studies were carried out in the cultivation area. This study was conducted for 40 days, seaweed that has been cleaned is put into an aquarium and given an injection of CO_2. We were exposed to present-day control seawater (400 ppm pCO_2) and seawater treated with CO_2 to simulate ocean conditions predicted for the next 50–100 years (700 ppm, 1000 ppm, and 1300 ppm) and temperature treatment (30 °C, 32 °C, 34 °C). The research design applied in this study is a Completely Randomized Design consisting of nine treatments with three replications. Data analysis used is Analysis of Variance (ANOVA) continued by Post hoc Test. The results obtained from this study there were significant differences (P <0.05) of carbon treatment in carotenoid pigments. The highest carotenoid pigments are found in 700 ppm CO_2 injection treatment.

***Keywords*— CO_2, Global warming, Gracilaria changii, pigment carotenoids, Temperature**

I. INTRODUCTION

Global warming is an increase in earth temperature due to the greenhouse effect, which is 50% caused by Carbon dioxide (CO_2) (Prasad et al. 2017; Forster, P., et al. 2007). So that this phenomenon has a major impact on living things and the environment (Fabry et al. 2008). The high CO_2 in the atmosphere will diffuse into the seawaters and cause chemical changes so that it makes the ocean acidic (Auerbachu et al. 1997). The absorption of carbon dioxide is indicated to cause a reduction of 0.1 units of sea surface pH which is equivalent to a 30% increase in the concentration of hydrogen ions in the sea (Caldeira, et.al 2005) so that it can cause ocean acidification (Doney et al. 2009).

Carbon dioxide is one of the materials in the process of photosynthesis by plants that have chloroplasts (Joseph et al, 1982; Richter 2018). One of the plants that live in waters is seaweed. Based on the pigment seaweed is divided into 3 major classes namely red seaweed (Rodophyceae), green seaweed (Chlorophyceae), and brown seaweed (Phaeophyceae) (Aryee et al. 2018).

Gracilaria changii is a type of red seaweed (Rhodophyceae) with carotenoids as the dominant pigment (Chan & Matanjun, 2016). Seaweed is resistant to environmental conditions compared to other types of grass (Wei et al. 2015).

The colors produced by carotenoids range from pale yellow, bright orange, to deep red, depending on the chemical structure of each. Carotenoid functions as an absorbent light energy for photosynthesis and functions to protect chlorophyll from O2 damage caused by oxidation when the radiation level is high (Richter 2018).

Based on the fact that there is an association between carotenoids and CO_2, this study was conducted to determine the effect of increasing carbon dioxide and temperature on the amount of carotenoid pigments. Research on the scenario of global warming in this region was first carried out on a laboratory scale, many previous studies were carried out in the cultivation area.

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II. METHODS AND MATERIAL

Gracilariia changii samples were obtained from cultivation sites in Ujung Baji Village, Takalar Regency, Indonesia.

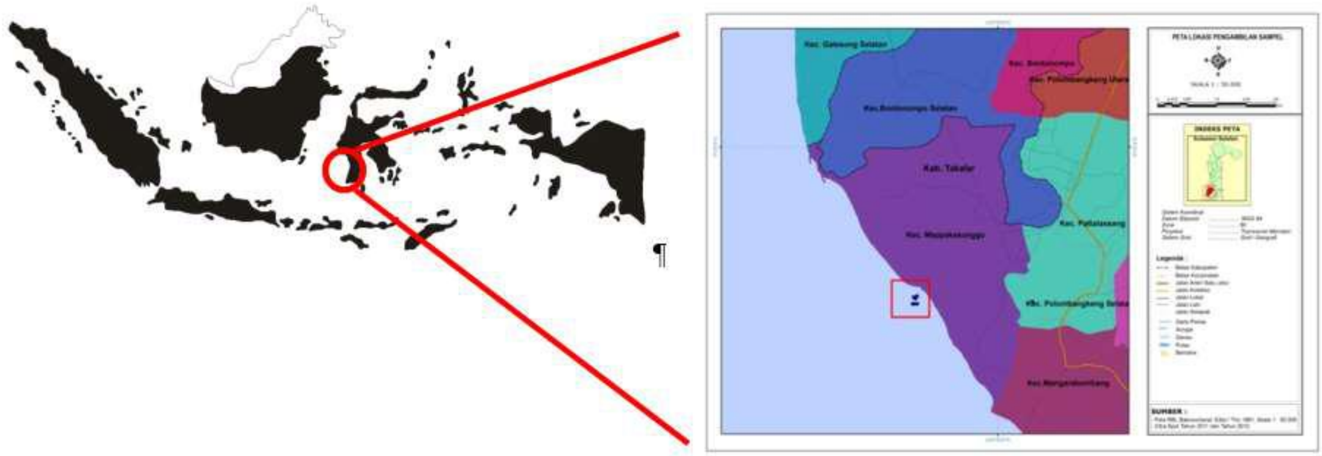

Fig.1: Research Location Map

Sumber: http://www.forumindonesiamuda.org/regional/peta-indonesia

The scenario of global warming is carried out in the Wet Laboratory of the Center for Science and Technology, the Development of Seaweed Research and pigment analysis carried out at the Faculty of Marine and Fisheries Laboratory, Hasanuddin University.

Gracilaria changii of 126 gr seaweed that has been cleaned is put into the aquarium (60x35x30) cm with a carbon system. The carbon system is used for global warming scenarios and the use of LED lights to optimize photosynthesis (Kim et al. 2015). The aquarium is under the illumination of LED lights on photoperiod 24 L and it is treated with CO_2 and temperature for 40 days.

Atmospheric CO_2 amounted to 380 ppm in 2007, increasing by an average of 0.5% per year and in a decade there will be an increase of 15 ppm so that the atmosphere ranges from 400 ppm in 2018 (Gattuso & Lavigne, 2009; Watson et al. 2012). Treatment of seawater for injection of CO_2 (1) control current time 400 ppm (2) low 700 ppm (3) Medium 1000 ppm (4) Height 1300 ppm and temperature treatment (1) T0 Control 28 ^oC, (2) T2 30 ^oC , (3) T3 32 ^oC (4) T4 34 ^oC. Consistent with predictions of ocean warming for the tropics (Poloczanska, E.S. et al, 2007). The research design applied in this study is a Completely Randomized Design consisting of nine treatments with each of three replications. Seawater parameters are shown in table 1.

Table.1: Seawater parameters

Treatment	Temperature (^oC)	Replicate	pH	Salinity	DO	pCO_2 (ppm)	CO_2
Control pCO_2 and T0	28.0	3	7.94 ± 0.17	36.67±6.00	5.20±2.00	400	28,09±3,99
Low pCO_2 and T1	30.0	3	7.68±2.78	37.00±6.08	6.00±2.66	700	59,12±3,61
Low pCO_2 and T2	32.0	3	7.68±2.78	37.00±6.08	4.73±2.41	700	57,64±3,03
Low pCO_2 and T3	34.0	3	7.85±2.80	37.67±6.16	4.10±2.26	700	55,26±3,04
Medium pCO_2 and T1	30.0	3	7.24±2.70	36.67±6.08	4.60±2.26	1000	51.93±2.63
Medium pCO_2 and T2	32.0	3	7.01±2.65	37.00±6.00	4.90±1.87	1000	61.26±1.52
Medium pCO_2 and T3	34.0	3	6.87±2.65	36.67±6.08	4.50±1.97	1000	79.94±3.72
Height pCO_2 and T1	30.0	3	6.29±2.51	36.00±6.00	4.93±2.14	1300	105.87±5,72
Height pCO_2 and T2	32.0	3	6.44±2.52	37.00±6.82	4.67±2.21	1300	109.20±4.83
Height pCO_2 and T3	34.0	3	6.31±2.52	36.67±6.08	4.57±2.19	1300	145.15±7.06

The research sample was dried using an oven with a temperature of 50 ^oC. Then take 2 grams and add 10 ml acetone, let stand for a day in a dark room. After that, absorbance is measured using a spectrophotometer. Measurement of carotenoids with a wavelength of 470 uses formula (De Carvalho et al., 2012): Carotenoids (µg/g) = [A x v (mL) x 104] / A1% x w (g), where A = absorbance; v = total volume of extract; w = sample weight; A1% = 2600 (coefficient of β-carotene in hexane).

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Data analysis used is Analysis of Variance (ANOVA) followed by Post hoc Test.

III. RESULTS AND DISCUSSION

Based on statistical analysis with ANOVA the initial carotenoid pigment content of 0.24 ± 0.51 µg / g showed a significant ($P < 0.05$) difference in the content of late carotenoid pigments. At the end of the study the highest carotenoid pigment was found in the injection treatment of pCO_2 700 ppm with a temperature of 34 °C having a pigment content of 2.05 ± 1.32 µg / g followed by a temperature of 32 °C with a pigment content of 1.66 ± 1.28 µg / g and temperature 30 °C has a pigment content of 1.66 ± 1.43 µg / g. The carotenoid pigment content at injection of pCO_2 1000 ppm with a temperature of 32 °C was 1.34 ± 1.04 µg / g whereas at 34 °C the carotenoid pigment content was 1.26 ± 1.24 µg / g and at a temperature of 30 °C the carotenoid pigment content amounting to 1.22 ± 0.79 µg / g. pCO_2 1300 ppm at 30 °C has a pigment content of 0.94 ± 0.91 µg / g, the pigment content at 34 °C is 0.91 ± 0.86 µg / g, and at 32 °C has a pigment content of 0.73 ± 0.86 µg / g. The carotenoid pigment content at the end of the study showed that injection of pCO_2 700 ppm had a significant difference ($p < 0.05$) for injection of pCO_2 1000 ppm and injection of pCO_2 1300 ppm. Variations in carotenoid pigment content in this research experiment are shown in Figure 2.

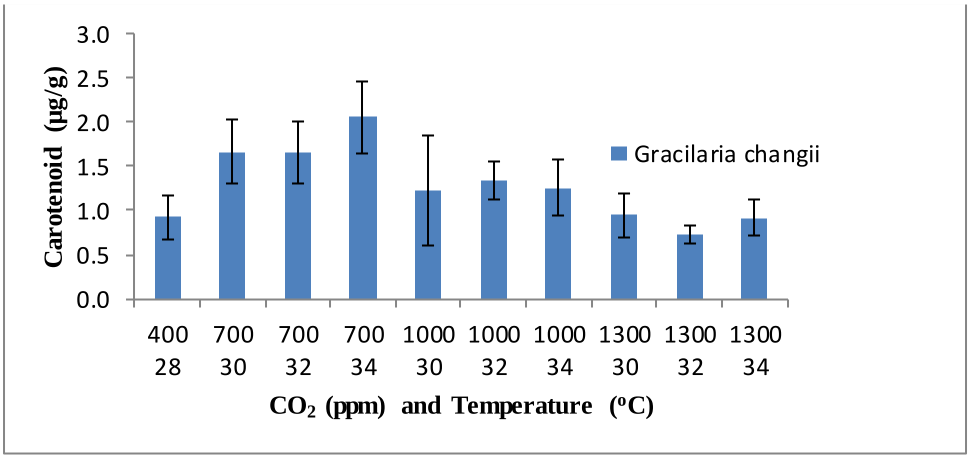

Fig.2: Carotenoid pigments in carbon sequestration treatment

This study showed an increase in the amount of carotenoid pigment *Gracilaria changii* after being given the addition of CO_2 and temperature. During the experiment, the control experienced an increase in pigment levels when compared with the initial levels of the sample before the experiment was carried out. The level of carotenoid pigment increases with the addition of pCO_2 700 ppm and then decreases slightly with the addition of 1000 ppm pCO_2. The carotenoid pigment content at the addition of pCO_2 1300 ppm has decreased and returned to the same as the control but the carotenoid pigment levels have all increased when compared to the initial pigment of the study.

Carotenoid pigments are one of the pigments found in chloroplasts which play a role in photosynthesis (Salisbury, F. B. & Cleon, W. R., -). Photosynthesis is the process of compiling organic compounds from CO_2 and Water that require light (Loveless, A.R., 1991). Light is very closely related to chloroplasts because light has the nature of wavelengths and properties of particles which are energy. The chloroplast pigment absorbs more than 90% of the purple and blue wavelengths that hit it and is almost as big as the percentage of orange and red wavelengths (Loveless, A.R., 1991).

Addition of carbon dioxide concentration to 700 ppm and supported by photoperiod 24 L caused an increase in photosynthesis (Loveless, A.R., 1991). This is because *Gracilaria changii* will take more carbon dioxide because the Rubisco enzyme that functions to hold CO_2 becomes active in the presence of light (Caemmere, S Von; G.D. 1981; Salisbury, F. B. & Cleon, W. R., -). The temperature of 34 °C is the optimum temperature in the tropics for increasing the speed of photosynthesis. Temperatures above about 35 °C cause temporary damage or permanent damage to the protoplasm, which causes a decrease in the speed of photosynthesis (Loveless, A.R., 1991).

At the end of the study the addition of pCO_2 of 1000 ppm and pCO_2 of 1300 ppm showed an increase in carotenoid pigment content when compared with the levels of carotenoid pigments at the beginning of the study, but rather decreased compared to the addition of pCO_2 700 ppm due to the high addition of carbon dioxide can affect pH levels in water. Low pH in water makes work function Rubisco enzymes found in inactive chloroplasts and decreases in pH greatly influence the transfer of electrons from polypeptides with molecular weights around 33kDa to P680 (Conjeaud 1980; Salisbury, F. B. & Cleon, W. R., -).

IV. CONCLUSIONS

The conclusion of this study:

1. shows effect of the scenario of global warming on carotenoid pigment.
2. Treatment of carbon dioxide injection and temperature differences indicate an increase in amount of carotenoid pigments and the highest increase occurs in the injection of carbon dioxide 700 ppm with a pigment content of 2.05 ± 1.32 µg / g.

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Effect of Irrigation Intervals on forage production and quality of different alfalfa varieties under semi-arid conditions

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***Abstract*— *Alfalfa (Medicago sativa* L*) is a well-known and most important forage crop throughout the world-wide, its yield and quality can be enhanced by well-managed irrigation and improved varieties. These two factors have significant changeable role among quantity and quality of the alfalfa crop. During the winter season of 2016-17, an investigation was performed at the University of Agriculture, Faisalabad to evaluate the effect of irrigation intervals on forage production and quality of different alfalfa varieties under semi-arid conditions. three irrigation intervals (10, 20 and 30 days after sowing) on three varieties of alfalfa (Supersonic, Sultana and Lucerne 2002) were used to study its effect on agronomic parameters (plant density, plant height, fresh and dry weights per plant, leaf area, fresh forage and dry matter yields per hectare) and quality parameters (crude protein, crude fiber and total ash content). The research was arranged in a randomized complete block design (RCBD) with split plot arrangement and having 3 replications. Data of the Crop growth, yield and the quality related traits was recorded by applying standard procedure. For statistical analysis of the recorded data, Fisher's ANOVA technique was used and the Treatments mean values were compared at 5% probability level using the least significant difference (LSD) test. Result of the field experiment revealed that the maximum green forage yield of 26.80 t ha^{-1} and protein percentage 21.05 was obtained when crop was irrigated 20 days interval and variety Lucerne 2002 was used. Therefore, irrigation with 20 days interval and using Lucerne 2002 variety proved to be best under agroecological conditions of Faisalabad.*

Keywords*— *Alfalfa varieties, Forage production, Forage quality Irrigation, Irrigation Intervals.

I. INTRODUCTION

The main source of feeding for livestock in Pakistan is fodder, and it is the cheapest form for the nourishment of livestock. The scarcity of fodder is the most essential factor which is accountable for the low productivity of animals around the Pakistan. In all Pakistan, the average yield of fodders is about 21.9 t ha^{-1} (Agric. Statistics. of Pakistan, 2014-15), which is not as much as the actual potential. Traditional cultivation methods, the lack of gorgeous cultivars, low levels of product and malnutrition are the key factors for the low amount of fodder production in Pakistan. Various types of livestock are exist in Pakistan. The Population of Livestock consist of 191.3 Million heads in Pakistan (Economic Survey, 2016-17) which including Cows, Goat, Cattle, Sheep, Camels, Asses, Horses and Mules. It has a significant role in supplying food security via providing of meat, milk, and self-employment for both men and women. For the furthering and evolvement of livestock, regularly provide of sufficient and nourishing fodder is essential. About 8.8% area is covered by fodder crops of the whole cropped region of 22.6 million hectare in Pakistan and the total production of fodder estimated 44.5 million tons per year. The cultivated area of fodder is reduced from 2.6 million hectare to 2 million hectare from 1997 to 2014 (Agric. Statistic. of Pakistan, 2014-15). Fodder crops which grow during winter season include Egyptian clover, Oat, Alfalfa, Vetch, mustard and barley while Maize, Sorghum, Millet, Cowpeas, cluster bean and some other fodder crops grow during the summer season.

Due to the high quality and high-level adaptability specifications, alfalfa (Medicago sativa L.) is a most valuable and momentous crop of winter season among the forage crops in Pakistan, that purveys high quality green fodder for feeding the livestock thru the year especially in tow times of the year (May-June) and (November, October) which are the fodder scarcity periods in Pakistan. An area of 0.13 million hectare of alfalfa is cultivated in Pakistan and the total yield of green fodder is 5.32 million tons (Agric. Statistic. of Pakistan, 2009-10). Alfalfa which is also known as "The Forages' Queen" is a standout amongst the most valuable forage crops in Pakistan and the worldwide. Alfalfa is a high potential forage crop that is able to produce high forage yield

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without using more nitrogen fertilizer. Moreover, alfalfa is best in palatable energy and also protein, which helps to make a very valuable nutrition when alfalfa is embraced in a livestock daily ration; alfalfa can decrease or dispel the necessity to protein complements while providing high amount of digestible energy. Despite on it, it's relatively high ranks of calcium, phosphorus and magnesium assist to reduce supplementation price of minerals. Alfalfa is a multipurpose crop which is using as silage, hay and green chop or for pasture. Due to the outcome of its versatility, quality and production potential, alfalfa can be used effectively in various kinds of livestock nourishing programs. This crop is also a good fruitful cash crop. Alfalfa also perform a significant role in crop rotations since it provides considerable quantities of organic nitrogen to the next crops and has abundant positive influences on soil structure, soil fertility and soil health. (Lacefield, *et al*., 2009).

In Pakistan, various reasons cause to depress the production of alfalfa which are irrigation, weeds infestation, the substandard method of cultivation, malnutrition, level of high yielding and disease resistant varieties. Another problem which is facing our farmer is the level of high yielding and resistant varieties. Mostly pure varieties are not available. Most key yield-limiting factor in western states is the management of irrigation. Using more amount of water, water stress, and absence of good drainage are main problems for Alfalfa production. Water stress often enhances the quality of forage, since the ratio of leaf-stem is boosting due to lack of the stem component's growth (Marble, 1990). However, yields are linearly associated with the availability of water and are dramatically decreased by water stress. The loss in yield linked with the stress of water is so great to rationalize stressing the alfalfa for water as a means of enhancing the quality of the forage crops. Increased irrigation interval cause to boost deeper roots that improve absorption huge quantity of nutrients per plant and assembling of these nutrients in the crop (stems and leaves) (Adam, 2015). For improving a good forage-production system; choosing the best varieties of alfalfa is an important issue. Actually choosing the alfalfa variety is an investment for more than 5 years. It is very important to find high quality and certified varieties. Cultivation of highly productive and adapted varieties not only necessary for the good production of alfalfa but also helps to have healthy and forceful stands. (Shroyer et al., 1998).

1.2 Objectives

Keeping in view the above facts, this field experiment was performed with the objective to determine the yield and quality of different varieties of alfalfa as affected by different irrigation intervals under the agroecological condition of Faisalabad.

II. MATERIALS AND METHODS

2.1 Information about the experimental region

The field research was undertaken at the Agronomy Department experimental region, University of Agriculture, Faisalabad (31° 25′ 10″ N and 73° 5′ 25″ E) above the sea level of 184.4 m height during the year 2016-2017.

The climate condition of the research area was classified into the sub-tropical zone with the mean temperature (17.41 c°), mean humidity (60.66 %) and mean rainfall (6.36 mm) during the research period. The soil pH of experimental area was 7.6 with having sandy loam texture.

2.2 Experimental Details

The research was planned in a split-plot arrangement of RCBD (Randomized Complete Block Design) while it had three replications and (8 m x 3.6 m) net size of plots. Land was well prepared and leveled. Three Alfalfa varieties (Supersonic, Sultana, and Lucerne 2002) were sown in a good-pulverized condition of soil through the using of hand drill. The seeding depth was half an inch and Nitrogen was applied 60 kg per hectare. Thirty Kilogram of nitrogen together with complete amount of Phosphorus and Potassium were applied to the field while the crop was sowing and the remained 30 kg of nitrogen was used at the time of first irrigation. The NPK (Nitrogen, Phosphorus and Potassium) fertilizers were applied to the crop field in the Urea, Diammonium phosphate (DAP) and SOP forms. Irrigation was applied in three intervals (10 days, 20 days and 30 days) and after every cut hand weeding was done in row spacing to keep the crop free from weeds. The crop was harvested twice. First cutting was done 70 days after planting and second cutting was done after 40 days from the first cut. At the time of each harvest; the crop was cut five centimeter above from the ground surface. The experiment was comprised of following treatments.

Factor A = Different Varieties (Main plot)

V_1 = Super Sonic
V_2 = Sultana
V_3 = Lucerne 2002

Factor B = Irrigation Intervals (Sub plot)

I_1 = 10 days
I_2 = 20 days
I_3 = 30 days

2.3 Observations and Data collection:

The data that collected regarding Plant density per square meter, Plant height (cm), Fresh and Dry weights plant^{-1} (g), Leaf Area (cm^{-2}), Fresh Forage and Dry matter yields (t ha^{-1}), Crude protein (%), Crude Fiber (%) and the Total Ash contents (%) was noted throughout the course of experimentation using standard procedures.

For measuring plant density (m^{-2}) the number of plants counted at the time of first harvest in one square meter (m^2) area of each plot at three randomly places and their average was calculated. The plant height data was taken randomly from five plants within each single plot through using measuring tape. Each of the plants were carefully gauged from the bottom part of the plant to the apical point of plant leaf, afterward the mean height was calculated. For recording fresh weight per plant, five plants were chosen arbitrarily in every plot at the stage of cutting and were weighted. Then the average fresh weight per plant was calculated and for measuring the dry weight per plant, 300 g sample of green forage was taken and then dried. The forage samples were dried under shade for 48 hours and after that samples were dried at 64° in an oven for 24 hours, till it reached to the constant weight. After drying the dry weight per plant in grams was calculated. For measuring green forage yield the entire plot was harvested and then weight was measured carefully in kilograms through using a springy scale directly after harvesting the crop and then changed to tons per hectare. A sample of 300 g forage from each plot was taken and then dried. The samples were dried under shade for 48 hours and after that samples were dried at 64° in an oven for 24 hours, till it reached to the constant weight. After this the electrical scale was used to measure the dry weight of each sample and then by using the following formula the percentage of dry matter was estimated.

Dry matter percentage= (Dry weight of the plant)/ (fresh weight of the plant) x 100

Thereafter, the percentage of dry matter was used for changing the amount of the fresh forage yield in to the dry matter yield of the crop. In each plot, the calculated percentage of dry matter was used for conversion the amount of fresh forage yield in to the dry matter yield of the crop. The quality analysis (Crude protein, crude fiber and total ash contents) was performed by the methods as recommended by AOAC (1990). The collected data were analyzed by using the Fisher's analysis of variance technique (ANOVA) and for the comparison of treatments mean values the least significant difference (LSD) test was used. (Steel *et al*., 1997).

III. RESULTS AND DISCUSSION

3.1 Plant density (m^{-2})

The result indicated that the impact of irrigation intervals and different varieties was significant over plant density. The maximum plant density (245.56 plants per square meter) was detected at 20 days irrigation interval and lowest plant density (211.44 and 169.22 plants per square meter) was recorded at 30 and 10 days irrigation intervals respectively. Maximum plant density (237.22 plants m^{-2}) was recorded in Sultana variety and minimum plant density (207.11 and 181.89 plants m^{-2}) was recorded statistically in Lucerne 2002 and Supersonic varieties respectively. The irrigation intervals and different varieties interaction effect on plant density (m^{-2}) was found significant which showed that 20 days irrigation interval with Sultana variety produced maximum plant density (313 plants m^2). While 10 days irrigation interval with supersonic variety produced minimum plant density (131.67 plants m^2). The rest of treatment combinations were intermediate.

3.2 Plant Height (cm^{-2})

The height of plant was non-significantly influenced by the irrigation intervals which were used in the experiment. The plant height of alfalfa was affected significantly by the different varieties of alfalfa. Statistically, the Lucerne 2002 variety had the supreme plant height (33.78 cm) but the minimum plant height (30.44 and 24.22 cm) was recorded in Sultana and Supersonic varieties respectively.

3.3. Fresh weight plant^{-1} (g)

The result declared that fresh weight per plant (g) was affected significantly by the irrigation intervals. Irrigation interval with 20 days produced the supreme amount of fresh weight per plant (3.60 g). It was followed by the fresh weight plant^{-1} (2.61 and 2.32 g) at 10 days and 30 days irrigation intervals respectively. The fresh weight plant^{-1} (g) was affected non-significantly by the different varieties of alfalfa. The irrigation intervals and different varieties interaction effect was found statistically non-significant. However, fresh weight per plant ranged from 1.77 to 4 g in different treatment combination.

3.4. Dry weight plant^{-1} (g)

The dry weight plant^{-1} (g) was affected significantly by the irrigation intervals. Statistically, the irrigation interval with 20 days produced the supreme amount of dry weight per plant (0.99 g) and the irrigation intervals with 30 days and 10 days produced the minimum amount of dry weight per plant (0.70 and 0.61 g) respectively which were statistically at parity with one another. The alfalfa dry weight per plant (g) was not affected significantly by the different varieties of alfalfa. The irrigation intervals and different varieties interaction effect on dry weight per plant (g) was found statistically non-significant. However, dry weight per plant ranged from 0.47 to 1.13 g in different treatment combinations.

3.5 Fresh forage yield (t ha^{-1})

The fresh forage yield of alfalfa per hectare was significantly influenced by the irrigation intervals. Statistically, the irrigation interval with 20 days produced the supreme amount of fresh forage yield (25.19 t ha^{-1}). Statistically, the irrigation intervals with 30 days and 10 days produced the minimum amounts of fresh forage yield (23.39 and 21.62 t ha^{-1}) respectively. The alfalfa fresh forage yield per hectare was not affected

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significantly by the different varieties of alfalfa. The irrigation intervals and different varieties interaction effect was statistically significant which showed that the Lucerne 2002 variety produced more fresh forage yield (t ha^{-1}) at 20 days irrigation interval and the less fresh forage yield (t ha^{-1}) was given by the Supersonic variety at 10 days irrigation interval.

3.6 Dry matter yield (t ha^{-1})

The irrigation intervals or different alfalfa varieties did not affect significantly the dry matter yield per hectare. The irrigation intervals and different varieties interaction effect on the dry matter yield of alfalfa was not found statistically significant.

Table.1: Mean values for plant density (m^2), plant height (cm), fresh weight plant^{-1}(g), dry weight plant^{-1}(g), fresh forage yield (t ha^{-1}) and dry matter yield (t ha^{-1}).

Irrigation intervals	Plant density (m^2)	Plant height (cm)	Fresh weight plant^{-1} (g)	Dry weight plant^{-1} (g)	Fresh forage yield (t ha^{-1})	Dry matter yield (t ha^{-1})
I_1 (10 days)	169.22 ^{c}	27. 89	2.61 ^{b}	0.61 ^{b}	21.62 ^{b}	5
I_2 (20 days)	245.56 ^{a}	30. 78	3.60 ^{a}	0.99 ^{a}	25.19 ^{a}	5.38
I_3 (30 days)	211.44 ^{b}	29. 78	2.32 ^{b}	0.70 ^{b}	23.39 ^{ab}	4.82
Varieties						
V_1 (Supersonic)	181.89 ^{b}	24.22 ^{b}	2.67	0.70	21.5	4.7
V_2 (Sultana)	237.22 ^{a}	30.44 ^{ab}	2.34	0.66	23.4	5.14
V_3 (Lucerne 2002)	207.11 ^{ab}	33.78 ^{a}	3.52	0.94	25.3	5.36

Note: Means having the same letter case are statistically non-significant at 5% level of Probability.

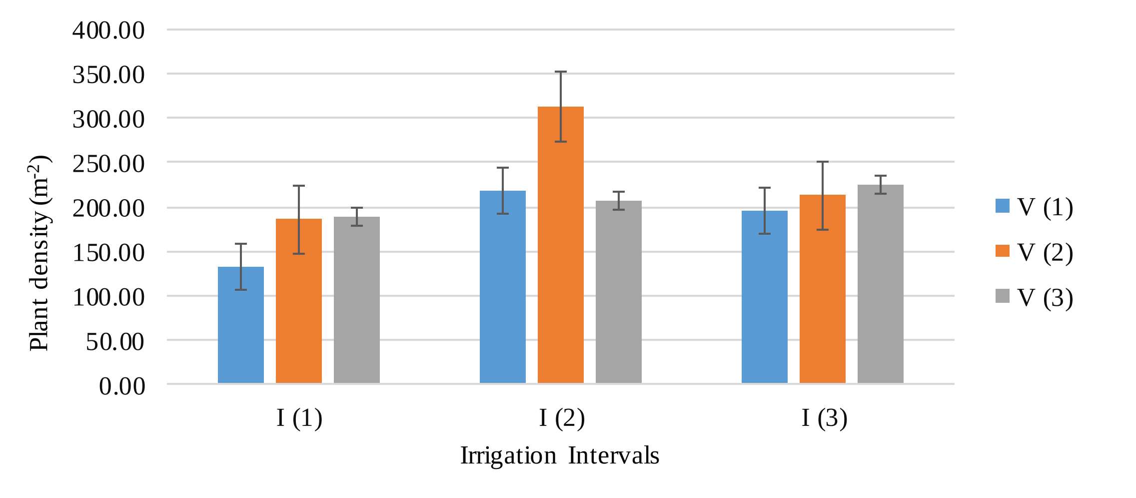

Fig.1: Irrigation intervals and different varieties Interaction effects on the plant density (m^{-2}) of Alfalfa.

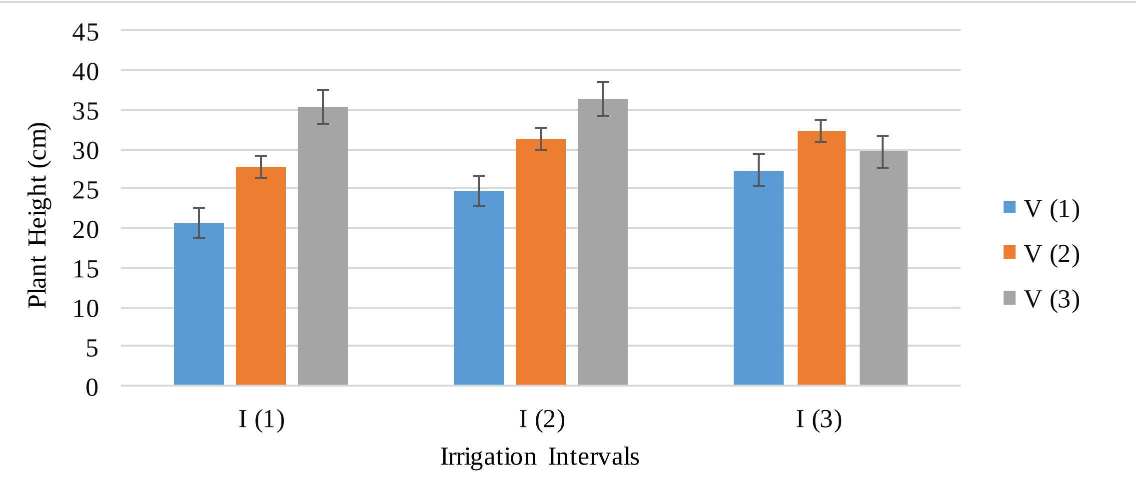

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Fig.2: Irrigation intervals and different varieties interaction effects on the plant height (cm) of Alfalfa.

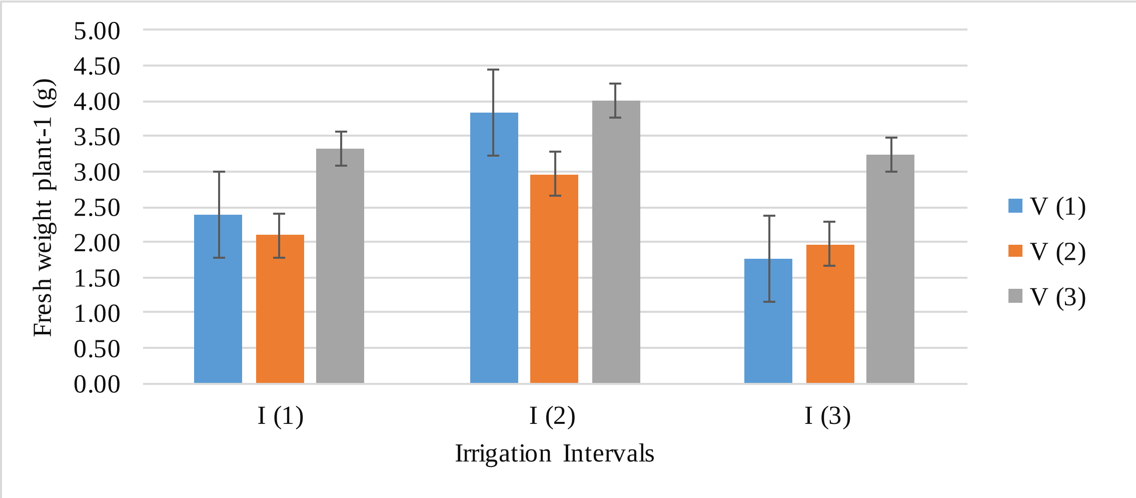

Fig.3: Irrigation intervals and different varieties interaction effects on the fresh weight plant^{-1} (g) of Alfalfa

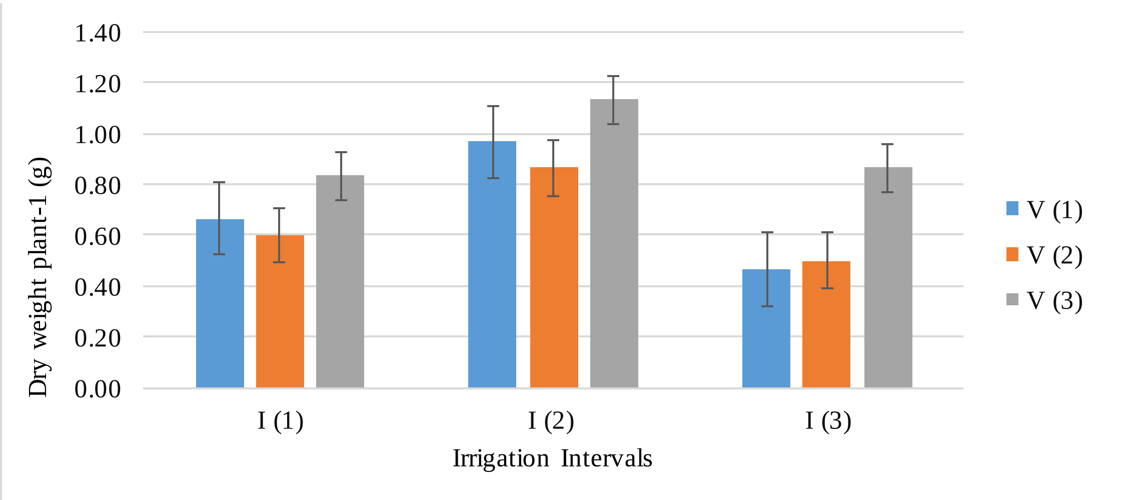

Fig.4: Irrigation intervals and different varieties interaction effects on the dry weight plant^{-1} (g) of Alfalfa.

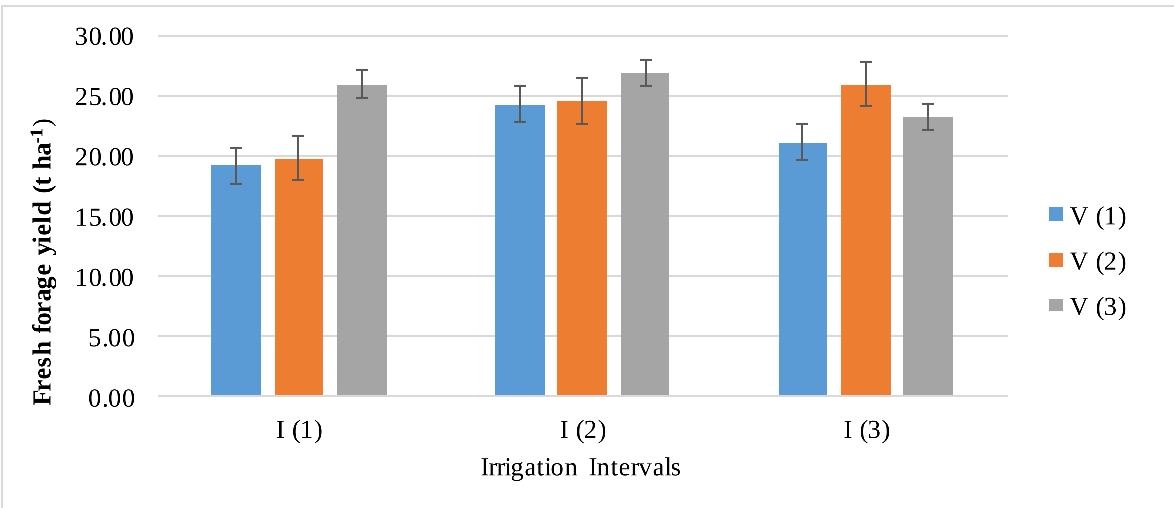

Fig.5: Irrigation intervals and different varieties interaction effects on the fresh forage yield (t ha^{-1}) of Alfalfa.

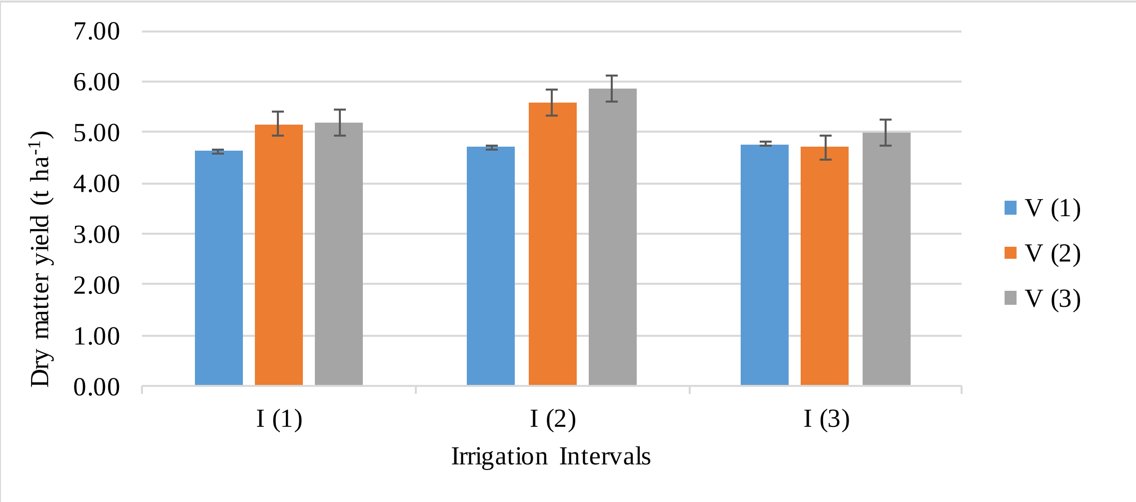

Fig.6: Irrigation intervals and different varieties interaction effects on the dry matter yield (t ha^{-1}) of Alfalfa.

Note: Factor A: Irrigation intervals (I1=10 days, I2= 20 days and I3= 30 days), Factor B: Varieties (V1= Supersonic, V2= Sultana, V3= Lucerne 2002)

3.7 Crude Protein (%)

The percentage of alfalfa crude protein was affected significantly by the irrigation intervals but it was not affected significantly by the different alfalfa varieties. Statistically, the irrigation interval with 20 days produced alfalfa with the supreme amount of Crude protein (21.05 %) and the irrigation intervals with 10 and 29 days produced alfalfa with the minimum amount of Crude Protein (20.45 and 19.34 %) respectively which similar result also reported by (El Din and Assaeed, 1993). The irrigation intervals and different varieties interaction effect was found statistically non-significant.

3.8 Crude Fiber (%)

The impact of irrigation intervals and different varieties on the Crude fiber percentage was significant. Statistically, the highest amount of Crude fiber (29.93 %) was recorded at 10 days irrigation interval and the minimum Crude fiber (29.37 and 28.30 %) was recorded at 20 and 30 days irrigation intervals respectively. Similar type of result were also reported by (Kandil and Shareif, 2016). Statistically, maximum Crude fiber (29.32 %) was recorded in Supersonic variety and the minimum Crude fiber (29.25 and 29.04%) was recorded in Sultana and Lucerne 2002 varieties respectively both were existing statistically similar with each other. The irrigation intervals and different varieties interaction effect was found statistically non-significant.

3.9 Total Ash (%)

The irrigation intervals effect on the Ash (%) was significant. Statistically, maximum Ash (8.96 %) was recorded at 10 days irrigation interval and the minimum Ash (8.90 and 8.85 %) was recorded at 20 and 30 days irrigation intervals respectively both were existing statistically similar with each other. similar result also reported by (Kandil and Shareif, 2016). The effect of different varieties on the Ash (%) was non-significant. The irrigation intervals and different varieties interaction effect was found statistically non-significant.

Table 2: Mean values for Crude protein (%), Crude fiber (%) and Total ash (%),

Irrigation Intervals	Crude protein (%)	Crude fiber (%)	Total ash (%)
I_1 (10 days)	20.45 ^{b}	29.93 ^{a}	8.96 ^{a}
I_2 (20 days)	21.05 ^{a}	29.37 ^{b}	8.90 ^{ab}
I_3 (30 days)	19.34 ^{b}	28.30 ^{c}	8.85 ^{b}
Varieties			
V_1 (Supersonic)	20.32	29.32 ^{a}	8.92
V_2 (Sultana)	20.20	29.25 ^{a}	8.95
V_3 (Lucerne 2002)	20.32	29.04 ^{b}	8.84

Note: Means having the same letter case are statistically non-significant at 5% level of Probability.

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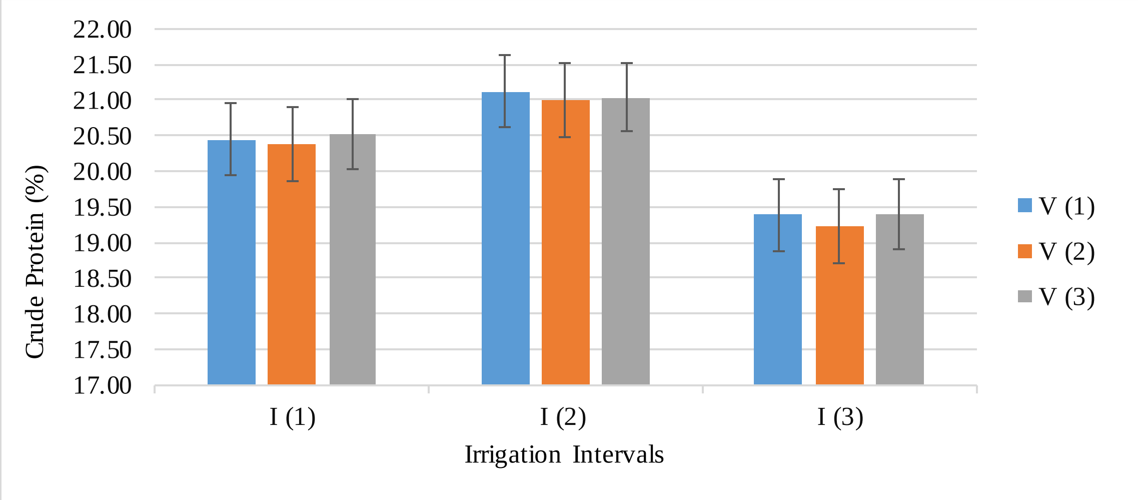

Fig. 7: Irrigation intervals and different varieties interaction effects on the Crude protein (%) of Alfalfa.

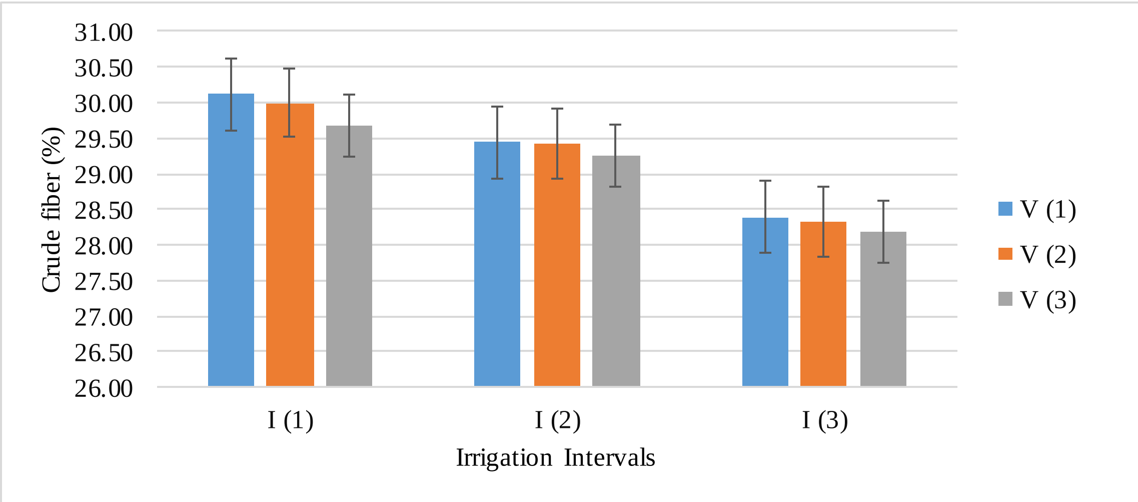

Fig. 8: irrigation intervals and different varieties interaction effects on the Crude fiber (%) of Alfalfa

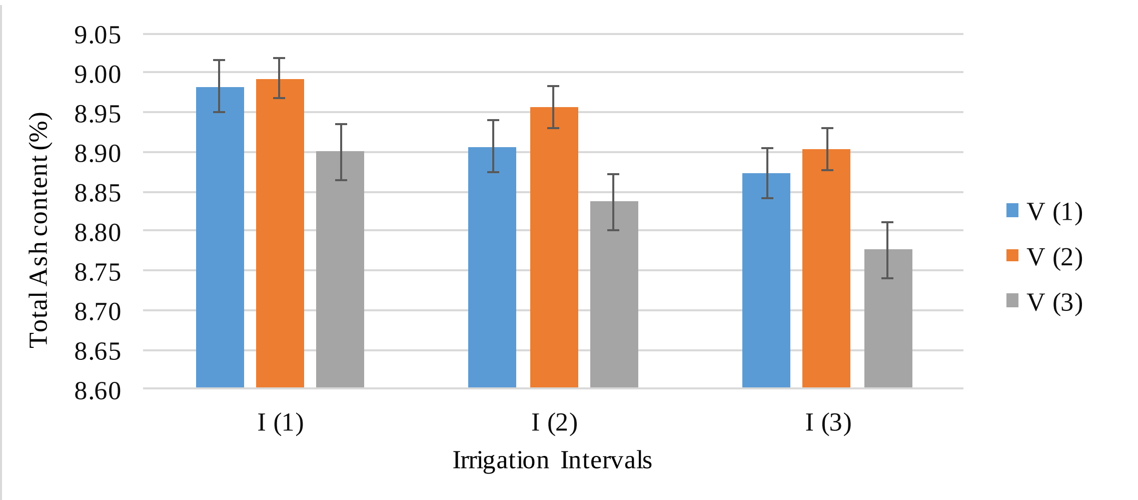

Fig. 9: Irrigation intervals and different varieties interaction effects on the Total Ash content (%) of Alfalfa

Note: Factor A: Irrigation intervals (I_1=10 days, I_2= 20 days and I_3= 30 days), Factor B: Varieties (V_1= Supersonic, V_2= Sultana, V_3= Lucerne 2002).

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IV. CONCLUSION

On the basis of results it was concluded that variety Lucerne 2002 irrigated 20 days interval seems to be best than other treatment combinations under the agro-ecological conditions of Faisalabad.

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Factors influencing Agripreneurship and their role in Agripreneurship Performance among young Graduate Agripreneurs

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Abstract— *Participation of young people in agriculture is not only needed towards addressing food security and youth unemployment challenges, but also critical in tackling issues of ageing farmers, technological and digital revolution in the agrifood sector, changing trends in food needs and consumption demands, and environmental changes and natural resource degradation. This paper argues for inclusive approach to involving youth in the expansive agrifood system, stressing the importance of young graduates (highly educated youth) participating in the agrifood sector, hence the need for steps to attract, support and retain them in the agrifood sector. Thus, this study sought to identify the factors that influence agripreneurship, and how these factors influence agripreneurship performance of young graduate agripreneurs. The study results and agripreneurship framework, emphasizes the need for a holistic (multilevel) examination and approach to agripreneurship; gender-sensitive, integrated and applied approach towards promoting and developing agripreneurship competencies among young graduates, which must include enhancing both enterprising traits and skills, and strong technical/professional business management competencies.*

Keywords— Agriculture, Agrifood, Agripreneurship, Entrepreneurship, Graduate, Youth

I. INTRODUCTION

The global demographic dynamics and transition will have varying socio-economic effects on countries and the larger global community. Data from the UN DESA (United Nations Department of Economic and Social Affairs) suggests high population particularly for less developed regions of the world, with young people constituting a significant cohort. This raises a number of important issues including how to produce enough nutritious food to meet the expected increases in food needs, and how to find decent and sustainable jobs especially for the large youth population. These issues are critical with respect to Africa because even though the continent is projected to experience high population, agricultural productivity on the continent remains very low and the economies are largely characterised by low levels of decent and sustainable jobs (ILO, 2017; Ehui and Pender, 2015). However, in seeking to address these issues, the agro-potential of many African countries and the continent's youth bulge becomes of strategic importance. As noted by Zorya, Gautam and Goyal, "agriculture is uniquely positioned to absorb these workers" [i.e. large cohort of young Africans] (2013, p. 2). Active youth engagement in agriculture (or more broadly the agrifood space), can contribute positively to addressing not only the issues of producing enough nutritious foods and providing decent jobs for young people, but can also have other positive outcomes: feeding and fuelling agro-processing industries, boosting the non-farm economy, and increasing national revenue generation via taxation and foreign exchange earnings among others. The multiple benefits and scales of impact that could be exacted from a synergistic relationship between youth and agriculture have ignited discourse on youth-in-agriculture in policy and development circles.

In seeking to engage more youth in agriculture, most interventions have seemingly focused on rural and/or less educated youth. However, considering the changes within the agrifood space, and the larger socio-economy, it is important for the youth-in-agriculture drive to be more inclusive. For instance in many African countries, graduate unemployment has become major development challenge and in Ghana, data shows that unemployment among young people in urban areas, who are relatively more educated, is higher (6.5%) than those in rural areas (4.3%) (see "Almost half of the 10 million graduates", 2016; GSS, 2014a). Furthermore, ongoing changes within and outside the agrifood space such as technological advancement, dynamics in food needs and demand, and environmental changes, is transforming how food is produced, sold and consumed. All of these make it imperative for participants in the modern agriculture and food industry to have high-end professional knowledge and skills. Thus, this paper argues that the drive to engage youth in agriculture must endeavour to attract, engage and

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retrain young graduates (highly educated youth) in the agrifood space. This argument falls in line with calls for youth heterogeneity (sex/gender, age and skills level, among others) to be recognised in the youth in agriculture agenda (Flink, I., Vaast, C., Jacobs, J. and Turolla, M, 2018; Goemans, 2014; Bennell, 2007).

Young graduates may either have the professional and/or technical training needed in the modern and evolving agrifood landscape (such as those trained in agriculture and/or food studies), or that their high-levels of education and exposure can be leveraged for them to acquire further or new competencies to enable them productively participate in the sector. As argued that agriculture needs to be modernised to attract young people, similarly in the present complex and evolving agrifood sector, and considering young graduates in particular, they cannot – whether out of their own ignorance or by design of external stakeholders – participate in the agrifood space using the conventional approach (usually phrased as 'hoe and cutlass') and be successful (higher productivity and incomes). Young people, especially graduates, are expected more than ever to become more entrepreneurial and contribute actively towards addressing social and national development issues including their own thorny issue of graduate unemployment. This entrepreneurial demand of graduates cannot be more needed than in agrifood sector, a dynamic and challenging sector, yet one that holds much promise and prize for its adventurers and the larger society (see also Montpellier Panel, 2014).

In contributing to the youth in agriculture discourse and practice, this study focused on young graduate agripreneurship, and sought to identify the factors that influence agripreneurship and how these factors influence (facilitated or inhibited) agripreneurship performance among young graduate agripreneurs. The study makes instrumental input towards informing the development of young graduate agripreneurs. This study did not seek to measure the entrepreneurial performance of young graduate agripreneurs, which would have required using indicators such profitability, employment generated, revenues, sales or production volumes among others (see Zamanian, 2017).

The next section of this paper reviews study literature, followed by the study approach and methodology, after which the study findings and discussion are presented, and finally the conclusion and recommendations.

II. LITERATURE REVIEW

The global demographic changes and transitions will lead to among others a huge youth population (youth bulge) in Africa. Considering the continents relatively low levels of agricultural productivity and weak economies, the demographic changes raises critical concerns about food security and employment on the continent. Whiles being a challenge on its own, the youth bulge also presents an opportunity for addressing the concerns of food security and employment through enhanced youth participation in the agricultural sector. Youth participation in the agriculture sector can also contribute to addressing the changes occurring in the sector. This section of the paper discusses the foregoing issues providing a contextual appreciation for this study.

II.a Demographic Transitions, Youth and Agriculture

The United Nations DESA (Department of Economic and Social Affairs), estimates world population to reach over 8.5 billion by 2030 and over 9.7 billion 2050 with a significant youthful cohort; those between the ages of 15 to 34 years will make up to 2.45 billion (29%) and 2.64 billion (31%) of the global population by 2030 and 2050 respectively (UN DESA, 2017). In Africa, those between the ages of 15 to 34 years will reach almost 580 and 830 million people by 2030 and 2050 respectively (accounting for 34 and 33 percent of the population in 2030 and 2050 respectively) (ibid). In Ghana, total population projections indicate it reaching over 36 and 50 million by 2030 and 2050 respectively, with those between 15 to 34 years constituting 34.7% in 2030 and 33% in (ibid). Currently of the estimated 26 million people in Ghana, 34.1% are between 15 to 35 years, and of these, 18.2% and 15.9% are females and males respectively (GSS, 2014a). Ghana's definition of youth follows that of the Africa Union, which is those between the ages of 15 – 35 years (Africa Union, 2006; Ministry of Youth and Sports, 2010). Food security is one of the major concerns associated with the projected population increase; how to provide adequate and nutritious food for the increasing population.

While it is thought that with increases in GDP and per capita income, world food production will rise to meet the increases in food demand, the situation for sub-Saharan Africa remains a worry (Alexandratos and Bruinsma, 2012). Though Africa will experience high population increase, it continues to face "inadequate food consumption and high levels of undernourishment"; by 2030 and 2050, 14.5 million and 7.1 million people respectively are still expected to remain undernourished in Africa (ibid, 2012, p. 2). In Ghana notable numbers of the population (about 5% of the population) remain undernourished and/or in poverty, with inequality being prevalent – and even increasing – in some parts of the country (McKay, Hague and Cooke, 2016; FAO, 2015; NDPC and UN Ghana, 2015; GSS, 2014b). Additionally, Ghana spends substantial amounts on the importation of staple foods such as rice, sugar, tomatoes and poultry

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('Food Imports', 2018). The foregoing, amidst the trend of increasing global food prices, Ghana's weakening currency and periodic shocks to the agriculture sector (such as disease and/or pest attack, flooding, and drought), makes the country's food sufficiency and security vulnerable. Other countries in the region are in much worse situations due to added burden of conflict and disease (HIV/AIDS).

In seeking to address this challenge within the context of a socio-economy which is changing along with its agrifood sector, and the rather low levels of agricultural productivity on the continent, young people become crucial; their numbers, energies, curiosity and adaptability can be harnessed within the agriculture sector towards ensuring improved food security. In the pursuit of this agenda, rural youth and/or generally less educated youth, have been the key target of efforts to engage young people in agriculture; the reasons include seeking to address unemployment among rural and/or out-of school youth, leveraging 'abundant' rural natural resources for improved food security, stimulating rural economic growth and addressing rural poverty, (see Pyburn, Audet-Bélanger, Dido, Quiroga and Flink, 2015; Saginga, 2013; Filmer and Fox, 2014; UNIDO, 2013; Brooks, Zorya, Gautam and Goyal, 2013; Oppenheimer and Spicer, 2011). However, in order to meet the new and emerging changes, demands and trends within the agrifood sector and the larger socio-economy, the youth-in-agriculture drive must be made more inclusive attracting in particular highly educated and skilled youth (young graduates). This is echoed by Weidinger, Youdeowei, University of Greeenwich, Mwaura and Quaye, who posits that "young people, who are dynamic and better educated…should be considered prime candidates for the required cadre of human capital needed to move African agriculture forward" (2015, p. 66).

The agrifood sector is being altered in new ways and forms, demanding 'new' crop of participants in the sector. The production, transportation, processing, marketing and consumption of food is now more complex and still evolving even as consumer needs and demands change (increased demand for more refined foods [processed, more nutritious, better packaged, ready-to-eat/serve], fruits, vegetables, dairy food and meat) (see EIU-BCN, 2017; FAO, 2017). As in other sectors, technological and digital progress is revolutionizing the agrifood space agritech). De Clercq, Vats and Biel (2018), notes that the influence of agritech will be on three broad fronts; "1) produce differently using new techniques; 2) Use new technologies to bring food production to consumers, increasing efficiencies in the food chain; 3) Incorporate cross-industry technologies and applications" (p. 11). Conceivably, the sector most vulnerable to the ongoing environmental change is the agriculture sector. The consequences and ramifications of environmental and natural resource destruction and degradation on the agriculture sector and the many livelihoods that depend – directly and indirectly – on the sector are grave. Thus, it is suffice to say that going forward, agrifood systems need daring, enterprising and better educated participants having requisite knowledge and skills, or are ready and capable of acquiring these knowledge and skills, and using them to build more sustainable and resilient agrifood systems (see also Montpellier Panel, 2014).

Fortunately, in this regard it is soothing to note that there is generally increasing levels of education attendance and attainment among young people in Ghana; since 2005, both gross and net school attendance at the senior secondary level has been increasing (see GSS, 2014b, p. 42). Gross enrollment in tertiary education is also increasing; in 2008 this stood at 8.63% compared with 16.6% in 2017 (UNESCO, 2018). However, as may be expected, educational attainment (senior secondary level and higher) among urban youth is higher (32.6%) than among rural youth (11.6%) (see GSS, 2014a, p. 45); this further echoes the need for a more inclusive youth-in-agriculture drive leveraging these diversities and educational attainments. In Ghana, and perhaps many other countries, young people are also needed to replace ageing farmers; for example the average age of cocoa farmers in Ghana is estimated at an advance age of 55 years (Fick, 2015). The participation of youth in agriculture is also vital to addressing the issue of youth unemployment (discussed in the following section). Thus, as Sumberg, Anyidoho, Leavy, te Lintelo and Wallard (2012) puts it, whether framed from the perspective of " 'youth in peril' or 'agriculture in peril' " (p.3), agriculture provides a strategic opportunities for productively and sustainably engaging the growing numbers of young people, yielding different types and levels of benefits.

Though the general narrative is that young people shun agriculture (farming), other studies have highlighted issues of aspirations and constraints to engaging in agriculture as contributing to deter young people from agriculture (see Dyer, 2013; Anyidoho, Leavy and Asenso-Okyere, 2012). Thus, as opined by Anyidoho, Leavy and Asenso-Okyere (2012), a blanket assertion that "young people in SSA are choosing to reject agriculture wholesale" lacks sufficient proof (p. 2). Evidence from the interest and participation of young people, especially educated ones, in recent agriculture centered or related activities (competitions, events, networks and incubators) indicates continuing and perhaps growing interest of educated young people in the agriculture sector, and an emerging crop of young graduate entrepreneurs in the agrifood sector. Some of these programs include the African Youth Agripreneurship Program (AYAP), Enhancing Growth in New Enterprises (ENGINE), Kosmos AgriTech Challenge, ENABLIS Business Launchpad, Total StartUpper Competition, Youth Enterprise Support (YES), Empowering Novel Agri-Business-Led Employment (ENABLE), Young Professionals for Agricultural Development (YPARD) and other recent agric-focused conferences in Ghana (Young People, Farming and Food Conference), Cote d'Ivoire (Youth Agripreneur Forum and AgriPitch Competition), Nigeria (Youth Entrepreneurship Summit for Agribusiness Advancement) and Rwanda (Youth Employment in Agriculture as a Solid Solution to ending Hunger and Poverty in Africa). These emerging young entrepreneurial 'farmers' could be motivated by personality (proclivity for an agrifood activity or livelihood) or necessity: push factors (unemployment or underemployment) or pull factors (identified or given opportunity) (see Schoof, 2006); within the Ghanaian context, necessity is said to drive most entrepreneurial activities (Herrington and Kelly, 2013).

II.b Youth Unemployment, Entrepreneurship and Agripreneiurship

Youth unemployment and underemployment are major global challenges particularly for developing countries, and other weak economies. According to the ILO (International Labour Organization), globally for every one unemployed adult, there are three unemployed youth (ILO, 2017). The ILO further reports that a total of 70.3 million young people (15-24 years) were unemployed in 2017, and this is will rise to 71.1 million in 2018 (13.1%) (ibid). For developing countries, "the unemployment rate among youth [15 – 24 years] is expected to remain stable at 9.5% in 2017 and 2018. However, considering the large cohort of young people entering the labour force each year, the number of unemployed youth in developing countries is projected to increase by half a million between 2016 and 2018" (ibid, p. 15). In Africa, Northern Africa has high incidence of youth unemployment (28.8 %), and a youth-to-adult unemployment rate ratio of around 3.5. For sub-Saharan Africa, youth unemployment was estimated at 11.1% in 2017 and projected to rise marginally to 11.2% in 2018 (ibid). However, it is important to note that, the figures exclude all unemployed people between the ages of 25 – 35 years, who also constitute youth on the continent (African Union, 2006). Regarding data on unemployment, cognisance must be taken of germane concerns about data deficiencies and gaps in many countries, Ghana included. This makes determination of levels of unemployment – general or among youth – difficult and/or inaccurate. In addition, the current definition of unemployment is noted to have some limitations, and does not allow capturing of all underutilized labour such as underemployed, discourage job-seekers and potential labour force (see Baffour-Awuah, 2014; GSS, 2014a; Dewan and Peek, 2007); in Ghana, whiles the national youth unemployment is estimated at 5.5%, youth labour force underutilization is more than seven times this figure, 42.6% (GSS, 2014a).

A critical aspect of youth unemployment is graduate unemployment, which has become an albatross around the neck of governments and a scar on the conscience of society which touts education as panacea to unemployment. In Ghana it is estimated that 250,000 educated youth join the labour force annually, of which 31% have some tertiary qualification (77,500). Out of this, only 6.5% (5000) find formal employment with the rest having to join the informal sector or remain unemployed (Oben-Torkornooo, 2009). As educational levels increase with more young people attaining higher levels of secondary and post-secondary education, the trend will continue if enough job opportunities are not generated at a faster rate. Unemployed youth, especially having achieved higher levels of education, do not only suffer from psychological and social challenges such as depression and social exclusion (see Moreane, 2006), but also from food insecurity; they do not have enough money to buy and consume both the right quantity and quality of food (Feighery, Ingram, Li and Redding, 2011). In seeking to address the challenge of unemployment among the young people, entrepreneurship is one of the strategies often suggested and/or used, and is included in many youth-centered policies, plans and strategies (see Ministry of Employment and Labour Relations, 2014; UNDP, 2014; OECD, 2013; Ministry of Youth and Sports, 2010; Commonwealth Secretariat, 1998). Participation of young people in entrepreneurship programs enables them to among others acquire and/or enhance enterprising skills, knowledge, traits and competencies leading in many cases to youth-led ventures focused on various socio-economic challenges. Thus entrepreneurship has come to assume an important option for tackling diverse issues across different domains.

'Entrepreneurship' is said to come from the French word 'entreprendre', meaning 'to undertake' and reportedly was first used by Richard Canitillon, a French banker, with another Frenchman, Jean Batiste Say, popularizing the term (Ananga, 2015; Pahuja, 2015; Buame, 2009). They are different definitions of the term from different authors (see Braunerhjelm, 2010, pp. 9-10), however the views of Schumpeter and Kirzner are said to have gone on to influence many other entrepreneurship definitions (Ananga, 2015; Buame, 2009). Joseph Schumpeter defined entrepreneurship as, "an innovative process where an individual or group of individuals create something new: a new product (goods or services); a new market (hitherto unexploited); a new source of raw material; a new method of doing things" (Buame, 2009, p. 24). Whiles for Israel Kirzner, "entrepreneurs can be seen as responsible for equilibrating market movements (such as changing prices), in the absence of dramatic changes in product specifications or in production methods. My entrepreneurs were engaged in arbitrage, acting entrepreneurially even when they might not be seen as Schumpeterian "creators" " (Kirzner, 2008, p. 5). Other entrepreneurship definitions which feed into the 'entrepreneurs are born' face criticisms, with Peter Drucker stating that "everyone who can face up to decision making can learn to be an entrepreneur and to behave entrepreneurially. Entrepreneurship, then, is behaviour rather than personality trait" (1985, p. 26). Davidsson and other authors have argued and/or shown that entrepreneurship is a multilevel phenomenon; individual, firm and social levels; which aside being a process, has outcomes (see Martin and Osberg, 2007; Davidsson, 2005; van der Veen and Wakkee, 2004). It is thus not surprising that concept has found its way into other domains leading to new constructs such as 'intrapreneurship', 'infopreneurship', 'webprenenurship', social entrepreneurship and now agripreneurship.

Carr and Roulin (2016) give two definitions of Agripreneurship: first, "an entrepreneur whose main business is agriculture or agriculture-related" (p. 9), citing Dabson and Markley (2009); and the second being, "generally sustainable, community oriented, directly marketed agriculture. Sustainable agriculture denotes a holistic, systems oriented approach to farming that focuses on the interrelationships of social, economic and environmental process" (p. 9), citing Sudharani n.d. The second definition brings aspects of social entrepreneurship (see Bornstein and Davis, 2010; Öztürk, 2013) into agripreneurship and feeds into the ongoing global agenda of sustainable development of which the sustainable and resilient agriculture has been identified as being critical to achieving many of the SDGs (see FAO, 2018). From the foregoing definitions of agripreneurship, gleaning from the different definitions or explanations of entrepreneurship and with the appreciation of the xpansive agrifood space, this study posits the following definition of Agripreneurship:

Identifying and seizing an opportunity (problem, idea, business or market imbalances) in the agrifood space and organising resources to convert the opportunity into solutions (new or innovative produce, product or service) whiles embracing the associated risk and potential benefits thereof (material and immaterial); this may occur within an existing agrifood enterprise or lead to establishment of new agrifood enterprise.

As noted by McElwee (2015), (citing several authors), the business of farming is entrepreneurial in nature, thus the "the methods used to analyse business entrepreneurs in other sectors can be applied to (entrepreneurial) farmers" (p. 2). It has also been noted that the lack of adequate entrepreneurial skills by small business owners is an important challenge and cause of failure among small businesses (Ananga, 2015; Adjei, 2012). Thus, attempts and interventions aimed at supporting and enhancing the emergence and/or growth of small businesses including agrifood enterprises; referred to as supportive Interventions in this study; are vital in the process of entrepreneurship and for that matter agripreneurship. Such supportive interventions include business plan/pitch competitions, small business growth and acceleration programs and innovation hubs, and mentorships and financial support and literacy programs among others. Examining the broad scope of literature on entrepreneurship, including also within the agriculture context, factors that influence agripreneurship are identified. These factors are subsequently examined as to how they influence agripreneurship performance of young graduate agripreneurs. The next section outlines the research method and approach used.

III. APPROACH AND METHODOLOGY

A case study strategy involving mainly qualitative methods was adopted for this study, thus data collection was intensive, with both study methods and data sources being triangulated. In this study, a young graduate agripreneurs was defined as: anyone between the ages of 19 – 39 years, who is pursuing or has completed a post-secondary education or training in a tutorial or tertiary institution and is an owner or owner-manager of an agrifood enterprise which had existed for at least six months. The official age range in the definition of youth in Ghana, that is 15 – 35 years, was modified as the study focused on persons who had completed their secondary level education; the usual completion age being 17/18 years. Young graduate agripreneurship can be described as a nascent phenomenon in Ghana's agrifood system, thus the numbers of young graduate agripreneurs (research population) are few and far between, both in the larger agrifood system and in specific agrifood value chains. Two broad groups of agripreneurship was constructed to guide respondents selection; 1) young graduate agripreneurship in traditional agrifood activity (production, processing or marketing of traditional food or cash crops and animals) and 2) young graduate agripreneurship in non-traditional agrifood activity (production, processing or marketing of non-traditional food crops and animals such as mushrooms, guinea fowl, and snails among others). Young graduate agripreneurship providing services (such as market food prices, tractor services, and agrifood business plan services) were excluded. Subjective and snowball sampling techniques were used to select primary respondents; in all 24 respondents participated in the research. Qualified respondents were selected to participate in the study irrespective of their geographical location, with deliberate efforts being made to find and include females.

Data for this study was through a fieldwork in the months of July and August 2017. The research methods included an in-depth desk review involving both academic and grey literature, interview with key informants from various agencies, interview with primary respondents, observation, and focus group discussions and activities. In-depth desk review was used to explore literature background, operationalize constructs and delineate factors that influence agripreneurship. Five key informant interviews were conducted and it was used to examine the topic from perspectives; government, policy-implementing agencies, academia, and development institutions (local and international). The primary respondents were interviewed using a semi-structured questionnaire (with embedded quantitative questions) and this examined how the identified agripreneurship factors influenced agripreneurship performance among young graduate agripreneurs; each interview lasted between 1.5 to 2.5 hours. Observation was used to understand the activities of the agrifood enterprises of primary respondents, in one case the researcher participated in the activities of the agrifood enterprise (participatory observation). The use of observation enabled the researcher to probe/clarify already given answers, validate previous answers, and for more information to be gathered. Two focus group discussions and ranking activities were conducted to further explore the research objective from a group (social) perspective. This involved mainly young women (three in all) and men (seven in all) owning, owning-managing or working in agrifood enterprises. A deductive approach was used in the data analysis and the collected data was analysed by way of content/thematic analysis. Microsoft Excel was used to organize quantitative data collected. Draft study report (including preliminary findings) was also presented at a stakeholders meeting at AAIN (African Agribusiness Innovation Network) towards enhancing construct and data validity. The research findings and accompanying discussions follows next.

IV. RESULTS AND DISCUSSION

Disaggregated data on gender, the type of employment and educational background of respondents provides for interesting insight into youth agripreneurship and this is discussed under the first subsection. The next sub-section shows the findings from the rigorous literature review regarding delineation of factors that influence agripreneurship, and this is followed with the findings and discussion of the how the factors (personal factor) influenced agripreneurship in this study.

In all 24 qualified young agripreneurs were identified and participated in the research; table 1 below shows disaggregated data of the respondents. Even with the deliberate sampling methods used, only two females were identified and participated in the study. This contrasts data from the larger entrepreneurial field in Ghana, which has a slightly higher female entrepreneurship rate (38%) than among men (35%) (Herrington and Kelly, 2013). Albeit, in the agricultural sector, there are more male than female participants, with only a slight difference; 45.1% for males and 38.3% for females (GSS, 2014a). The huge difference or perhaps the difficulty in finding female young graduate agripreneurs in this study could indicate a less preference among young graduate females for the agrifood sector or perhaps there are constraints that hinder their participation. Opinions among respondents on the role/influence of gender (female or male) in the pursuit of agripreneurship were divided; some believed the drudgery of agriculture activities made the sector more suitable for males, whiles others differed and opined that females could actually partake in the sector.

Of the 24 respondents, eight (33.3%) worked on a part-time basis, and had another job (source of income) which complemented benefits (income/food) gained from their enterprises. This supports the calls for issues of underemployment and low income to be critically examined in the youth employment discourse (see ILO, 2017; FAO; 2014, Bennell, 2007). Data also shows that majority of the young agripreneurs (21 [87.5%]) are university graduates, out of which only five had undertaken agriculture or food related studies. This may very well indicate the possibility of youth of different educational backgrounds being able to actively participate in youth agripreneurship and how accommodating and engaging the sub-sector is or can be.

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Table.1: Disaggregated research data

Category		Number of Respondents
Gender	Male	2
	Female	22
Part-time or Full-time	Part-time	8
	Full-time	16
Type of Post-Secondary School/Education	Tutorial College	1
	Polytechnic	2
	University	21
Area (Subject) of Studies		**Number of Respondents**
Agriculture/Food Studies		5
Business Studies (Finance, Marketing, Accounting, Commerce, Management)		6
Environment & Natural Resource Studies		2
Engineering Studies		2
Political Science and Land Economy Studies		3
Design and Theatre Arts Studies		2
Science and Mathematics Studies		4

Source: *Research Data*

IV.a Factors influencing Agripreneurship

A rigorous desk study was undertaken to identify the factors that influence agripreneurship; academic literature (published and unpublished), and grey literature, which also contained vast information, were scrutinized. During the process key entrepreneurship models and/or literature, many of which had also reviewed various other entrepreneurship models and literature, were identified and these provided critical information. Following the understanding of entrepreneurship being a process and outcome, with multilevel aspects, factors identified as influencing agripreneurship were put in three broad categories, namely Personal Factor, Organisational Factor and External Environment or Institutional Factor (see table 2 on the next page). The categorisation is encompassing, allows for further operationalisation and underscores a holistic (multilevel) approach to agripreneurship. Personal Factor refers to elements related to the person of the entrepreneur, such as psychology, trait, qualities, and experience among others. This category is akin to Individual Entrepreneurial Orientation (IEO), which many studies have confirmed is related to and/or influences business performance (see Koe, 2016). Entrepreneurial elements which are hinged upon the enterprise or should exist within the enterprise are grouped under Organisational Factor, whiles those existing outside of the entrepreneur and enterprise are grouped under External Environment or Institutional Factor.

Further literature reviews was undertaken towards operationalisation of the three factor groupings, leading to delimitation of sub-dimensions and selection of indicators for the study. Following Botha, Veeruen and Kunne (2012), two sub-dimensions of the Personal Factor were constructed; Entrepreneurial and Personal Skills (EPS) and General Business and Technical Skills (GBTS). Applying the 'Black Box' of the IOM (Integrated Organisation Model) (see Lewinsky and Muharemovic, 2011) six sub-dimensions of the Organisational Factor was outlined; Organisational Structure, Staff/Team Members, Systems and Processes, Strategy, Culture and Management Style/Approach. Applying the PEST/ PESTEC tool four sub-dimensions of the External Environment/Institutional Factor was outlined: P (Laws, Policies and Programs and Political Dynamics); E (Economic & Environment); S (Socio-Cultural) and T (Technology). These informed the agripreneurship performance conceptual framework of the study (fig. 1 on the next page). The three factor groupings are the independent variables that influence agripreneurship performance (dependent variable) with supportive interventions moderating this performance in terms of seeking to enhance or strengthen agripreneurship performance. As explained by O'leary (2004), dependent variable are the, "the things you are trying to study" and an independent variable is "what might be causing an effect on the things you are trying to understand" (p. 188). It must be noted that the term independent does not mean there are no influences on those variables themselves – only that within the constraints of the research, those other possible influencing factors will not be studied (Verschuren and Doorewaard, 2010).

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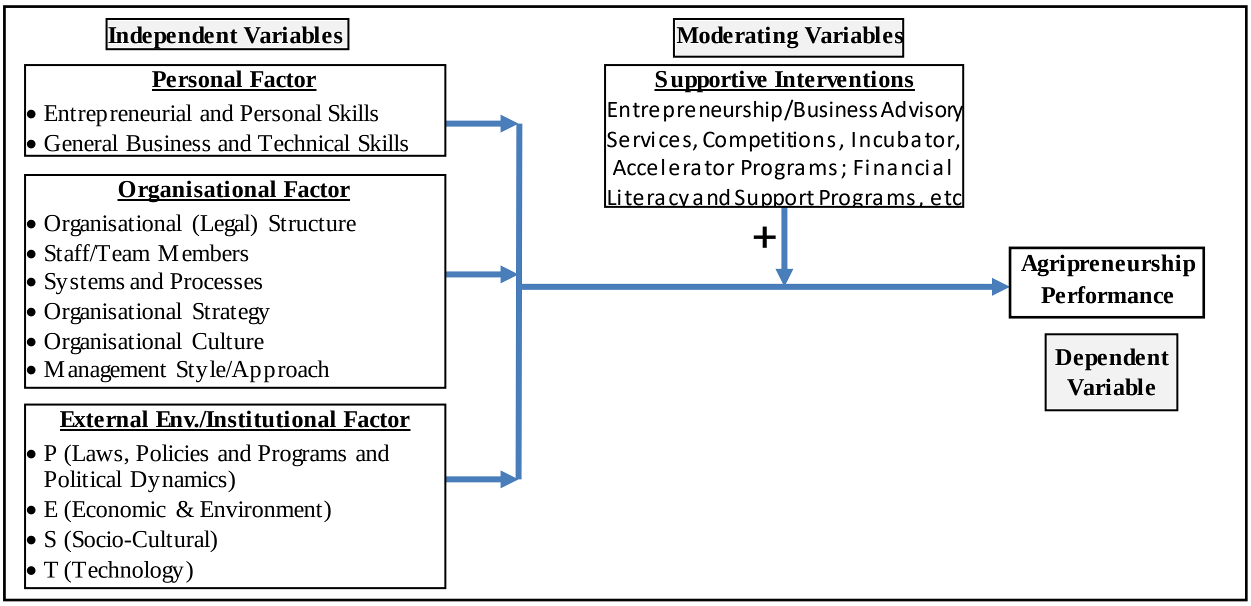
Table.2: Categorisation fo the factors that influence entrepreneurship

Entrepreneurship Models or Literature Works	Categories of Entrepreneurial Performance Factors		
	Personal Factor	**Organisational Factor**	**External Environment or Institutional Factor**
Timmons Model **Source: Poerwowidagdo and Wee Y. G (n.d.)**	Founders having right skills and knowledge; Ambiguity; Creativity; Communication Skills	Team; Business Plan	Opportunity; Resources; Exogenous Forces
Per Davidsson Model **Source: Davidsson, 2005**	Individual Factors	Idea (Business Idea)	Environmental Factors
Ahmad and Hoffman (OECD) **Source: Ahmad and Hoffman, 2007**	Entrepreneurial Capabilities	Research and Development; Technology	Technology Regulatory Framework; Access to Finance; Market Conditions
Bygrave Model (based on Moore's Model) **Source: Nassif, Ghobril & da Silva2010**	Achievement; Locus of control Ambiguity; Tolerance; Risk taking; Personal values; Job Satisfaction/Loses; Age; Vision; Education; Experience; Commitment;	Team; Strategy; Culture; Products	Competitors; Customers; Bankers; Suppliers; Investors; Lawyers Resources; Government policy; Incubator; Role Models; Opportunities; Creativity
Hisrich and Peter's Model **Source: Kunene, 2008**	Risk taking; Locus of control; Personal values; Education; Experience; Age; Job loss; Job Dissatisfaction; Commitment; Entrepreneur; Leader; Manager	Team; Structure; Strategy; Culture Products	Opportunities; Role Model; Competition; Resources; Parents Incubator; Customers; Suppliers; Investors; Bankers; Lawyers; Resources; Networks; Family; Government Policy; Role Models

Source: *Author's compilation – sources indicated*

Fig.1: agripreneurship performance framework



Source: *Author's construct*

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This paper focuses on the Personal Factor, subsequent papers shall focus on the on the other two groups of independent variables. Scanning various literatures showed a host of elements (indicators) centered on the Personal Factor (see table 3 below). Thus, a critical examination was carried out to select an encompassing and workable number of indicators fit for this study. After further interrogation of literature including the meaning (applied, contextual and general) of the various indicators, 14 key indicators (seven under each sub-dimension) were selected or framed for the study (see table 4 below). Using the semi-structured questionnaire, the 14 indicators were examined as to how they influence agripreneurship performance of respondents.

Table 3: List of various elements (indicators) of personal factor

Initiative and drive; Innovative thinking; High sense of achievement; Sets example for himself; Hard work; Capacity to take risk; High intelligence and deep knowledge of the project or new venture; Long range vision; Motivation; Sound judgment; Leadership qualities; Taking full personal responsibilities; High level of ambition; Organizer of resources; Target setting and fighting for achievements; Sociable and flexible in his approach; Continuous learning by feedback; Future orientation. **Source: *Saxena, 2013.***
Individual smartness/ability to recognize highly potential business opportunity; Creativity; Innovativeness; Self efficacy /Self Confidence/Self-belief; Dedication & Hard-work; Internal locus of control/believing that actions determine the rewards; Risk taking propensity/Attitude towards risk/taking calculated Risk ; Tolerance of Uncertainty/ambiguity; Sincerity and Commitment; Endurance/Continuing for long time; Good planning; Ability to make decisions; Flexibility / Adaptive to change; Goal oriented **Source: *Ratvi, 2013.***
Motivation; Risk Tolerance; Vision; Mental ability & Creativity; Clear Objectives; Good Communication Skills; Human Skills **Source: *Pahuja, 2015***
Ability to Plan; Communication Skills; Marketing Skills; Interpersonal Skills; Basic Management Skills; Leadership Skills. ***Pahuja 2015, citing University of Illinois Center for Economic and Financial Education***
Confidence; Foresight; Perseverance, Determination; Accuracy-thoroughness; Energy, diligence; Cooperativeness; Responsibility; Resourcefulness; Profit Orientation; Ability to take calculated Risks; Ability to learn from mistakes; Dynamism, Leadership Mistakes; Sense of Power; Optimism; Pleasant Personality; Need to Achieve; Egotism; Versatility, Knowledge of Product; Courage; Creativity; Imagination; Ability to Influence others; Perceptiveness; Ability to get along well with people; Toleration for Ambiguity; Initiative; Aggressiveness; Flexibility; Capacity for Enjoyment; Intelligence; Efficacy; Orientation to clear Goals; Commitment; Positive Response to Challenges; Ability to trust Workers; Independence; Sensitivity to others; Responsiveness to suggestions; Honesty, Integrity; Time competence, Efficiency; Maturity, Balance; Ability to make decisions quickly. **Source: *Amiri and Marimaei (2012)***

Source: *Author's compilation – sources indicated*

Table.4: List of indicators of personal factors examined in this study

Entrepreneurial and Personal Skills	General Business and Technical Skills
1. Creativity/Innovation	1. General Business Management and/or Administrative Skills
2. Risk-taking or tolerance	2. Business planning and/or Business Goal-Setting Skills
3. Initiative and Drive (Proactive)	3. Communication Skills
4. Determination and commitment (Persistent and Dedicated)	4. Team Building and Leading Skills
5. Personal Effectiveness (Planning and time-management)	5. Financial Management Skills
6. Motivated to Succeed	6. Marketing/Selling Skills
7. Self-confident and Shameless	7. Skills related to undertaking/working in the enterprise (technical knowledge and/or skills)

Source: *Author's compilation*

The selected indicators capture entrepreneurial qualities suggested in other studies: the three domains of entrepreneurial qualities suggested by Kahan, (2013); the six domains of entrepreneurial competencies (see Lans, Bergevoet, Mulder and Van Woerkum, 2005 citing Man et al, 2002); the five domains entrepreneurial skills (see de Wolf and Schoorlemmer, 2007). The semi-structured questionnaire also made room for respondents to suggest other indicators outside the selected 14 which they deem important. The next section contains findings and discussions from the field.

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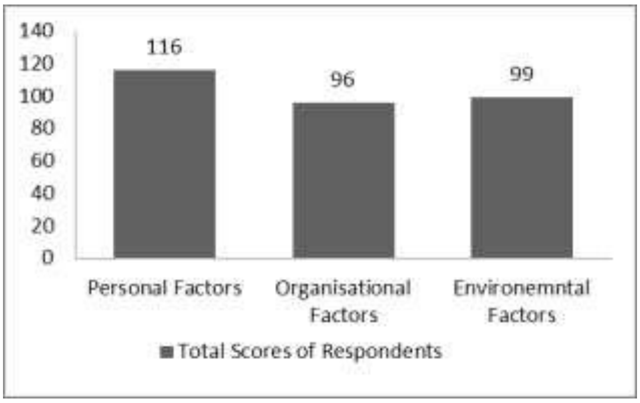
IV.b Influence of Personal Factor (EPS and GBTS) on Agripreneurship Performance

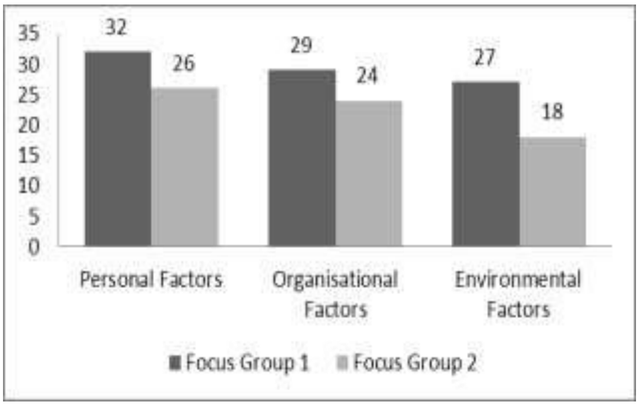
Among the three factorial groupings delineated, personal factor was rated as most important by all the individual respondents and also during the focus group discussion and exercises; figures 2 and 3 shows the scoring of the factor groupings by individual respondents and also during the two focus group discussions. This agrees with most literature which put the individual entrepreneur and her or his set of skills as being pivotal to the whole entrepreneurial process and its outcomes. Poerwowidagdo and Ghee (2011) reports Timmons as opining that "if the entrepreneur is equipped with the right skills and knowledge, he will be able to pull the right people together, search for relevant and ample resources to tackle the opportunity he sees in the market, shapes it well and turns it into potential business venture" (p. 3). Thus, the entrepreneurial qualities of the entrepreneur are decisive in the process of building an enterprise to leverage opportunities. Respondents scored/rated each of the seven indicators of the two sub-dimensions, after which further probing on each element (indicator) was carried out to unravel and understand how these elements influenced (facilitated/supported or inhibited/constrained) their agripreneurship performance; concrete context/situations and examples were asked to for meaningful appreciation of the influence of these elements. The findings and discussions flows in the next segments.

Figure 2: Scores of the three factors by respondents



Source: *Research Data*

Figure 3: Scores of the three factors by focus groups



Source: *Research Data*

IV.b.1 Entrepreneurial and Personal Skills (EPS)

As evident from the graph (fig. 4 – next page), aside Personal Effectiveness, all other indicators were scored as being Sufficient and above, a clear indication of how strong agripreneurs deemed their EPS levels. The influence of the EPS could be summed up as including, 1) inspiration and decision to embark on the agripreneurship and working to maintain their agrifood enterprises; 2) learning, discovery and innovation and 3) developing a thick-skin (positively) and emotional strength. Kahan (2013) notes that starting and sustaining a new farm enterprise is an indication of some entrepreneurial qualities and also that emotional transformation (growth/maturity) – on the part of the agripreneur – is also needed as the business also goes through transformation. Respondents indicated having had to take difficult and uncomfortable decisions in pursuing their agrifood ventures; some had to forego their regular jobs its regular salaries, some respondents indicated having had to invest their life savings to start their enterprises hoping for a positive outcome, while others had to make their spouses quit regular employment to join them in their agrifood enterprises. Being motivated and determined to succeed they had to endure and continue their operations despite challenges such as mass crop failure and death of livestock, and low sales among others. All of the respondents have had to embark on a process of learning and discovery to either acquire or update their technical know-how, or to institute some innovation in their enterprises towards ensuring better operations, management and outputs. Both simple and sophisticated innovations such as a locally made carbonator and improved oil milling machines were observed. Whiles some respondents had produce entirely new products, others had also made adjustments such as better packaging and/or targeting and satisfying a niche market. This aligns with arguments that entrepreneurship can be about newness or not necessarily so (see Davidsson, 2005; Braunerhjelm, 2010 referencing Aldrich and Martinez, 2001).

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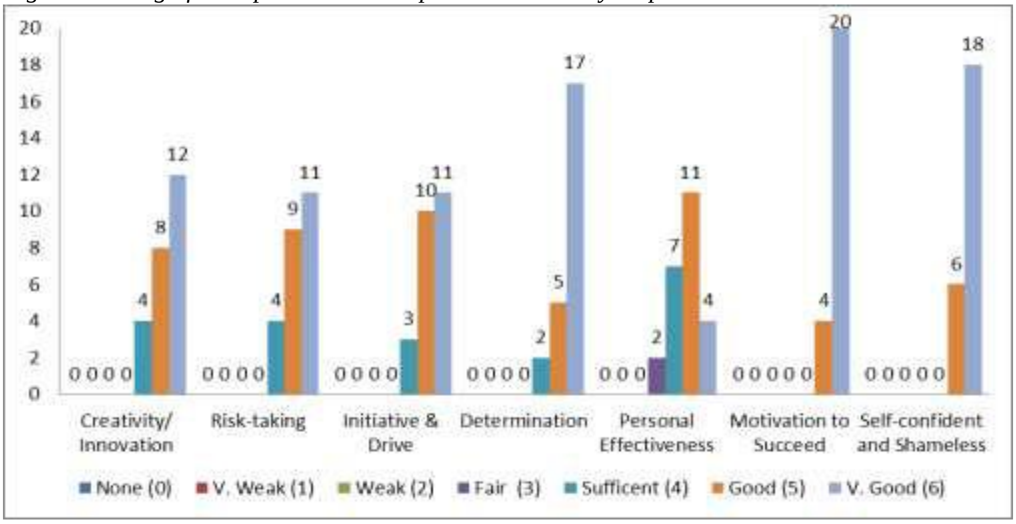
In addition to taking and facing risks, and dealing with sometimes difficult stakeholders (customers, suppliers), many respondents also had to face harsh criticism from family, friends or their community for being graduates yet engaged in farming; other studies have also reported farmer parents' hoping and acting for their children to pursue other livelihoods rather than farming (Leavy and Hossain, 2014; Anyidoho, Leavy and Asenso-Okyere 2012). These challenges had gone on to make respondents become thick-skinned (positively) and emotionally strong. The generally strong EPS, especially the determination and motivation to succeed, also reflect findings of the Global Entrepreneurship Monitor (2012), which noted a relatively lower business discontinuation rate (16%) among entrepreneurs in Ghana, compared to some other African countries (Malawi-29%; Angola-26%; Uganda-26%; Zambia-20%) (Herrington and Kelly, 2012). However, respondents were also candid about the weak aspects of these elements and how it influences (inhibits) their performance. For example respondents who deemed their personal effectiveness to be weak noted that effectively combining their personal lives and that of the enterprise was a challenge, and this inhibited their ability to make quick and effective decisions and/or implement decisions taken. During the study, respondents also mentioned Resource Mobilisation and Long-term Vision as being important enterprising and personal skills; these qualities are captured in entrepreneurship literature in same words or in antonyms such as resourcefulness and foresight (see table 3 above). Generally, the EPS was scored very high, was skewed in the positive direction with the skills generally mutually reinforcing.

Fig. 4: Scoring of entrepreneurial and personal skills by respondents



Source: *Research*

IV.b.2 General Business and Technical Skills

Like its counterpart, the GBTS had varying and reinforcing influence on the agripreneurs and their activities. These influences is summed up as including 1) planning and coordinating enterprise activities 2) administrative and technical management of daily activities and 3) building and maintaining relationships among internal and with external stakeholders (customers, suppliers, partners). Kahan (2013) opine that entrepreneurial personal qualities are not enough for the entrepreneurial farmer, they also "require knowledge in key areas of farm management: planning, implementing and controlling" (p. 52), and also that "their success can rest in the hands of other people. So they recognise the need to work with other people" (p. 57). During the study it was noted that, some of the processes and activities in the enterprise of agripreneurs were simple others were also quite complicated and advance, albeit the full attention of agripreneurs was demanded and respondents had to plan well, ensure proper coordination and to undertake the right activity at the right time, produce desirable produce/products, meet customers demand and/or supply at the right time. Whiles general administrative duties and planning was executed well, also indicated by high scores of related indicators (see fig. 5), administrative duties requiring technical or professional skills, particularly financial and marketing, was a challenge for some of the respondents. It was thus not surprising that respondents admitted market access being a challenge; many literature have identified this particular challenge as a critical factor for young people in agriculture and entrepreneurship (Brooks, Zorya, Gautam and Goyal, 2013; Adjei, 2012). Another respondent in admitting his weak financial skills, said that "*I don't keep very good records; I just put everything in the business. If you ask me how much the business is now*

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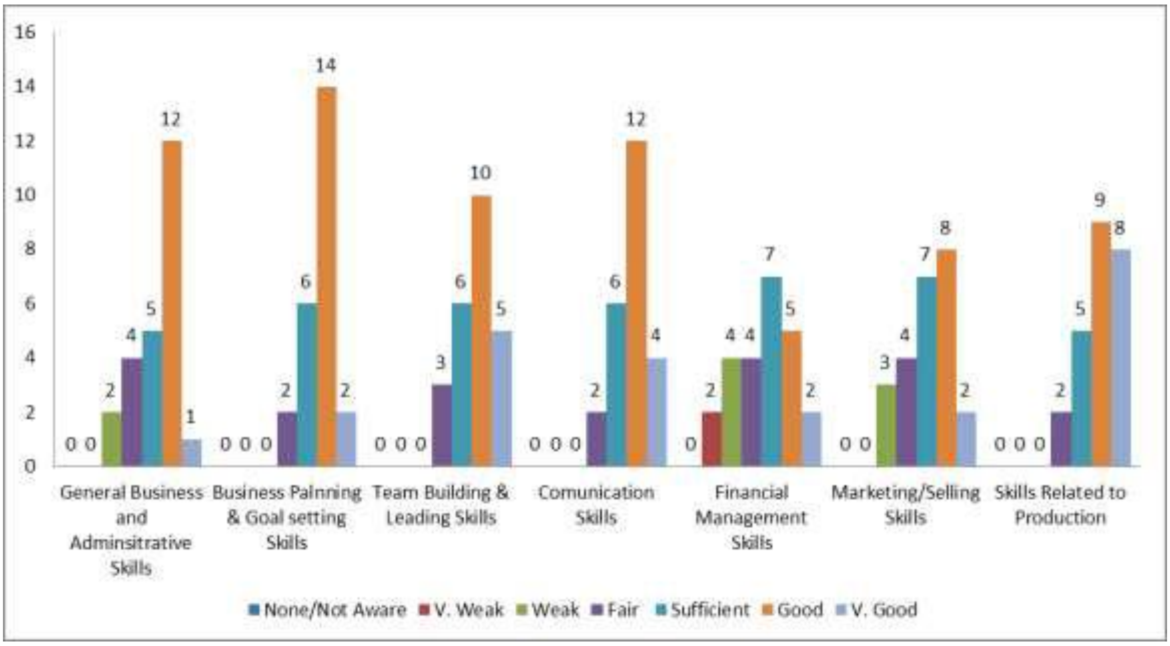
[business worth/value], *I cannot really tell you"* (Respondent, A). Respondents had to deal with various internal and external relationships towards ensuring sustained enterprise performance, meeting product standards, guaranteed market access and meeting customer demands. One respondent indicated that, his task even extended to settling dispute among farmers who formed part of his agrifood enterprise value chain. These were possible due to communication and team building skills much of which they acquired on the job.

Fig.5: Scoring of entrepreneurial and personal skills by respondents



Source: *Research Data*

Comparing the EPS scores with that of the GBTS (figs. 4 and 5), the GBTS scores are very high, and also EPS scores were more spread out; whiles only one indicator of the EPS recorded a 'fair' score, each of seven GBTS had a 'fair' rating and some even lower. Among the two sub-dimensions, the GBTS can be said to be weaker than the EPS. This is unfortunate considering that successful business management of agrifood enterprises is important for ensuring higher profitability and good incomes, an issue which is noted to be a major concern for young people regarding taking up agriculture as a livelihood (see Leavey and Hossain, 2014). Proper business management in entrepreneurship ventures is also decisive for the growth and transition of nascent enterprises (Kahan, 2013). However, the low GBTS scores fit other findings which noted that EPS was deemed more important than GBTS (see Botha, van Vuuren and Kunene, 2015). In this study, it was observed that respondents with business related education had a more 2062rganized (and seemingly profitable) agrifood enterprise. This study aligns with authors and other findings which stress the importance of business management competencies/skills as being essential to 'holistic entrepreneurship', with Phelan stating that, "both an entrepreneurial and managerial skill-set are required to run a successful venture" (2014, p. 85). Thus, though the scoring was subjective, the results align with other arguments and findings.

V. CONCLUSION

Towards addressing the key issues of food security and unemployment amidst ongoing demographic transition, whiles also addressing important dynamics in the agrifood sector (ageing farmers, technological and digital revolution, emergence of an expansive and complex agrifood system and environmental changes), entrepreneurial participation of young graduates (highly educated youth) in the agrifood sector is of strategic importance and value. Thus the study focused on identifying the factors that influence young graduate agripreneurship and how these factors influence their agripreneurship performance with a view of contributing to how young graduate agripreneurship can be enhanced. The study showed that young graduates, irrespective of educational background, can actively participate in the agrifood space, more so since the production, supply and consumption of food has and continues to change/evolve. These changes incorporate different processes into agrifood systems and it allows different actors of diverse educational backgrounds to also participate in different areas (chains) of the system. Particular difficulty in finding sizeable female young graduate agripreneurs may well indicate the need for deliberate efforts at ensuring gender-inclusiveness in the nascent young graduate agripreneurship phenomenon. Three broad categories of factors (dimensions) can be said to influence agripreneurship; Personal, Organisational and External; with the Personal Factor dimension being pivotal. This categorisation is derived from diverse entrepreneurial models and literature, and provides an encompassing categorisation framework. The framework underlines a holistic perspective and approach to the examination of agripreneurship. Personal Factor was found to have varying influence on agripreneurship performance and cuts across the following sectional areas/topics of: 1) inspiration and decision to embark on the agripreneurship and working to maintain their agrifood enterprises; 2) learning, discovery and innovation and 3) developing a thick-skin (positively) and emotional strength; 4) planning and coordinating enterprise activities 5) administrative and technical management of daily activities and 6) building and maintaining relationships among internal and with external stakeholders (customers, suppliers, partners). These influences were noted to reinforce each other towards enhancing overall agripreneurship performance. Though it plays an important role in the stability, growth and transition of nascent and micro enterprises, technical/professional business competencies/skills were generally weak and this negatively affected sound business management of agrifood enterprises. In seeking to train and developed effective and efficient young graduate agripreneurs, it is important for the use of an integrated and applied approach which ensures acquisition and/or enhancement of the various elements of the Personal Factor (i.e EPS and GBTS). Technical business management competencies are as important as personal entrepreneurial competencies, and in training and developing young graduate agripreneurs, these skills must be an integral part of the training regime, more so, when it is desired for micro entrepreneurial ventures to grow and transition into small and medium scale enterprises for greater socio-economic impact.

Like all research activities, this study had some limitations. The use of a case study approach implies that the findings of this research though provide detailed insights, data may not be applicable to the broader population, more especially when the young graduate agripreneurship is still budding; this informed a rigorous triangulation of method and sources, and the use of a relative sizeable number of respondents. Use of purposive sampling and snowball sampling is noted to having some influence on findings such as biasness and similar responses from respondents. Towards eliminating or at least reducing this effect, each interview was conducted on a one-on-one basis without the presence of other respondents. Additionally, in cases where a respondent had provided a lead to another potential respondent, the researcher took control in establishing contact with the potential respondent. Subjective data and scores are vulnerable to either exaggeration or deprecation. It was therefore important to seek concrete examples from respondents and also to situate and compare the findings of this research within other tested arguments and empirical studies. In some cases (very limited) quotations of respondents had to be ‘cleaned’ to fit the format and/or formality of this report; however this is deemed insufficient to invalidate research findings. Mention must be made of the numerous elements under Personal Factor, though the study focused on a critical few.

Going forward other studies exploring other indicators under Personal Factor will contribute to understanding of this topic. Additionally, quantitative mechanisms and studies able to measure the strength of indicators under Personal Factor will also be helpful to this topic and the larger discourse of youth entrepreneurship. This study also makes it evidential the need for a gender-based study into young graduate agripreneurship, including how to promote young female graduate agripreneurs. Studies on young graduate agripreneurship along specific agrifood value chain – even as the chains evolve and develop – may be needed in the long-run to generate valuable data for the development of those chains.

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Biodiversity of Freshwater Shrimp of the Genus Macrobrachium (Decapoda Palaemonidae) in the Nyong Basin of Cameroon

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***Abstract*— *The population of shrimps, especially the macrobrachium genus, has been affected with habitat pollution and overexploitation. Shrimps provide a major protein source to animals higher in the food chain. The importance of studying the ecology of shrimps in their different habitats helps in their preservation and provides possibilities of carcinoculture. This study examines diversity, ecology and reproduction parameters of fresh water shrimps of the genus macrobrachium in the basins of Lepmassoun and Ondoamedza rivers. Lepmassoun and Ondoamedza rivers form part of the larger Nyong river basin in Cameroon. In situ water physicochemical parameters were determined on site, preserved water samples used in mineral analysis and subsequent ecological health assessment. Shrimps were sampled using the scoop method with hand nets and analyzed. Sampling was done in 5 seasons distributed from January 2017 to February 2018. The results of physicochemical parameters indicate that water in the two rivers was slightly mineralized, sufficiently oxygenated and slightly turbid. It was generally a non-polluted ecological zone for shrimps. A total of 113 shrimps distributed among 14 species were collected. The shrimp population included Macrobrachium macrobrachion Macrobrachium idae, Macrobrachium rude, Macrobrachium niloticus , Macrobrachium dux Macrobrachium sp1, Macrobrachium sp2, Macrobrachium sp3,Macrobrachium sp4, Macrobrachium sp4, Macrobrachium sp5, Macrobrachium sp6, Macrobrachium sp7, Macrobrachium sp8 and Macrobrachium sp9.In the river Odoameza 11 species were collected among which Macrobrachium sp8 (26.02%) is abundant, though,in the river Lepmassoun we collected 10 species dominanced by Macrobrachium macrobrachion (22,5%). The species Macrobrachium macrobrachion is most ubiquiste throughout river Lepmassoun (%O = 83.33%) The river basin of Lepmassoun had a higher population of Macrobrachium macrobrachion with a percentage occurrence of 66.67%. then It is concluded that the water in the two river basins is of good ecological quality for shrimp survival with species Macrobrachium macrobrachion dominating in the river lepmassoun. In the river Ondoameza Macrobrachium sp8, Macrobrachium idea, Macrobrachium macrobrachion,Macrobrachium sp4 having all the percentage of occurrence (%O) of 66.67% are relatively represented. Only Macrobrachium dux have Ovigerous females in our study. This Ovigerous females ranged from 50.38 to 64.18 mm and egg size varied from 1.7 to 2 mm. The prawn attained a maximum total length and weight of 64,18 m and 2,96 g respectively. In our basins slope the Macrobrachium dux reproduces twice year during the big dry season and small dry season since production is early and the eggs are rather broad by consequence the larval development is shortened.*

Keywords*— *Shrimp; Macrobrachium; ovigerous, Lepmassoun; Ondoamedza.

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I. INTRODUCTION

The world production of shrimp exceeded 240 T in the year 2000, which roughly corresponds to 20% of the total quantity produced (Sampaio, Silva et al. 2007).Africa's contribution to shrimp production remains very minimal with almost null participation in carcinoculture (FAO 2010). The main species of fresh water shrimp with commercial value belongs to the family paleamonidae (Nnana Noah, 2010). Within this commercially viable family, the genus Paleamon, Leander, and Macrobrachium are dominant (Monod 1966). Furthermore, Macrobrachium (Bate, 1868) has been found in most of the biogeographic areas and more than 240 species have been recorded (De Grave and Fransen 2011).

Overfishing and pollution affects biodiversity of aquatic animals (Omwoma 2012). Continuous aquatic system assessment for water quality and biodiversity helps in system management and product quality. Use of agricultural products such as pesticides and fertilizers including urbanization are known to affect water quality and species diversity (Allan and Flecker 1993). The fact that production of shrimp in Africa has remained low leads scientists to determine possible reasons and mitigation measures over the same. This is particularly the case given that Africa is dominated with several fresh water bodies that are conducive for shrimp production.

Furthermore, shrimps are of great ecological, medical and socio-economic interest. They can be characterized by their life cycle (New and Singholka 1985) and they play a significant role in water trophic networks. They are regarded as indicators of good water quality. In addition, the market of shrimps in the east is a gold basket and their price is higher than fish. Such good qualities of shrimps makes them an important subject of study especially their ability to provide high protein content in different diets (Doume doume, Toguyen et al. 2013).

In Cameroon, shrimps of the genus Macrobranchium (Herklots 1851) might be exploited by artisanal fishermen that use bow nets. There is little data available on the ecology and the biology (reproduction) of shrimps in Cameroon (Doume doume, Toguyen et al. 2013), (Tchakonte , Ajeagah et al. 2014)and (Ajeagah, Yogback et al. 2017), (Ajeagah, Yogback et al. 2018). As such we endeavor herein to characterize the ecology of shrimps river Lepmassoun and the river Ondomedza. Lepmassoun and Ondoamedza rivers form part of the larger Nyong river basin in Cameroon. The study considers biodiversity of shrimps and ecological quality parameters of the two river basins.

II. MATERIAL AND METHODS

2.1. Study site

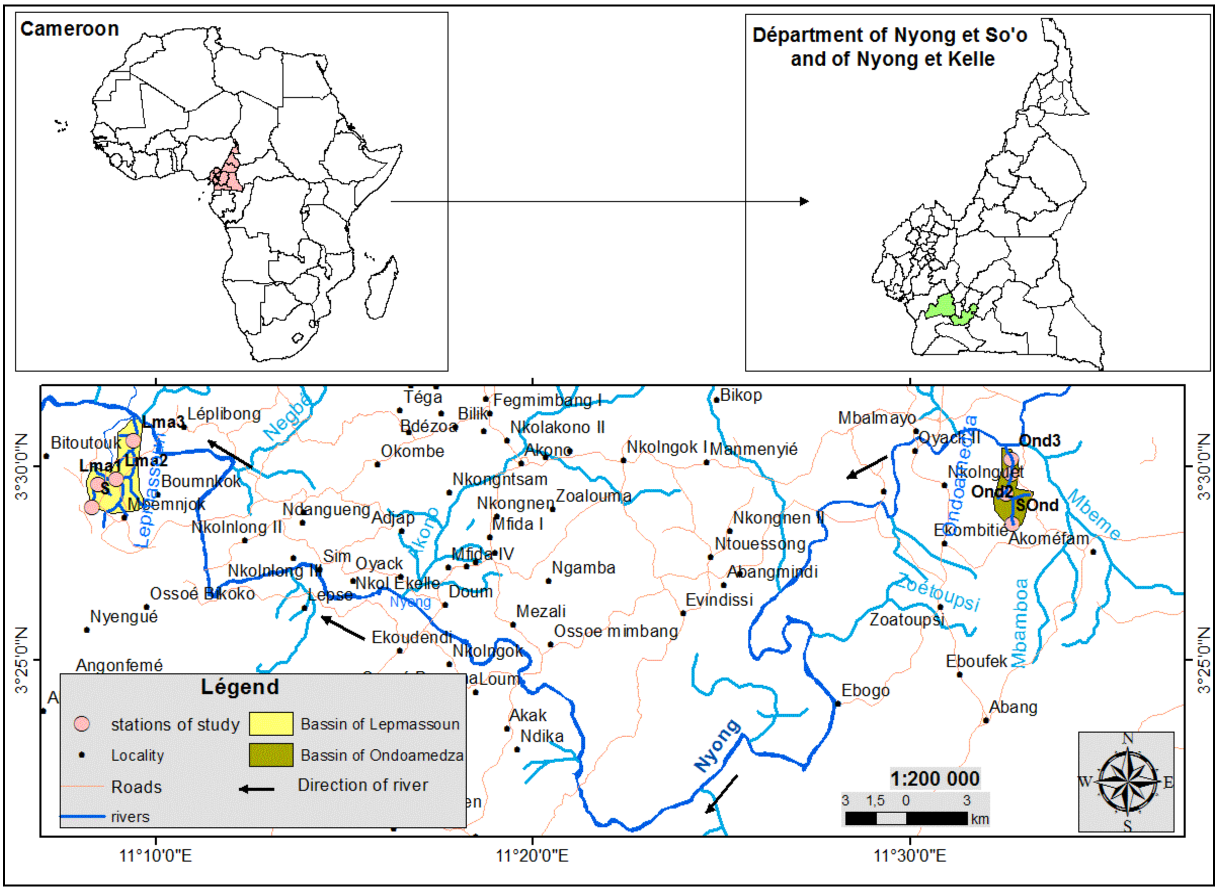

Fig.1: Study areas that comprise of River Lepmassoun and River Ondoamedza along River Nyong in Cameroon. Lma 1 -3 are sampling points on Lepmassoun River while Ond 1-3 are sampling points along the Ondoamedza River.

The study site, Nyong River Basin, comprises of two tributary rivers namely Lepmasoun and Ondoamedza (**Fig. 1**). These two river tributaries lie within an equatorial climate. Such a climate is characterized with four main seasons per year (two dry seasons and two wet seasons). The main dry season is experienced from December to February while the main wet season is experienced from September to November. The rainfall distribution ranges from 3 000 mm per month to 1500 mm per month in the two basins resulting to the entire area being covered with forest (Olivry 1986). Six stations were identified as marked in Fig. 1 for sampling and they were identified as Lma1 (0329' 41,164'' N; 118' 45,068" E), Lma2 0329' 44 ";118' 45,072'' E and Lma3 (0330' 58,19'' N;119' 29,727" E) for the river Lepmassoun;Ond1 (0329' 40,25 '' N;1132' 38,336" E), Ond2 (0330' 1,451'' N;1132' 43,048" E) and Ond3 (0330' 18,166' ' N;1132' 37,413" E) for the river Ondoamedza (see Fig. 1).

2.2. Physicochemical parameters determination

Physicochemical parameters including Temperature, Dissolved Oxygen, pH, Electric Conductivity and TDS were determined insitu. Dissolved CO_2, Alkalinity (HCO_3^-), Nitrates (NO_3^-), Nitrites (NO_2^-), Orthophosphate (PO_4^{3-}), and Ammoniacal Nitrogen (NH_3-N) were determined using standard procedures on unfiltered water samples. Shrimps were collected using a scoop method with a hand net and preserved with formalin in containers that had been washed with alcohol (95%). In the laboratory, the shrimps were identified by placing them in a petri dish, sorted accorded to their morphology and identified using a binocular magnifying glass according to cited keys of identification features (Monod 1966), (Powell 1980); Won and Lawrence, 1988; Bruce and Thomas, 1991; (Day, Stewart et al. 2001)).

2.3. Determination of Shrimp biodiversity

The diversity index of (Shannon and Weaver 1948) was used in determination of species distribution within their habitat (**Equation 1**).

$$N = \frac{n}{N} x100 .... Eqn.1$$

Where n = numerical proportion of a taxonomic group, N = total number of individuals

Percentage species of occurrence (%SO), the percentage of stations where a species is sampled was determined using ***Equation 2*** (N'zi, B.G. et al. 2008).

$$\%SO = \frac{Si}{St} x100 .... Eqn.2$$

Where: Si = number of stations where species i was captured, St = total number of stations prospected.

2.4. Reproduction of shrimp

Ovigerous females were identified and sex-ratio determined according to ***equation 3*** (Agadjihouede 2006**).** The number of eggs in the female was physically counted.

$$SR = \frac{Nm}{Nf} .... Eqn.3$$

Where Nf = number of females and Nm = number of males

The femininity rate was determined using **equation 4**

$$TF = \frac{FX100}{F + M} .... eqn.4$$

Where F = number of females in the given sample and M = number of males in the given sample.

Fecundity was done by counting the number of eggs from the weight sampling method. The eggs were taken out of the pill organizers and wrung out on blotting paper. A fraction of 0.05g was then taken and counted under a magnifying glass. From the results, absolute fertility (**Equation 5**) and relative fertility (**Equation 6**) was determined where absolute fertility is the total number of eggs and relative fertility is the number of eggs per unit of body weight.

$$FT = \frac{NxP(G)}{0.05} .... Eqn.5$$

Where FT = absolute fertility, N = number of eggs in the 0.05g fraction, P (G) = gonad weight.

$$FR = \frac{FTx1}{Pt} .... Eqn.6$$

Where FR = relative fertility; FT = absolute fertility; Pt = body weight

The reproductive period was determined through the gonado-somatic relationship (RGS) given by equation 7 (Goore Bi 1998). This relationship reflects the progress of maturity of the ovaries. The higher this ratio, the closer is the laying, when it is weak, the female is in a state of sexual rest. In the state of immaturity, the value of this relation is zero or near zero.

$$RGS = \frac{P(G)}{Pt} x100 .... Eqn.7$$

Where RGS = Gonado-somatic relationship; P(G) = *Gonad weight; Pt = body weight*

III. RESULTS

3.1. Physicochemical parameters

The data for physicochemical parameters of River Lepmassoun and River Ondoamedza are recorded in **Table 1**. During the period of study, abiotic parameters did not significantly vary according to the test of Kruskal Wallis. However, temporarily, some parameters varied except for temperature, dissolved oxygen, oxygen content, MES, color, oxydability, ammoniacal nitrogen and magnesium hardness.

Temperature was constant with an average of 21.66±0.86ºC in River Ondomedza. However in River Lepmassoun, it varied from one season to another according to Kruskal-wallis test ($P < 0, 05$) of 19,5 ºC (GSP) at 23 ºC (PSP). In the river Lepmassoun, the profile of variation of turbidity lies between 0 (GSP-Lma1) and 48 FTU (GSS 2018-Lma3) and significantly varied from one season to another. That of MES was 0 mg/l (GSS-Lma3 and GSP-Lma2) and 32 mg/L (GSS 2018- Lma 3) and did not vary significantly with an average of 8.2±8.47 mg/L, according to the test U of Mann Withney. In River Ondoamedza, the minimal values of turbidity, MES and colors are of 0 FTU, 0mg/L and 52 Pt-Co respectively and the maximum values are of 20 FTU (Ond1- GSS), 15 mg/L (Ond3- PSS) and 362 (Ond3- PSS) Pt-Co. With regard to the color, it did not vary significantly in the rivers under study with average value of 126.67±47.8 Pt-Co in the River Lepmassoun and 135.67±89.27 Pt-Co in the River Ondomedza. However these values of turbidity recorded in the two rivers are in the standard (< 35, g/L). neutrality. Their pH significantly varied from one season to another ranging between 6.66 CPU (Lma1, PSS) and 7.57 UC (Lma2, GSP) in the river Lepmassoun. River Odoamedza had a small variation in pH ranging between 5.25 UC and 7.97 UC (6.66 ±0.75 CPU).The curve of conductivity curve and the TDS are stacking and confirms the positive strong correlation between the two parameters. Conductivity and TDSONT significantly varied on the temporal level in our two rivers. In Lepmassoun the smallest values of conductivity (22 µS/cm) and TDS (11 mg/l)) are recorded in Lma3 during GSP and the maximum values are observed in Lma2 during the great dry season (49 µS/cm for conductivity and 25 mg/l for the TDS) with the averages of conductivity and TDS of 36, 47±8.25 µS/cm and 18.27±4.26 mg/l respectively. In the river Ondoamedza, conductivity varied from 14 (Ond3-GSP) to 138 mg/l (Ond3-PSP) and the TDS varied from 7 to 69 µS/cm. The percentage of oxygen significantly did not vary on the spatiotemporal plan according to the test of Mann Whitney in the river Ondomedza with an average of 62±0,85 %, however in the river Lepmassoun it varied from 60 (Lma2- PSS) to 69.9 (Lma3-GSS 2018). The profile of variation of the dissolved oxygen contents when superimposed with that of the percentage of oxygen in the river Lepmassoun it varied from 4.78 (Lma3-GSP) to 6.75 mg/l (Lma3- GSS 2018). However, it is of 4.30±1.25 mg/l in the river Ondoamedza. The dissolved CO_2 rate and alkalinity significantly varied among the sampling campaign to the other according to the test of Mann Withney. Thus the CO_2 rate varies from 1.76 mg/l (PSP) to 102.08 mg/l (GSS 2017) in the river Lepmassoun whereas in the river Ondoamedza it varies from 1.76 mg/l (Ond2 - PSP) to 133.76 mg/l (Ond3-GSS 2017). Alkalinity also varied from 2 mg/l (GSS 2017) to 20 mg/l (GSS 2018) in Lepmassoun. In the river Ondoamedza the highest values of alkalinity (48 mg/l) were recorded at the Ond3 station during the PSS and the low values were observed in Ond2 during the GSS 2017 (1 mg/l). In Lepmassoun, the maximum NO_3 values and NH_4^+ recorded at the Lma3 station are of 3.7 mg/l and 0.67 mg/l respectively and the minimal values of 0.05 mg/l (GSP) and 0.14 mg/l (GSP) respectively are recorded as Lma1 and Lma2. In the river Ondoamedza the minimal values of NO_3 and that of the NH_4^+ are of 0mg/l (Ond1 and Ond3 during the GSS 2018) and 0 mg/l (Ond2 - GSS 2018) respectively and the maximum values of NO_3 and NH_4^+ are of 0.5 mg/l (Ond3-PSS) and 2.1 mg/l (Ond3-PSP) respectively. The test of Mann Whitney showed a significant difference in nitrate values of between the GSS 2017 and the GSP, the PSP and GSS 2018 and between the PSS and GSP. The contents orthophosphate vary from 0.1 mg/l (Lma2- PSP) to 4.36 mg/l (Lma1- GSS 2017) in the river Lepmassoun. The curve of variation of the contents orthophosphate is three-phase in the river Ondoamedza. It presents three peaks, the first (3.7mg/l) was recorded in Ond1 (PSP), the second peak (2.71 mg/l) is observed in Ond2 during the PSP and the third peak (2.54 mg/l) is recorded at the Ond3 station during the PSP. Calcic hardness significantly varied from one campaign to another. It however varies from 0.06 mg/l (Lma3- PSS) to 2.27 mg/l (Lma3- GSP) in the river Lepmassoun and in river Ondoamedza it varied from 0.04 mg/l (Ond1-GSS 2017 and GSS 2018) to 0.08 mg/l (Ond3- GSP).

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Table.1: Physicochemical parameters of water in River Lepmassoun and River Ondoamedza both tributaries to River Nyong in Cameroon

	Site	Season	Temp	pH	Cond	TDS	%DO	CO_2	Alka	Turb	MES	Color	NO_3^-	NH_4^+	PO_4^{3-}	Salin	Resist.	Hard. Ca	Hard. Mg
River Lepmassoun	Source	1.0	22.0	6.7	47.0	23.0	62.9	102.1	2.0	5.0	2.0	83.0	2.1	0.1	4.1	0.0	21280.0	1.8	0.2
		2.0	22.0	6.8	34.0	17.0	66.9	1.8	6.0	16.0	7.0	117.0	2.6	0.2	0.0	0.0	29400.0	0.2	0.3
		3.0	22.0	6.7	42.0	21.0	62.7	40.5	2.0	18.0	8.0	180.0	0.7	0.2	0.5	0.0	24400.0	0.1	0.5
		4.0	19.5	7.3	21.0	10.0	62.9	8.8	16.0	0.0	4.0	132.0	0.1	0.1	0.1	0.0	31300.0	0.4	0.2
		5.0	22.8	7.4	40.0	20.0	63.2	5.3	20.0	33.0	16.0	60.0	0.1	0.1	0.3	0.0	25000.0	0.2	0.1
	Average		21.7	7.0	36.8	18.2	63.7	31.7	9.2	14.4	7.4	114.4	1.1	0.1	1.0	0.0	26276.0	0.5	0.3
	Middle	1.0	21.0	6.7	39.0	20.0	64.4	95.1	2.0	14.0	6.0	62.0	2.8	0.3	4.4	0.0	25600.0	0.6	0.7
		2.0	23.0	6.8	32.0	16.0	66.0	24.6	14.0	15.0	4.0	145.0	2.6	0.3	0.0	0.0	31300.0	0.2	0.8
		3.0	21.5	6.9	38.0	19.0	60.0	26.4	4.0	12.0	9.0	157.0	0.4	0.2	0.2	0.0	25600.0	0.1	0.4
		4.0	21.0	7.6	34.0	17.0	62.6	7.0	4.0	1.0	1.0	132.0	0.1	0.1	0.3	0.0	32300.0	0.6	0.2
		5.0	22.1	7.4	49.0	25.0	68.8	7.0	16.0	34.0	20.0	188.0	2.6	0.3	0.1	0.0	20410.0	0.3	0.3
	Average		21.7	7.1	38.4	19.4	64.4	32.0	8.0	15.2	8.0	136.8	1.7	0.2	1.0	0.0	27042.0	0.4	0.5
	Mouth	1.0	21.0	6.7	36.0	18.0	65.4	70.4	2.0	2.0	0.0	47.0	1.6	0.2	2.1	0.0	27000.0	1.6	1.0
		2.0	22.0	6.7	30.0	15.0	66.8	25.8	10.0	9.0	5.0	104.0	3.7	0.7	1.0	0.0	34500.0	0.3	0.4
		3.0	22.0	7.1	36.0	18.0	60.9	35.2	6.0	13.0	4.0	133.0	0.4	0.17	0.1	0.0	27800.0	0.1	0.1
		4.0	21.0	7.4	22.0	11.0	60.4	1.8	10.0	0.0	5.0	202.0	0.1	0.26	0.4	0.0	30300.	2.3	0.4

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		5.0	22.0	7.4	47.0	23.0	69.9	317.0	20.0	48.0	32.0	157.0	2.7	0.2	0.3	0.0	21280.0	0.32	0.21
	Average		21.6	7.1	34.2	17.0	64.7	90.0	9.6	14.4	9.2	128.6	1.7	0.3	0.8	0.0	28176.0	0.9	0.4
	Average of River		**21.6**	**7.0**	**36.5**	**18.2**	**64.3**	**51.2**	**8.9**	**14.7**	**8.2**	**126.6**	**1.5**	**0.2**	**0.9**	**0.0**	**27164.7**	**0.6**	**0.4**
River Ondoamedza	Source of River O.	1.0	22.0	6.4	32.0	16.0	61.7	37.0	4.0	20.0	11.0	86.0	0.5	0.2	0.6	0.0	31800.0	3.2	1.4
		2.0	21.5	8.0	28.0	14.0	61.1	37.0	4.0	0.0	0.0	183.0	1.4	0.3	3.7	0.0	35700.0	0.3	0.4
		3.0	22.0	6.8	24.0	12.0	61.4	14.1	12.0	3.0	3.0	63.0	1.0	0.4	0.0	0.0	43500.0	0.0	0.4
		4.0	22.0	6.6	18.0	9.0	60.5	3.5	4.0	0.0	0.0	52.0	0.0	0.1	0.0	0.0	55600.0	0.1	0.0
		5.0	22.0	6.6	28.0	14.0	62.0	25.5	8.0	11.0	7.0	75.0	0.8	0.3	0.3	0.0	37650.0	1.1	0.9
	Average		21.9	6.9	26.0	13.0	61.3	23.4	6.4	6.8	4.2	91.8	0.7	0.3	0.9	0.0	40850.0	0.9	0.6
	Middle of River	1.0	22.0	6.4	32.0	16.0	62.4	125.0	2.0	1.0	7.0	88.0	0.3	0.1	1.1	0.0	38500.0	64.0	3.2
		2.0	21.0	7.9	24.0	12.0	64.2	1.8	6.0	3.0	6.0	210.0	2.0	0.4	2.7	0.0	41700.0	0.5	0.6
		3.0	22.0	6.6	24.0	12.0	62.1	15.8	18.0	2.0	4.0	74.0	0.5	0.1	0.0	0.0	40000.0	0.1	0.1
		4.0	23.0	6.5	18.0	9.0	62.1	31.7	2.0	7.0	6.0	123.0	0.1	0.2	0.0	0.0	58800.0	0.3	0.0
		5.0	21.8	6.5	25.0	13.0	62.7	12.3	6.0	5.0	0.0	94.0	0.0	0.0	0.1	0.0	40000.0	0.1	0.0
	Average		22.0	6.8	24.6	12.4	62.7	37.3	6.8	3.6	4.6	117.8	0.6	0.2	0.8	0.0	43800.0	13.0	0.8
	Mouth of River	1.0	21.0	6.0	30.0	15.0	62.4	133.8	1.0	10.0	6.0	73.0	0.3	0.1	0.2	0.0	32800.0	1.5	0.7
		2.0	22.5	8.0	138.	69.0	61.2	24.6	6.0	3.0	6.0	245.0	2.1	0.4	2.5	0.1	71900.	0.4	0.2

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	3.0	22.0	6.2	24.0	12.0	62.3	5.3	48.0	13.0	15.0	362.0	1.4	0.5	0.0	0.0	41700.0	0.1	0.1
	4.0	24.0	5.3	14.0	7.0	61.6	31.7	6.0	3.0	5.0	223.0	0.1	0.5	0.0	0.0	65700.0	0.9	0.1
	5.0	21.0	6.3	32.0	16.0	62.5	12.3	20.0	14.0	0.0	84.0	0.0	0.1	0.1	0.0	32300.0	0.2	0.0
		22.1	6.4	47.6	23.8	62.0	41.5	16.2	8.6	6.4	197.4	0.8	0.3	0.6	0.0	48880.0	0.6	0.2
Average of River		**22.0**	**6.7**	**32.7**	**16.4**	**62.0**	**34.1**	**9.8**	**6.3**	**5.1**	**135.7**	**0.7**	**0.2**	**0.8**	**0.0**	**44510.0**	**4.9**	**0.5**
Aquatic standards (MEDD and AE 2003), (NQS 2007), (SEQ-EAU, MEDD et al. 2013)		**-**	**6.5 – 9.0**	**2500 - 3000**		**70-90**			**15-35**	**25-50**	**50-58**	**2-10**	**0.1-0.5**	**0.1-0.5**				

Sampling site 1 = long dry season 2017, 2 = short rain season 2017, 3 = short dry season 2017; 4 = long rain season 2017; 5 = long dry season 2018; Temp. = Temperature; TDS = total dissolved solids; DO = dissolved oxygen; Alka. = Alkalinity, Turb. = turbidity; Resist. = Resistivity; Hard. Ca = hardness due to calcium, Hard. Mg= Hardness due to Magnesium

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Biological variables

Specific composition

During this study, a total of 113 shrimps was collected set out again in 14 species.40 specimens were recorded in the river Lepmassoun and 73 ispecimes in the river Ondoamedza (Table II). In the river Lepmassoun we collected 10 species set out again by order of predominance as follows *Macrobrachium macrobrachion (22,5%), Macrobrachium sp1 (20%) Macrobrachium dux (12,5%) Macrobrachium* sp4 (5%), *Macrobrachium* sp5 (5%) and *Macrobrachium* sp6 (5%), Macrobrachium sp9 (5%), *Macrobrachium niloticus (2,5%)*and Macrobrachium *rude* (2,5%). In the river Odoameza 11 species were collected, *Macrobrachium sp8* (26,02%) is abundant pus, followed respectively of Macrobrachium *idea* (19, 18 %), *Macrobrachium* sp1 (16,44%),*Macrobrachium* sp7 (9,59 %), *from Macrobrachium* sp2 (8, 22%), *Macrobrachium* sp4 (6,85%), *Macrobrachium macrobrachion (5,48%), hard* Macrobrachium (2,74%), *Macrobrachium niloticus* (1,37%), *Macrobrachium* sp5 (1,37%) and *Macrobrachium* sp6(1,37%).According to the test of Kruskal wallis, in the river Ondomedza all the species did not significantly vary on the plan spatiotemperal. However in the river Lepmassoun, *Macrobrachium macrobrachion* varied from one season to another. The quantity of *Macrobrachium macrobrachion* varied from 0(GSP) to 6 individuals (GSS 2017).

The index of Shannon and Weaver in the river Lepmassoun is of 2.05 bit/individual and that of Piélou is 0.57. These indices varied respectively in this river of 1.06 (Lma1) to 2.17 Bit (Lma 3) and 0.29 to 0.61. In the river Ondomedza these indices are 2.94 bit/individual and 0.87 respectively. The index of Shannon and the equitability of Piélou varied from 0 bit/ individual (Ond1) to 2.83 bit/ individual (Ond2) and from 0 to 0.17 respectively.

Table.2:Dynamics of abundances of the genus Macrobrachium (M.) collected for the period of study.

tions	Seasons	*M. macrobrachion*	*M. niloticus*	*M. dux*	*M. rude*	*M. idea*	*M. sp1*	*M. sp2*	*M. sp3*	*M.sp4*	*.M sp5*	*M. sp6*	*M. p7*	*M. sp8*	*M. sp9*	to
m1	GSS 2017	0	0	0	0	0	0	2	0	0	0	0	0	0	1	
	PSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	PSS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	GSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	GSS 2018	2	1	0	0	0	1	0	0	0	0	0	0	0	1	
	TOTAL	2	1	0	0	0	1	2	0	0	0	0	0	0	2	
m2	GSS 2017	2	0	2	0	0	0	0	0	0	0	0	0	0	2	
	PSP	1	0	0	0	0	0	0	0	0	1	0	0	0	0	
	PSS	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
	GSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	GSS 2018	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
	TOTAL	3	0	2	0	0	0	0	1	1	1	0	0	0	2	
m3	GSS 2017	2	0	1	0	0	0	0	0	0	0	0	0	0	2	
	PSP	1	0	0	1	0	0	0	0	0	0	0	0	0	0	
	PSS	0	0	2	0	0	2	0	0	1	0	0	0	0	0	
	GSP	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
	GSS2017	1	0	0	0	0	5	0	1	0	1	0	1	0	0	
	TOTAL	4	0	3	1	0	7	0	2	1	1	0	1	0	2	
d1	GSS 2017	0	0	0	0	0	0	0	0	0	0	0	0	7	0	
	PSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	PSS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	GSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	GSS2018	0	0	0	0	0	0	0	0	0	0	0	0	9	0	
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	16	0	
d2	GSS 2017	2	0	0	0	9	5	6	0	3	0	0	0	2	0	
	PSP	0	1	0	1	0	0	0	0	0	1	0	0	0	0	

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	PSS	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	GSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GSS 2018	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	TOTAL	2	1	0	2	9	5	6	0	3	1	0	0	3	0
d3	GSS 2017	0	0	0	0	4	1	0	0	0	0	0	0	0	0
	PSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PSS	0	0	0	0	3	1	0	0	2	0	0	7	0	0
	GSP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GSS 2018	1	0	0	0	0	5	0	0	0	0	1	0	0	0
	total	1	0	0	0	7	7	0	0	2	0	1	7	0	0

Longitudinal distribution

Generally,the species *Macrobrachium macrobrachion*, *Macrobrachium* sp2 and Macrobrachium sp1, *Macrobrachium sp4*, *Macrobrachium sp5* are most present in our basin with the following percentages of presence of occurrence (%O) respective of 83,33 %, 66.67%, 60% and 50% (Table III). The species *Macrobrachium macrobrachion* is most ubiquiste throughout river Lepmassoun (%O = 83,33%) that the other species like *Macrobrachium* sp1(66.67%,), *Macrobrachium* sp3 (66.67%),*Macrobrachium* sp4 (66.67%), *Macrobrachium* sp5 (66.67%), *Macrobrachium* sp9 (66.67%), *Macrobrachium niloticus* (%O = 33.33%, *Macrobrachium rude* (%O = 33.33), and *Macrobrachium sp7* (%O = 33.33%*)* are secondary represented along the gradient upstream downstream. In the river Ondoameza *Macrobrachium sp8*, *Macrobrachium idea*, *Macrobrachium macrobrachion*,*Macrobrachium sp4* having all the percentage of occurrence (%O) of 66.67% are relatively represented throughout river as for the other species of which the percentage of presence is inferior with 50% (%O = 33,33%*)*, they are passably present upstream downstream from the river.

Table.3: percentage of occurrence (%O) of genus Macrobrachium in our basin

	si	st	0%
M. macrobrachion	5	6	83,3333333
M. niloticus	2	6	33,3333333
M. rude	2	6	33,3333333
M. idea	2	6	33,3333333
M. sp1	3	5	60
M.sp2	4	6	66,6666667
M. sp3	1	6	16,6666667
M. sp4	3	6	50
M. sp5	3	6	50
M. sp6	1	6	16,6666667
M. sp7	2	6	33,3333333
M. sp8	2	6	33,3333333
M. sp9	2	6	33,3333333

Influence of environmental factors on crustacean distribution

Relationship between abiotic parameters and the shrimp community

According to the correlations of SPEARMAN, conductivity is correlated positively and significantly with the TDS (R = 0.563;p = 0.01), oxygen (R = 0.676;p = 0.01), turbidity (R = 0.563;p = 0.01). However it negatively correlated with the resistivity (R = -0.695, p=0.01). MES of course are correlated positively with turbidity (R = 0.641);p = 0.01).The resistivity as for it negatively correlated with turbidity ((R = -0.526;p = 0.01) and the TDS (R = - 0.694;p = 0.01). The pH correlated positively with calcic hardness (R = 0.512;p = 0.01). The ammoniacal nitrogen correlated positively with the color (R = 0.540;p < 0.01) and negatively with magnesic hardness (R = - 0.623;p = 0.01). Oxygen negatively correlated with the carbon dioxide (R = -0.573;p = 0.01) and positively with the temperature (R = 0.553;p = 0.01).The contents nitrate strongly correlated with magnesic hardness (R = 0.623;p = 0.01).As regards the relations existing between the shrimp species and the parameters abiotic (Table III) shows that *Macrobrachium macrobrachion* significantly and positively correlated with the percentage of oxygen, However this species negatively correlated with the resistivity and the color. Macrobrachium dux negatively correlated with CO2, , *Macrobrachium* sp2 negatively correlated with the hardness magnesic, the The species *Macrobrachium rude* and *Macrobrachium niloticus*, , *Macrobrachium* sp3, *Macrobrachium sp4*, *M* sp7 significantly correlated with no physico-chemical parameter. *Macrobrachium idea* negatively correlated with the pH, *Macrobrachium sp3* negatively correlated with dissolved CO_2 and the resistivity. The species *Macrobrachium sp5* positively correlated with the percentage of saturation out of O_2. As regards *Macrobrachium sp7*, it has significantly and positively correlated with MEs,alkalinity and the conductivity and finally *Macrobrachium sp8* positively correlated with magnesic hardness. *Macrobrachium* sp9 positively correlated with the alkalinity

An Analysis in Principal Components (ACP) is made thereafter to determine the physico-chemical parameters characteristic of the various formed groups. The analyzed matrix is a table of 19 columns corresponding to the environmental parameters taken into account and 30 lines representing the samples taken in the 6 stations of sampling during the 5 study campaigns. The essence of the original variance is provided on the first 5 factorial axes F1 (24.05 %) and F2 (19.38 %), F3 (15.55 %), F4 (10.73 %) and F5 (9.009 %) which cumulate 63.31% of total inertia (Figure 2b). The variable like *Macrobrachium* sp1, *Macrobrachium* sp3, the calcic hardness one, CO_2 and *Macrobrachium sp4* are more negatively correlated known the axis F1; however on turbidity, *Macrobrachium* sp2, the percentage of oxygen and nitrate are correlated positively on the axis F2. On the axis F3, conductivity, orthophosphates, the TDS and salinity is correlated there positively. The species *Macrobrachium sp7*, alkalinity and the color are positively correlated on the axis hard F4. Finally *Macrobrachium sp8*and the ammoniacal nitrogen are positively correlated on the axis F5

Table.4: Spearman correlation between Macrobrachium shrimp abundance and physicochemical parameters

Parameters \ Species		*M. macrobrachion*	*M. niloticus*	*M.dux*	*M.rude*	*M.sp8*	*M.idea*	*M.sp1*	*M.sp2*	*M.sp3*	*M.sp4*	*M.sp5*	*M.sp6*	*M.sp7*	*Msp9*
pH (UC)	ρ	-,055	,332	,009	,064	-,352	-,459*	-,196	-,159	,347	-,165	,315	-,247	,035	-,043
	p	,774	,073	,964	,736	,056	,011	,300	,400	,061	,384	,090	,189	,856	,823
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
conductivity(µS/cm)	ρ	,334	,023	,265	-,200	-,109	-,108	,194	,195	,193	,062	,064	,022	,403*	,052
	p	,071	,903	,158	,290	,567	,570	,305	,301	,307	,747	,735	,910	,027	,787
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
TDS (mg/L)	ρ	,331	,015	,271	-,200	-,109	-,108	,185	,203	,187	,062	,058	,022	,409*	,044
	p	,074	,935	,147	,290	,567	,570	,328	,282	,323	,747	,761	,910	,025	,817
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Percent O2(¨%)	ρ	,505**	,216	,074	,283	-,209	-,056	,063	,059	,186	-,316	,417*	,011	,338	,176
	p	,004	,251	,698	,130	,268	,767	,741	,758	,324	,089	,022	,955	,067	,351
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
CO2(mg/L)	ρ	,162	-,348	,365*	-,193	,244	,263	,011	,402*	-,411*	,168	-,321	-,086	,302	-,315
	p	,393	,060	,048	,307	,193	,160	,955	,028	,024	,374	,083	,652	,104	,090
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Alkalinity (mg/L)	ρ	,081	,195	-,280	,065	-,034	-,165	,243	-,343	,344	-,026	,260	,271	-,252	,422*
	p	,672	,302	,133	,733	,857	,385	,195	,063	,063	,893	,166	,147	,179	,020
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MES (mg/L)	ρ	,055	,233	-,184	-,149	,225	,260	,250	-,023	,342	,264	,155	-,270	-,079	,402*
	p	,775	,215	,331	,433	,232	,165	,182	,903	,064	,158	,413	,149	,679	,028
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
color (mg/L)	ρ	-,384*	-,015	-,280	,096	-,270	,004	-,058	-,153	,334	,226	,282	-,118	-,514**	,321
	p	,036	,935	,135	,613	,149	,984	,762	,420	,071	,230	,130	,534	,004	,084

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	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
nitrate (mg/L)	ρ	,249	,000	,205	,090	-,058	-,085	-,152	,040	,199	-,079	,379*	-,301	,245	,251
	p	,185	1,000	,277	,636	,761	,656	,422	,835	,291	,679	,039	,106	,192	,182
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
orthophossphate (mg/L)	ρ	,280	,224	,233	,206	,111	-,017	-,061	,337	,058	-,069	,019	-,140	,464**	-,107
	p	,135	,233	,215	,275	,558	,930	,748	,068	,761	,718	,919	,462	,010	,574
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
salinity(PSU)	ρ	,114	,071	,400*	-,223	-,261	-,222	-,039	,063	,193	,080	-,015	-,360	,470**	,063
	p	,547	,708	,028	,237	,163	,238	,837	,741	,307	,674	,938	,051	,009	,741
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
resistivity	ρ	-,311	-,023	-,295	,238	,170	,202	-,135	-,106	-,411*	,010	-,090	,000	-,447*	-,050
	p	,095	,903	,113	,206	,370	,284	,476	,576	,024	,958	,637	1,000	,013	,791
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Hardness calcic (mg/L)	ρ	,191	,015	,046	-,129	,303	,183	-,059	,403*	,180	-,186	,013	-,140	,290	-,161
	p	,311	,935	,808	,498	,103	,334	,758	,027	,341	,324	,946	,462	,121	,395
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Hardness magnésic(mg/l)	ρ	,249	-,046	,150	-,013	,383*	,236	-,149	,179	-,006	,068	,206	-,279	,112	-,134
	p	,184	,808	,429	,946	,037	,209	,432	,343	,973	,723	,275	,135	,557	,481
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30

*. La corrélation est significative au niveau 0,05 (bilatéral).

**. La corrélation est significative au niveau 0,01 (bilatéral).

Reproduction of *Macrobrachium dux*

Determination of the sex-ratio and rate of femininity

All in all, the females are more numerous than the males. During the period of study 5 individuals of *Macrobrachium dux* were collected either 3 individuals (4 females and 1 males) in the river Lepmassoun giving a sex-ratio of 0.25. From a campaign to another in the river Lepmassoun the sex-ratio at this species varied from 0 (PSS) with 0.5 (GSS 2017) and the females are dominant except during the small dry season where the males are equal to the females. Genrally, the rate of feminity (TF) during all the period of study in the river Lepmassoun is 57.14%, it varied from 66, 67% (GSS2017) to 100 % (PSS) (Table V).

Table.5: Number of males (M), females (F) sampled by campaign and sex-ratio (Sr), and feminity rate (TF)

Macrobrachium mabrachion	F	M	FO	f+m	Sr F	Sr M	TF
GSS 2017	2	1	1	3	0,5	2	66,67
PSP	0	0	0	0	0	0	
PSS	2	0	2	2	0	0	100
GSP	0	0	0	0	0		
GSS 2018	0	0	0	0			
	4	1	3	5	0,25	4	80

Fruitfulness and gonado-somatic ratio (RGS)

Three ovigerous females were collected during our study. An ovigerous female was obtained at the Lma3 station during the first countryside, it has a size (LT) of approximately 52 mm and it weighs (W) 1,79g and has an absolute fruitfulness of 39 eggs. The two other ovigerous females were recorded at the Lma3 station during the PSS (Table V).One has a size of approximately 50.38mm, it weighs 0.176g and carries 39 eggs, the other as for it weight of 0.312g, it has a size of 64.18mm and its absolute fruitfulness is of 100 eggs. Average absolute fruitfulness at this species is of 59 eggs. Relative fruitfulness as for it varied from 22 eggs/g for the female which measures 52 mm (Lma3-GSS 2017) to 34 eggs/G for the largest female which measures 64.18 mm, giving an average of 28 eggs/g. The eggs carried by the females are of yellow color orange sharp. Concerning the report/ratio gonado-somatic (RGS), it varied from 4. 44% for the female collected in first countryside (GSS 2017) to 12.35% for the female collected during the third countryside with an average value is 9.11%. The GSI showed highest percentage of mature females (<50%) from January 2017 to February 2018. Maxima of GSI (10.52%) were recorded at PSS (July) and minim of GSI (1.73%) were recorded during the GSS 2017 (January). The GSI mean is 7.67% in PSS. This indicates that *M. macrobrachion* in Lepmassoun River underwent a reproductive period during the dry season.

Table.5: Absolute fruitfulness (FT), relative fruitfulness (FR), Gonadosommatic report/ratio (RGS) and gonadosomatic index (RGI) at Macrobarchium dux.

Number of eggs	Lt(mm)	Lc(mm)	Pt(g)	P(G) (g)	FT(eggs)	FR(eggs/g)	RGS %	RGI(%)
39	52	14.5	1.758	0.078	39	22.18	4.43	1.73
38	50.38	11.72	1.424	0.176	39	27.19	12.35	4.82
100	64.18	15.14	2.963	0.312	100	33.69	10.52	10.52

Relationship between the number of eggs and morphological parameters at *Macrobrachium dux*

In our zone of study the coefficient of correlation (R2) are respectively 0.42;0.99 and 0.96 for the relation which exists between the number of egg and the length of the carapace (Lc) (Figure 2a), then the number of eggs and overall length (Lt) (Figure 2b) and finally the number of egg and weight (w) (Figure 2c).The greatest constant of regression (a = 42.59) is observed in the existing relation between number of egg and Pt, follow-up of that putting forward the number of eggs and Lt (a = 4.64) and finally that connecting the number of eggs and Lc (a=0.0334). As regards the coefficient of regression (b), it is negative for the existing relation between a number of eggs and Pt (b = - 28.05) and between the number of eggs and Lt (b=- 198.55).This coefficient (b) is positive for the existing relation between the number of eggs and Lc. We note that when the female is large it produces more eggs to its advantage.

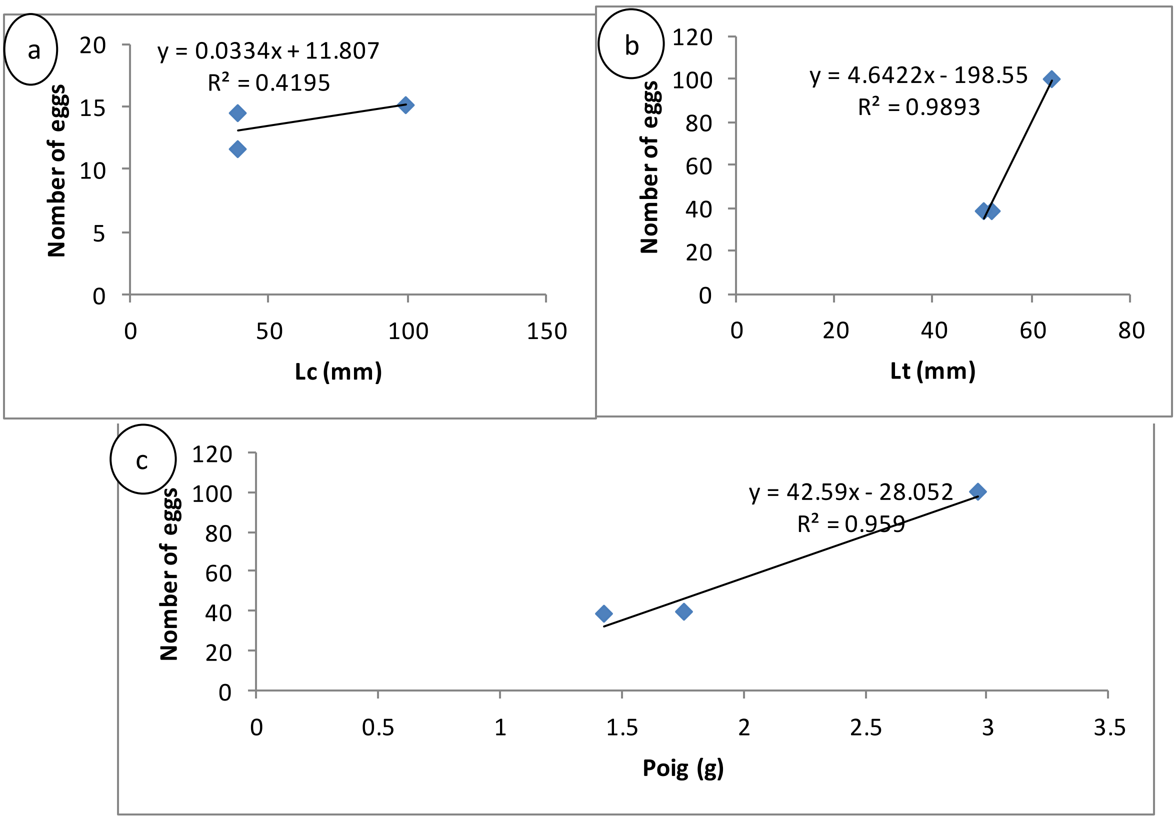

Fig.2: relationship between the number of eggs and Lc (a), the number of eggs and Lt (b) and the number of eggs with weight (c) at Macrobrachium dux

IV. DISCUSSION

Environmental variables

The values of temperature recorded in the river Lepmassoun and Ondoamedza all located in medium rural significantly did not vary from one station to another. This would be explained by the presence of canopée which is present and almost identical to all the stations which constitutes a barrier reducing the penetration of the solar rays on the variation in the temperature of water along the river. This observation is in agreement with those of(Foto Menbohan, Koji et al. 2012) (Foto Menbohan, Mboye et al. 2017)and (Tchakonte , Ajeagah et al. 2014), Biram À Ngon and al..(2018)(BIRAM à NGON, FOTO MENBOHAN et al.) obtained on Nga, Mabounié, Nsapè jets, Abouda, Fam, Nkoumou and Nga respectively. However the variations observed from one season to another in the river Lepmassoun would result from the variation in the temperature during dry seasons. Ebang, 2004 underlines on this subject that the temperature of surface water is strongly influenced by the ambient temperature and the seasons. These values of temperature are favorable to the good biological development (Ouhmidou *and al*., 2014).The range of the values obtained is located in the range of the temperature of bearable water by the fresh water shrimps which support some until 34°C beyond which they are vulnerable (Griessinger *and al*., 1990).

The low values of conductivity (34.6 mg/l) obtained during our study in our rivers would be explained by nature slightly anthropized of our various areas catchment and with the nature of the grounds. These results approaches those obtained by Ajeagah and *Al*, 2017 in the river Matourou of the catchment area of Nyong (25,89 mg/l).The strong value recorded during the PSP means that there exists in this month a great concentration of dissolved electrolysable salts which is explained by the scarcity of the rains.The brutal fall of conductivity during the great season rain is due to arrival of the rains leading to the flood. These values of conductivity (< 35mg/l) respect the standards of quality of surface water (AE 1999). Light acidity with a tendency of neutrality recorded in the two rivers could be explained by the presence of the humuses resulting from the degradation of the sheets died in our rivers which are under cover vegetal. Welcome (1985) affirms that the forest rivers, with water with humic characteristics rich person in substance, are slightly with strongly acid with a pH located between 4 and 7 UC. These forest rivers are favorable to the development of the watery organizations. According to (AE 1999), the pH ranging between 6.0 and 8.5 UC is favorable to the expression of the biological potentials of many groups.The low values of my study recorded in the two rivers approaches those recorded by Ajeagah *and Al*, 2017 in the same ecological area. These results could be explained by the fact that water of the river Lepmassoun and Ondomedza is slightly charged. The values of turbidity (< 35, g/l) recorded are relatively low and testify to a good ecological quality according to (MEDD and AE 2003). The differences between the campaigns mentioned by the test of U of Mann Withney could be explained by the fact that during the season of rains the particles are suspended thus affecting turbidity.The average values of color observed in our rivers could be explained by the presence of the colloidal particles of negative charge, these result approach work of (Ajeagah, Yogback et al. 2017) carried out in the catchment area of Nyong. Generally, the average values of dissolved oxygen recorded in our different river make it possible to qualify their water of passable with good (Villeneuve, Legare et al. 2006). These oxygen values which we obtained are inferiors with that obtained by Agadjihouede, 2006 in the lagoon of large-popo (9.76mg/l) but are acceptable for a good growth of the shrimps (Griessinger, Lacroix et al. 1991) for these authors, with the tops of 5 mg/l, the shrimp is under favorable conditions of breeding. With the lower parts of 2 mg/l, the shrimps cannot balance their needs anymore and die when this content persists. The orthophosphate contents recorded in the river Lepmassoun are relatively weak and significantly varied from one season to another according to the test of Kruskal Wallis ($p<0,05$).The strong values recorded during the first countryside which corresponds to the great season dries 2017 could be due to the strong mineralization of the organic matter. During this season the river has undergoes a very significant stress hydrous which caused the accumulation of the organic matter (sheets dead) as our rivers are under wood what supports a very thorough mineralisation of the organic matter. The NH_4^+ having increased station Lma1and the Lma3 station in the river Lepmassoun is nevertheless below the standards recommended by the (SEQ-EAU, MEDD et al. 2013) (Table V).This would be in relation to the bacterial decomposition of the nitrogenized organic matter of made light reductions in the contents of O_2 dissolved recorded in these periods. Their weak presence in the river Lepmassoun and Ondoamedza could be explained by made that the medium is sufficiently oxygenated. For this purpose (IBGE 2005) stress that it is in absence of oxygen that the anaerobic bacteria transform nitrates and produce ammonia (NH_3) or ammonium (NH_4^{+}).The strong values of nitrate recorded in the river Ondoamedza during the small season of rain could be explained by the scrubbing of the agricultural grounds in the catchment area. Liechti, 2010 underline on this subject which if the contents nitrates exceed 1.5 mg/L, there probably was arable land scrubbing.

Biological variables

During this study the inventory of shrimps of the genus *Macrobrachium* made it possible to put forward 14 shrimp species. This specific richness is higher than that obtained by (Tchakonte , Ajeagah et al. 2014) in the river Nsapè in zone périurban of Douala and no species of Macrobrachium is common for us. Our specific richness is also high than that obtain by Makoumbou and al., 2015 in the rivers Lokoundje, Kienke and Lobe Rivers of South Region, Cameroon where we have two species (Macrobrachium macrobrachium and Macrobrachium dux).This difference could be explained by the fact Nsapè , Lokoundje, Kienke and Lobe river are a coastal river and cuts the throat of the coastal species and the land species. Of share the position péri urban, the court of water Nsapé could start to be subject to the influence of the urban activities contrary to our rivers which are located in rural zone where the anthropic activity is quasi null. It is also necessary to note that specific richness of each one of our rivers is higher than that of (Ajeagah, Yogback et al. 2017)in the river Matourou where only one species of Macrobrachium was obtained. This difference would be explained since our rivers are rich in microhabitats contrary to river Matourou. Our specific richness is higher than the specific richness of the genus *Macrobrachium* (6 species) obtained by (Konan 2009) in seven rivers in Ivory Coast, it is also higher than that obtained in Ivory Coast in the Boubo river (N'zi, B.G. et al. 2008) where nine shrimp species identified and also higher than that is obtained by (Djiriéoulou Kémomadjèhi, Bamba et al. 2017.) in the Forest of the Tanoé-Ehy Marshes in Ivory Coast. This specific difference is explained by the methods of fishing used, the types of sampled habitats and the periods of sampling. Seasonal of the specific richness showed that greater specific richness was recorded for the period of rising. These data show that the living conditions are more favorable for the watery organizations during this period (Djiriéoulou Kémomadjèhi, Bamba et al. 2017.).In our site of study, *Macrobrachium macrobrachion* (10,61%) is not dominating as in work of (Agadjihouede 2006) in the lagoon of large-popo with a percentage higher than our (51%), but this predominance is not observed by (N'zi, B.G. et al. 2008) in the river Mboumbo and where it is *Macrobrachium vollenhovenii* which dominates rather, in the river Boubo (N'zi, B.G. et al. 2008) this species is found only in the station which is very well oxygenated contrary to our rivers which are fairly oxygenated . We think that oxygen is a factor discriminating for the presence or not of *Macrobrachium Macrobrachion*. The under predominance of *Macrobrachium macrobrachion* in our work is also observed by (Djiriéoulou Kémomadjèhi, Bamba et al. 2017.), where this species is dominated by far in the forest of the Tanoé-Ehy Marshes in Ivory Coast. These observations could be explained by the environmental conditions which more prochoche or similar from the drill of the marsh Tanoé-Ehy water where oxygen is not very good. It is however advisable to underline like Troadec *and al.* (1967) that the distribution and the abundance of the macro invertebrates like shrimps in the rivers, is on the whole, function of the specific requirements of various taxed and the environmental characteristics with the various portions of the rivers, as well as availability of food and nature of the substrate. As regards the reproduction, absolute fruitfulness had an average of (59 ±35 eggs) which we obtained form *Macrobrachium dux* is less than that brought back by Deeka and Aowei, 2010 (1403 eggs);Eni and al, 2013 (442058 eggs) and Boguhe and al, 2016 (19906 ± 6640 eggs) for *Macrobrachium macrobrachion*. this fruitfulness is also less than that found by Kouton (2004) in the valley of Ouémé, by Goore Bi (1998) in the basin of Bia in Côte.d'ivoire and by Agadjihouede, 2006 in the lagoon of Large the popo for the species Macrobrachium macrobrachion. The weak production of eggs by our females compared to the others species could due to the fact that our rivers are less favorable to the development of this species (low depth, raised color, temperature, average oxygenation) compared to the other rivers referred to above. The differences observed could also be allotted to the differences in egg dimension (Beacham and Murray, 1993), the techniques of sampling and the overall length of the female (Deeka and aowei, 2010). In addition, the variations found for fruitfulness can also be due to the differences of environmental conditions, the provisioning food, the seasons and the physiological parameters of environment (Bagenal, 1978) and the physiology of species. Total length of ovigerous females ranged from 50,38 mm to 64,18 mm and egg size varied from 1.5 to 1.9 mm. Compared to other species, the eggs of *Macrobrachium dux* are larger than those of *Macrobrachium lanchesteri* 0.8-1.0 mm and *Macrobrachium olfersii* 0.4-0.6 mm reported by Hla et al. (2005) but nearly similar to those of M. lamarrei (1.1-1.5 mm) reported by the same authors and nearly similar to the same species in river Orogodo in Nigeria (Orimono and al., 2007). It was explained that in the genus *Macrobrachium*, fruitfulness is associated extremely with the female age, and that it can increase while the female becomes ripe (Graziani and Al, 1993) and the size of eggs. The high average value of RGS (11.44) obtained to the PSS could be explained by the fact that for this period the ovaries of the individuals females reached a state of more thorough advance compared to the female collected during the GSS 2017 having a smaller index RGS (4.44). Kingdom and Erondu (2013) underline for this purpose that when index RGS lies between 10.55 and 15.57, the fresh water shrimps enter an intense phase of activity of reproduction. This is corroboration by the presence of the ovigerous females with the PSS, corresponding to the period of laying which takes place from July to December (Villé, 1972). It should be noted that the presence of the ovigerous females during the GSS 2017 which corresponds to the period of low water level could be explained by a new period of reproduction thus knowing that the reproduction of the genus *Macrobrachium* is not continuous throughout the year. In our basins slope the *Macrobrachium dux* reproduces twice a year since production is early and the eggs are rather broad by consequence the larval development is shortened. In this connection Gangbe and al., 2016 stress that reduced fruitfulness is compensated by early fecundation.

V. CONCLUSION

In relation to our work, the diversity and the fertility of shrimps of the genus *Macrobrachium* in the catchment area of Nyong, we conclude that our various rivers water are of good ecological quality which are slightly acid, fairly oxygenated, slightly mineral-bearing, slightly turbide but with a rather significant color. This rivers have a very significant diversity comprising 14 species of genus Macrobrachium which are, *Macrobrachium macrobrachion*, *Macrobrachium rude*, *Macrobrachium niloticus*, *Macrobrachium dux*, *Macrobrachium idea*, *Macrobrachium* sp1, *Macrobrachium* sp2, *Macrobrachium* sp3, *Macrobrachium* sp4, *Macrobrachium sp4*, *Macrobrachium sp5*, *Macrobrachium sp6*, *Macrobrachium sp7 Macrobrachium sp8* and *Macrobrachium* sp9. *Macrobrachium macrobrachion* is dominate in the river Lepmassoun but *Macrobrachium sp8* dominates in river Ondoamedza. We note as a whole an equal distribution of the species in the river Lepmassoun. They are diversified enough according to the index of diversity of Shannon. The équi-partition of the species in the river Ondoa medza is higher than river Lepmassoun. *Macrobrachium macrobrachion* significantly and positively correlated with *Macrobrachium sp7*. However this species negatively correlated with the the color. The species Macrobrachium sp5 positively correlated with the percntage of saturation out of O_2 . As regards *Macrobrachium sp7*, it has significantly and positively correlated with MES and alkalinity and finally *Macrobrachium sp8* positively correlated with magnesic hardness.

The species *Macrobrachium dux*, had 3females ovigerous whose settlement is dominated by the females. The river Lepmassoun, the species *Macrobrachium macrobrachion* enters in intense phase of activity of reproduction during the small dry season but another period of reproduction was observed during the great dry season. In our basins slope the *Macrobrachium dux* reproduces twice a year since production is early and the eggs are rather broad by consequence the larval development is shortened. The species *Macrobrachium macrobrachion* is a ubiquist in our two rivers, it is it more in the river Lepmassoun compared to the other species and average in the river Ondoamedza. For a better knowledge of the reproduction of Macrobrachuim in the forest belt in Cameroon it would be interesting to traverse other aquatic environments.

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Surveillance of the Disease Incidence and Severity of *Papaya Ringspot Virus* at Four Selected Districts of Bangladesh

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Abstract— *An experiment was conducted to survey the prevalence of disease incidence and severity of Papaya ringspot virus (PRSV) at eight locations of four districts in Bangladesh. Papaya is one of the most popular fruits in the world. It suffers from several diseases including fungi, bacteria, nematodes and viruses. Among them, viral diseases are found to cause considerable yield loss, with the most important one being PRSV. The survey was conducted at three plain districts and one hill tract area from July 2016 to December 2016. During the survey period, six different symptoms were found in the selected fields and were identified as PRSV based on symptomology. These symptoms were mild mosaic (MM), mosaic (MO), severe mosaic (SM), fern leaf (FL), leaf distortion (LD) and vein clearing (VC). The highest disease incidence (36.24%) was found in BSMRAU farm in Gazipur whereas the lowest (12.04%) was found in Panchari, Khagrachari hill tract. The maximum severity (11.53%) was found in BSMRAU campus, Gazipur on the country and the lowest severity (2.50%) was found in Panchari, Khagrachari hill tract. The yield and yield contributing parameters of papaya found to be differ significantly among the surveyed area. The lowest fruit weight (324.3 gm) due to PRSV infection was recorded in BSMRAU, Gazipur while the highest fruit weight (643.6 gm) was conducted in SAU Campus, Dhaka.*

Keywords— Survey, Disease incidence, Disease severity, PRSV, Selected districts, Bangladesh.

I. INTRODUCTION

Papaya (*Carica papaya* L), belonging to the family Caricaceae, is an important fruit of tropical and subtropical regions in the world. It is an important and popular vegetable as well as fruit crop in respect of its food value and taste. Papaya fruit is the second highest fruit that is rich in vitamin A, next to mangos (Aykroyed, 1951). It contains a fair amount of vitamin C, riboflavin and niacin and is a good source of moisture, protein, fat, carbohydrate, calcium, phosphorus and iron (Bosh, 1985). Papaya has also been regarded as medicinal as well as an industrial cash crop. Carpaine, an alkaloid present in papaya, can be used as a heart depressant, amoebicide and diuretic (Burdic, 1971). Papain, extracted from green papaya, can be used in beverage, food, and pharmaceutical industries (Watt, 1989).

Although papaya is successfully grown all over Bangladesh, statistics regarding the papaya production is not satisfactory. In 2009-2010, papaya has been cultivated in 2790 ha of land with a total production of 40.42 t/ha (BBS, 2010) in contrast about 1, 13, 52, 202 tons' production of papaya in 2010 was in the world (FAO, 2010).

Papaya production is greatly hampered due to some constraints, of which diseases play an important role, especially viral diseases. Such as *Papaya ringspot virus, Papaya leaf curl virus, Papaya yellow mosaic* virus, etc. Viral diseases have been recognized as a major limiting factor for commercial papaya production throughout the tropics and subtropics (Jensen, 1949 a and b, Cook and Zettler, 1970). The infected plants produce different types of symptoms on leaves like mild to severe mosaic, vein-clearing, vein-yellowing, chlorotic spots, fern leaf, shoe-sting etc. (Rahaman, 2003). The infected plants produce small flowers and distorted fruits showing stunted growth. The distorted fruits bear conspicuous ringspot symptoms and the taste becomes watery. The disease drastically deteriorates the yield, market value, and quality of the fruits (Purcifull *et al*., 1984). In Bangladesh, the virus causes 70%-100% yield reduction of papaya depending upon the stage of infection as estimated by Akanda (1991). The virus also infects various cucurbitaceous crops like cucumber, bitter gourd, sweet gourd, ash gourd, ribbed gourd etc. and causes tremendous yield losses of those crops (Akanda *et al*., 1991 a, b and c).

The papaya viral diseases may show peculiarity in their prevalence and symptom development throughout the year. Sometimes, masking of the symptom occur in the infected plants depending upon the seasons (Kiranmai *et al*., 1998)

A papaya plant may get infected by PRSV-P at any stage of the growth (seedling to maturity) and yield loss might reach even up to 100% (Purcifull *et al*., 1994). For causing a devastating disease that severely interferes with commercial papaya production, *Papaya ringspot virus*-Papaya strain (PRSV-P) is well recognized in all papaya growing countries of tropic and sub-tropic regions (Gonsalves, 1998). Akhter and Akanda (2008) stated that seven symptoms, namely mild mosaic (MM), mosaic (MO), severe mosaic (SM), leaf distortion (LD), fern leaf (FL), vein clearing (VC), chlorotic leaf spot (CS) all are reacted positively in DAS-ELISA against the antisera of *Papaya ringspot virus*- papaya strain (PRSV-P).

The economically sustainable production of papaya needs efficient management of the disease caused by papaya viruses. Several attempts were made like roughing, controlling of insect vectors by spraying mineral oil and insecticides, mulching, inter-cropping with barrier crop (corn), protecting young seedlings with plastic bag, developing papaya varieties resistant to papaya viral disease for managing the disease (Yeh *et al*., 1988) but none of the measures gave satisfactory results. Considering the above facts, the present experiment was undertaken to achieve following objectives: (i) to conduct a survey on PRSV disease in papaya field at selected locations of Bangladesh; (ii) to quantify the effect of PRSV disease on the growth and yield contributing parameters of papaya; and (iii) to know the reduction of growth and yield parameters of papaya due to PRSV infection.

II. MATERIALS AND METHODS

2.1 Selection of the survey area: The experiment was conducted to survey the incidence and severity of *Papaya ringspot virus*-papaya strain (PRSV-P) on the basis of symptoms in the field. The survey was conducted at eight locations of four districts in Bangladesh. The locations of survey area are given in Table 1.

Table.1: Selection of eight locations for survey

Districts	Locations
Dhaka	Sher-e-Bangla Agriculture University (SAU) Campus, Dhaka Jahangirnagar University (JU) Campus, Savar
Gazipur	Bangladesh Agriculture Development Corporation (BADC), Kashimpur BSMRAU Campus, Salna, Gazipur
Narayanganj	Narayanganj Sadar Upazilla Sonargaon Upazilla
Khagrachari	Khagracchari Sadar Upazilla Panchari Upazilla

2.2 Survey period: Eight surveys were conducted during the period from 25 May 2016 to 14 December 2016.

2.3 Observation of the symptoms: Symptoms of the disease PRSV was identified by visual observation described by Jensen (1949a), Conover (1964), Gonsalves (1997), Akanda (1991) and Rezende *et al.* (1995), Rahaman (2003), Akhter and Akanda (2008).

2.4 Selection of Plants: During the survey, twelve plants were selected randomly in each location with four plants in one replication, resulting in three replications from each location. Following the procedure, twenty-four replications were selected from eight locations in four districts.

2.5 Determination of the disease incidence and severity: Every plant in the field was counted to determine the disease incidence and severity. Then it was expressed in percentage. The disease PRSV was calculated following formula (Agrios,2005)

Disease incidence (%)

$$= \frac{\text{No. of diseased plant (or parts)}}{\text{No. of total plant (or parts)}} \times 100$$

The disease severity was expressed in PDI. The PDI was computed by using standard formula (Paper *et al*., 1996) is giving below:

$$PDI = \frac{\sum Disease\,grade \times number\ of\ plants\,in\,grade}{Total\,number\ of\ plants \times highest\,disease\,grade} \times 100$$

2.6 Quantitative assessment on the effect of PRSV on growth and yield contributing parameters of papaya: The effect of PRSV infection on growth and yield contributing characters of papaya plants were assessed by collecting the data on six selected parameters: plant height (cm.); number of leaves; petiole length (cm.); leaf area (cm^2); fruit number; and fruit weight (gm.)

Percent reduction of growth and yield parameters was calculated using formula: $\% \, Reduction = \frac{\mathrm{A-B}}{\mathrm{A}} \times 100$

Where A= any parameter of healthy plant; and B= that parameter of infected plant

2.7 Statistical analysis: Randomized block design (RCBD) was used to analyze the different parameters through computer software MSTAT-C. To calculate the level of significant difference and to separate the means within the parameters, Duncan's Multiple Range Test (DMRT) and Least Significant were performed.

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III. RESULTS

3.1 Survey and identification of PRSV in papaya at eight locations of four districts

For observing the prevalence of disease incidence and severity of PRSV virus in papaya, the disease was identified by symptomology of infected papaya plants and compared with standard literature. It was found that there were six distinct symptoms prevalent at eight locations of four districts in Bangladesh.

The seven different symptoms so far categorized are named as mild mosaic (MM), mosaic (MO), severe mosaic (SM), fern leaf (FL), vein clearing (VC), leaf distortion (LD) and ringspot on fruit. The development of streaking on the young stem and leaf petioles as well as green ringspot developing on leaves was common and consistent with all the seven types of symptom. Yellowing of the leaf and distortion of fruits were observed in association with other symptoms.

3.2 Incidence and severity at eight locations of four districts in Bangladesh

Significant differences were found in disease incidence at eight locations in Bangladesh as shown in Table 2. The incidence ranged from 12.04% to 36.24% and the severity ranged from 2.50% to 11.53%.

3.2.1 Disease incidence: There were significant differences found among different locations. The highest disease incidence (36.24%) was found in BSMRAU, Gazipur and the lowest incidence (12.04%) was found in Panchari, Khagrachari hill tract.

3.2.2 Disease severity: Significant differences were found in disease severity among eight locations in Bangladesh. The highest disease severity (11.53%) was in BSMRAU campus followed by SAU (9.03%), where the lowest disease severity (2.50%) was found in Panchari upazilla preceded by Narayanganj Sadar (3.44%).

Table.2: The disease incidence and severity of PRSV in papaya at eight locations of four districts in Bangladesh

Locations		Disease Incidence (%)	Disease Severity (%)
Dhaka	SAU, Dhaka	29.84 b*	9.03 b
	JU, Savar	30.05 b	7.49 bc
Gazipur	BADC, Kashimpur	17.40 c	3.05 e
	BSMRAU, Salna	36.24 a	11.53 a
Narayanganj	Narayanganj Sadar	17.60 c	3.44 e
	Sonargaon, Upazilla	30.17 b	6.25 cd
Khagrachari hill tract	Khagrachari Sadar	17.72 c	4.16 de
	Panchari, Upazilla	12.04 d	2.50 e
Coefficient of Variation (CV %)		13.64	17.88
LSD value (0.05)		5.216	2.166

*Values within the same column with a common letter(s) do not differ significantly (P=0.05)

3.3 Comparison of incidence and severity of PRSV at eight locations of four districts in Bangladesh

The comparison of disease incidence and severity of different locations are shown in Figure 1, indicating that the highest incidence and severity was in BSMRAU and the lowest result in Panchari upazilla.

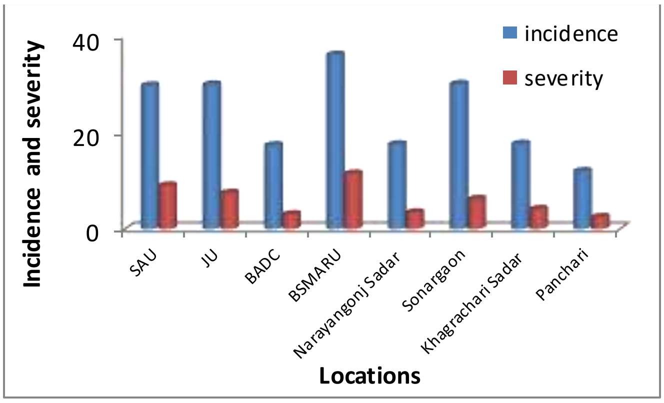

Fig 1: Comparison of disease incidence and severity of PRSV at eight locations of four districts in Bangladesh

3.4 Effect of PRSV on growth parameters in papaya

Significant variation was found in growth parameters due to PRSV infection in papaya, are shown in table 3 and location wise growth parameters in Figure 2-5. The highest plant height (178.6 cm) was found in SAU campus followed by Panchari upazilla (159.6 cm) while the lowest (127.5 cm) was found in Sonargaon upazilla. Maximum number of leaves (20.67) was found in Sonargaon upazilla followed by SAU campus (19.08) while minimum was found in BSMRAU (15.67). Among the eight locations, the longest petiole length (53.66 cm) was found in Khagrachari sadar followed by SAU campus (47.95 cm). On the other hand, the shortest petiole length was found in BSMRAU campus (30.90 cm) that was significantly similar to Narayanganj Sadar. The largest leaf area was found at Panchari upazilla (1330 cm^2) whereas the smallest (535.1 cm^2) at BSMRAU.

Table 3. Effect of PRSV infection on growth parameters at eight locations in Bangladesh

Location	Plant Growth parameters			
	Plant height (cm)	No. of leaf (no.)	Petiole length (cm)	Leaf area (cm^2)

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Dhaka	SAU	178.6 a*	19.08 b	47.95 b	1167 c
	JU	146.9 de	16.08 de	35.39 cd	959.9 d
Gazipur	BADC	146.0 e	16.67 cde	31.86 de	857.4 g
	BSMRAU	150.5 cde	15.67 e	30.90 e	535.1 h
Narayanganj	Narayanganj Sadar	153.1 bcd	17.60 c	30.95 e	887.4 f
	Sonargaon Upazilla	127.5 f	20.67 a	36.62 c	954.9 e
Khagrachari hill tract	Khagrachari Sadar	155.8 bc	18.58 b	53.66 a	1186 b
	Panchari upazilla	159.6 b	17.08 cd	34.93 cd	1330 a
CV (%)		7.52	9.82	16.93	21.19
LSD value (0.05)		6.314	0.9750	3.543	3.234

*Values within the same column with a common letter(s) do not differ significantly (P=0.05)

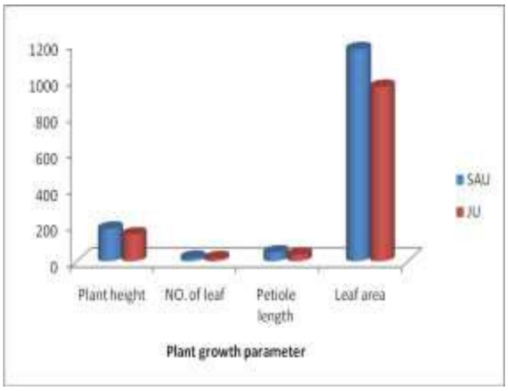

Fig 2: Effect of growth and growth parameters due to PRSV disease in two locations of Dhaka district

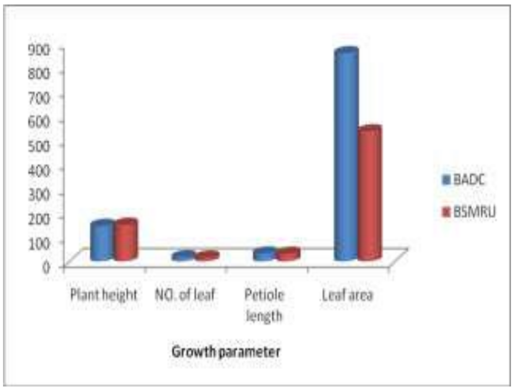

Fig 3: Effect of growth and growth parameters due to PRSV disease in two locations of Gazipur district

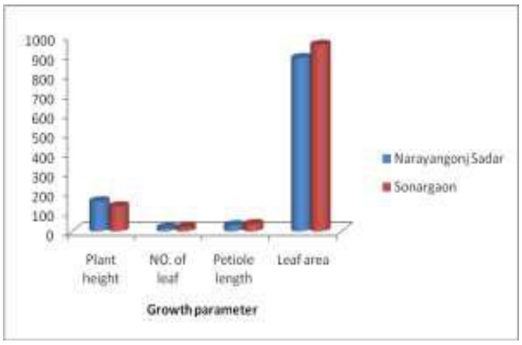

Fig 4: Effect of growth and growth parameters due to PRSV disease in two locations of Narayanganj district

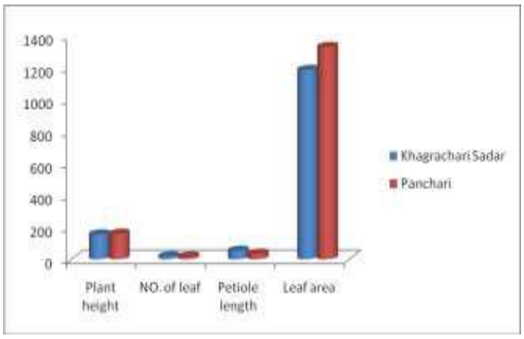

Fig 5: Effect of growth and growth parameters due to PRSV disease in two locations of Khagrachari hill tract

3.5 Effect of PRSV on yield parameters

Yield parameters at eight locations of four districts in Bangladesh were varied significantly due to PRSV infection in papaya as shown in table 4. In terms of fruit number, the range of fruit number was 6.167-4.583. The maximum number (6.167) was found in BSMRAU and the lowest number (4.583) was found in BADC and Panchari which were statistically similar with Sonargaon (4.917). The highest fruit weight (643.6gm) was found in SAU campus and the lowest (324.3gm) was found in BSMRAU. The range of fruit weight was 643.6-324.3 gm.

Table.4: Effect of yield parameters due to PRSV infection

Locations		Fruit /plant	Fruit weight
Dhaka	SAU, Dhaka	5.500 b*	643.6 a
	JU, Savar	5.000 bc	527.7 cd
Gazipur	BADC, Kashimpur	4.583 c	567.8 bc
	BSMRAU, Salna	6.167 a	324.3 e

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Narayanganj	Narayanganj Sadar	5.517 b	515.5 cd
	Sonargaon Upazilla	4.917 c	491.2 d
Khagrachari hill tract	Khagrachari Sadar	5.083 bc	504.6 d
	Panchari Upazilla	4.583 c	584.5 b
CV (%)		8.12	18.11
LSD value (0.05)		0.4859	51.56

*Values within the same column with a common letter (s) do not differ significantly (P=0.05)

3.6 Percent reduction in growth and yield parameters of papaya due to PRSV disease infection

The percent reduction of growth and yield parameters are shown in table 5 & 6 and Fig 6-9. The minimum plant height reduced (1.17%) was in SAU and the maximum (23.85%) in JU. In terms of leaf number, the lowest reduction (5.5%) was found in SAU and the highest reduction (21.9%) was found in Panchari. In Panchari, the lowest reduction (13.04%) of petiole length was found while the highest reduction (38.46%) was found in BADC. The highest reduction in fruit number (70.33%) was found in BSMRAU and the lowest (5.46%) in Khagrachari. But in the case of fruit weight, the maximum reduction (42.93%) was found in BADC while the lowest reduction (12.90%) was in SAU.

Table.5: Percent reduction of growth characters of papaya due to PRSV infection

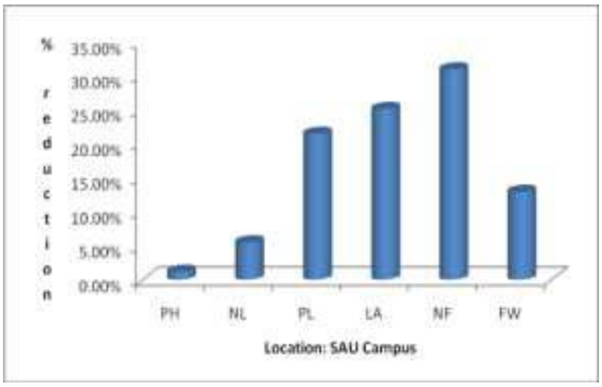
Locations		% RPH*	% RNL	% RPL	% RLA
Dhaka	SAU	1.17	5.5	21.52	25.19
	JU	23.85	5.63	36.71	11.02
Gazipur	BADC	8.59	12.35	38.46	0.88
	BSMRAU	14.13	11.54	17.50	9.87
Narayanganj	Narayanganj Sadar	8.67	18.82	19.29	6.23
	Sonargaon	2.56	11.62	17.94	12.97
Khagrachari hill tract	Khagrachari Sadar	10.97	12.59	18.44	4.43
	Panchari	10.37	21.9	13.04	25.69

*RPH= Reduction of plant height, RNL= Reduction of number of leaf, RPL= Reduction of petiole length, RLA= Reduction of leaf area

Table.6: Percent reduction of yield characters of papaya due to PRSV infection

Locations		% RNF	% RFW
Dhaka	SAU	12.90	5.5
	JU	26.86	5.63
Gazipur	BADC	42.93	12.35
	BSMRAU	9.87	11.54
Narayanganj	Narayanganj Sadar	41.34	18.82
	Sonargaon	36.61	11.62
Khagrachari hill tract	Khagrachari Sadar	37.62	12.59
	Panchari	17.18	21.9

*RNF= Reduction of number of fruit, RFW= Reduction of fruit weight



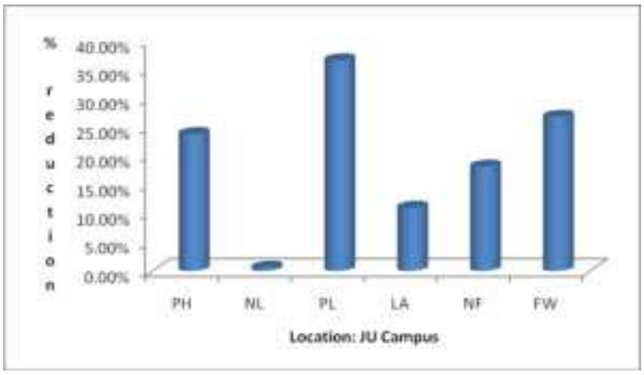


Fig 6: Percent reduction of growth and yield parameters in Dhaka district

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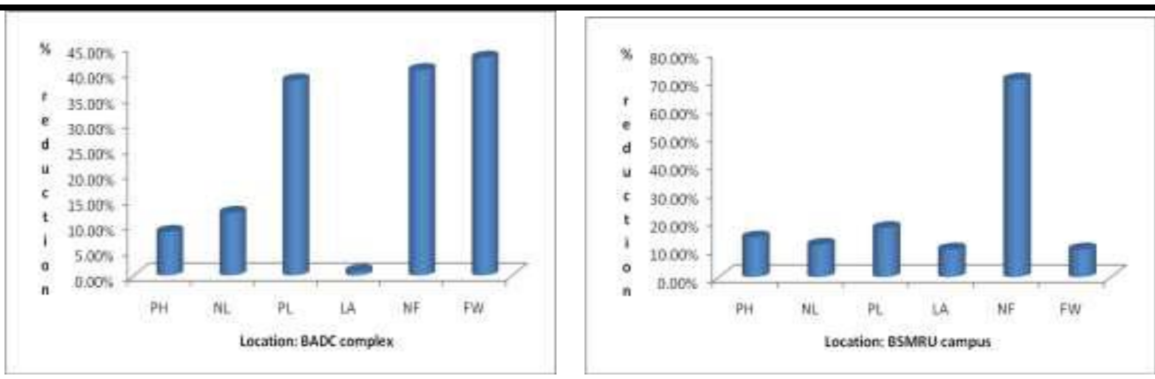

Fig 7: Percent reduction of growth and yield parameters in Gazipur district

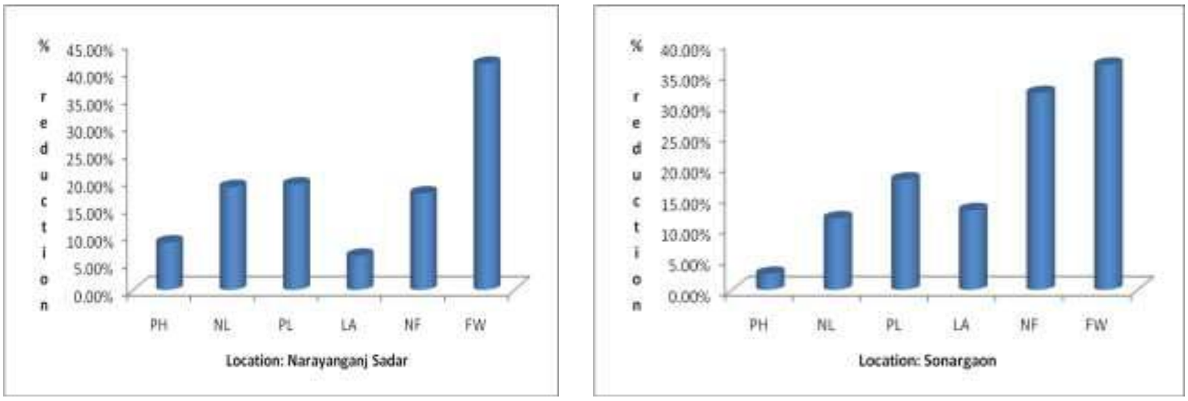

Fig 8: Percent reduction of growth and yield parameters in Narayanganj district

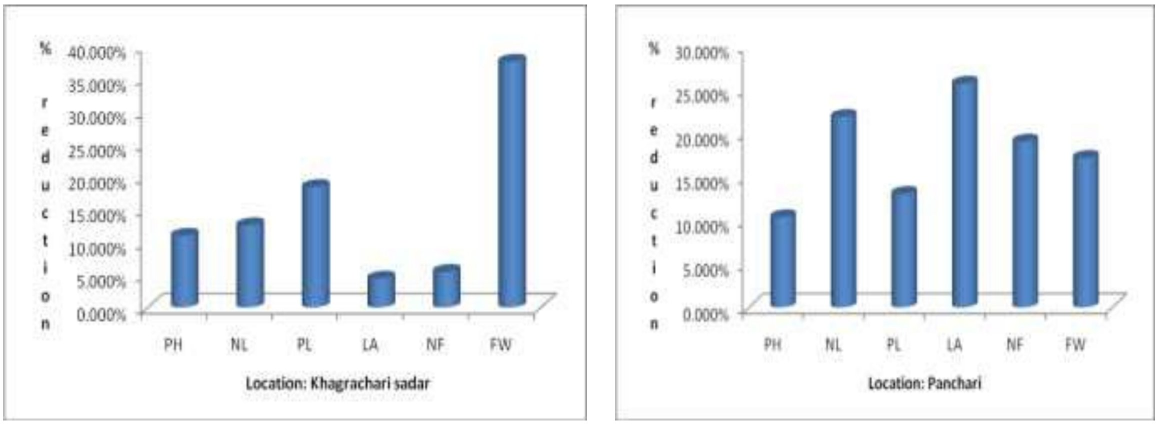

Fig.9: Percent reduction of growth and yield parameters in Khagrachari hill tract

IV. DISCUSSION

Papaya (*Carica papaya* L.) belongs to the family Caricaceae and is grown in Australia, Hawaii, Philippines, Sri Lanka, South Africa, India, Bangladesh, Malaysia and other countries in tropical America (Anuara *et al*. 2008). In 2009-2010, papaya has been cultivated in 2790 ha of land with a total production of 40.42 tons/ha (BBS, 2010) in contrast to about 11352202 tons' production of papaya in 2010 in the world (FAO, 2010). The papaya fruit is very rich in vitamin A, which refers to the second highest among of fruits and comes next to mango (Aykroyed, 1951).

There are several diseases causing damage is papaya cultivation, including fungal, bacterial and viral diseases. The diseases are very harmful for commercial cultivation. Among the viral diseases PRSV causes severe damage in growth and yield. Linder *et al*., 1945 has published a report about PRSV and brought it in literature for the first time. An investigation was done by Jensen (1949a and b) about the virus infecting papaya in Hawaii and named the virus as *Papaya ring spot virus* (PRSV).

In the present survey, the highest (36.24%) incidence was found in BSMRAU in Gazipur, whereas, the lowest value was found in Panchari (12.04%), Khagrachari. The maximum severity was recorded in BSMRAU (11.53%)

while minimum severity was recorded in Panchari (2.50%). A similar survey was done by Akhter (2007) where he showed the reduction percentage of growth and yield of the plant due to infection of PRSV in different locations in Bangladesh. Seedlings showed prominent vein clearing and downward cupping of the young leaves stated by Conover (1964). Gonzalvez *et al*. (1997) established that PRSV caused three types of leaf symptom on papaya which are mosaic, yellowing and deformation. Rahaman (2003) also found similar symptoms during an investigation about PRSV in Kashimpur farm, BSMRAU farm and nineteen other districts. He showed there are seven symptoms visible in the infected plants. Among them, the maximum number of symptom was observed in BADC, Gazipur. Castro *et al*., (2015) had done similar type of survey to study incidence and severity in the state of Guerrero and found similar results.

During the survey, it was recorded that PRSV had a great influence in growth and yield parameters. PRSV also affected growth-contributing characteristics such as plant height, leaf number, petioles length and leaf area too. A similar experiment was conducted by Akhter, (2007). He had noted the reduction of seedling height due to inoculation of seven symptoms of four locations. A similar experiment was done by Akhter and Akanda (2008). They showed the remarkable effect of *Papaya ringspot virus*- papaya strain (PRSV-P) on growth and yield on papaya.

The yield loss due to papaya viral disease infection can reach up to 100% very often. In this survey, BSMRAU was recorded for maximum fruit number/plant (6.167). On the other hand, the minimum fruit number 4.583 was calculated in BADC and Panchari, respectively. The maximum fruit weight per fruit was found at SAU (643.6 gm) and the minimum was found at BSMRAU (324.3gm). There was similarity found by Akanda (1991) and showed that the virus causes 70%-100% yield reduction of papaya depending upon the stage of infection as estimated in Bangladesh.

During the survey, the minimum plant height reduction was at SAU (1.17%) and the maximum at JU (23.85%). In terms of leaf number, the lowest number was found at SAU (5.5%) and the highest number found at Panchari (21.9%). In Panchari the lowest value of petiole length was found (13.04%) and the highest was at BADC (38.46%). Leaf number reduction was the highest (21.9%) at Panchari and the lowest value (5.5%) was found in SAU campus. Rahaman (2003) also showed similar reduction of different characteristics of papaya due to PRSV-P infection. He described different parameters like plant height, flower per plant, fruit per plant fruit weight and fruit yield. In every parameter there was remarkable reduction caused by PRSV-P infection.

V. CONCLUSION

Papaya (*Carica papaya* L.) is a very important fruit all over the world and though its demand is increasing day by day, the production of papaya is not satisfactory. The present experiment was designed to study the surveillance and identification of PRSV disease based on symptomology and to observe the disease incidence and severity of PRSV at eight locations of four districts in Bangladesh. In the survey period among the eight locations, the highest incidence was found at BSMRAU (36.24%) and lowest at Panchari (12.04%). In the case of severity, the maximum severity was found at BSMRAU (11.53%) and minimum was recorded at Panchari (2.50%), BADC (3.057%) and Narayanganj Sadar (3.443%). In the selected locations, the growth parameters were also recorded, including plant height, leaf number, petioles length and leaf blade area. There were significant differences found in different growth parameters at different locations. The highest number of fruit was harvested from BSMRAU campus (6.167) as yield parameters and the lowest number was found at JU and Panchari (4.583). Significant variations also found in percent reduction of growth and yield parameters. From the findings of the study, it may be concluded that the disease incidence and severity and its effects on growth, yield, and yield parameters varied significantly in the surveyed areas by the infection of PRSV in papayas the lowest incidence and severity was found at Panchari (Hill tract area). The farmer may be suggested to cultivate papaya in that region. However, further study need to be continued to have information prissily.

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Macroinvertebrate Communities Associated with *Hydrilla verticillata* (Royle, 1839) and Relationship with Environmental Factors in Ono Lagoon, Southeast of Côte d'Ivoire

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Abstract— *The macroinvertebrates associated with Hydrilla verticillata was studied in Ono lagoon, South-eastern of Côte d'Ivoire. M*onthly samples of macrophytes with their associated macroinvertebrates were collected in *upstream, centre and downstream*using a Van veen grab *of 0.314 m^2 internal area. The environmental variables (temperature, transparency, depth, conductivity, TDS, pH, dissolved oxygen,* NH_4^+, NO_3^-, NO_2^- *and* PO_4^{3-}*) were also recorded. A total of 71 taxa belonging to 28 families, 11 orders, 05 classes and 03 phyla of which 40 taxa were recorded in upstream, 45 taxa in centre and 44 taxa in downstream. Insects numerically dominated the capture, comprising 91.55% of the collectedtaxa with Odonata and Coleoptera being the most diverse and abundant groups. The density was higher in upstream (1407ind. per 100 g d.w.) and lower in downstream (1062 ind. per 100 g d.w.), whist theLibellulidae and Corduliidae exhibited the highest density communities. The rarefied richness did not show spatial variation but vary significantly between seasons. The Evenness did not show spatial and seasonal variations. However, Shannon diversity index varied significantly between sites and seasons. From the results of RDA analysis, conductivity and pH showed a strong environmental gradient and had a structuring effect on macroinvertebrate communities.*

Keywords— Aquatic macroinvertebrates, macrophytes, Ono lagoon, taxonomic richness, Côte d'Ivoire.

I. INTRODUCTION

Submerged macrophytes in freshwater lakes, reservoirs, lagoons and ponds play an important role in aquatic systems, providing shelter, breeding habitat and epiphytic forage for numerous fishes and aquatic macroinvertebrates. The macroinvertebrate communities associated with specific macrophytes in freshwater have frequently been examined(Albertoni*et al*., 2007; Kouamé*et al*., 2011; Phiri *et al*., 2011). It has been reported that macroinvertebrates are not equally abundant on all plant species (Downing and Cyr, 1985). According to Carpenter and Lodge (1986), aquatic plants provide a physically and chemically complex habitat in aquatic ecosystems, and architectural features of this habitat can affect invertebrate species diversity, density and distribution. Submerged vegetation significantly modifies the water flow, while emerged species stabilise the sediment and shoreline zone and thus improve water quality (Krischik*et al*., 1999). Submerged and floating-leaved macrophytes differ in structure, offering diverse opportunities for phytophilous organisms (Cattaneo*et al*., 1998). Macroinvertebrates abundance is often higher on macrophytes with dissected leaves than on those with undissected leaves, because the latter have a larger surface with periphyton for grazing macroinvertebrates and because additional complexity provides a better refuge from predators(Cheruvelil*et al*., 2002). However, according to Cyr and Downing (1988) and Irvine *et al*. (1990),

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macrophytes with complex broad leaves can be a better refuge from predators than macrophytes with dissected leaves. Macrophytes like *Ceratophyllumdemersum* and *Myriophyllum* spp. generally do not support higher macroinvertebrates abundance in relation to macrophytes with broad leaves. Can *Hydrilla verticillata* which looks about the same as *Ceratophyllumdemersum* and *Myriophyllum* spp. support more macroinvertebrates abundance? This current study is one of the first to be carried out on macroinvertebrate community of Ono lagoon. The aim was to investigate the spatial and seasonal variation of macroinvertebrates associated with *H. verticillata* and their relationship with environmental factors.

II. MATERIAL AND METHODS

2.1. Study area

Ono lagoon (5°22'22 "N; 3°33'53' W) is located in the Southeast of Côte d'Ivoire (Fig. 1). This lagoon had an initial surface area of about 481 ha. In recent decades, the exploitable area has been reduced to 162 ha because of variety of habitat types such as emerged plants, free-floating macrophytes, floating leaf plants, submerged plants and white habitats.This lagoon is irrigated by a small river (Wamonriver) and connected in downstream to Comoériver. The climate of the study region is tropical and humid characterized by two seasons (dry and rainy seasons). The dry season extends from December to March and from August to September while the rainy season extends from April to July and from October to November.

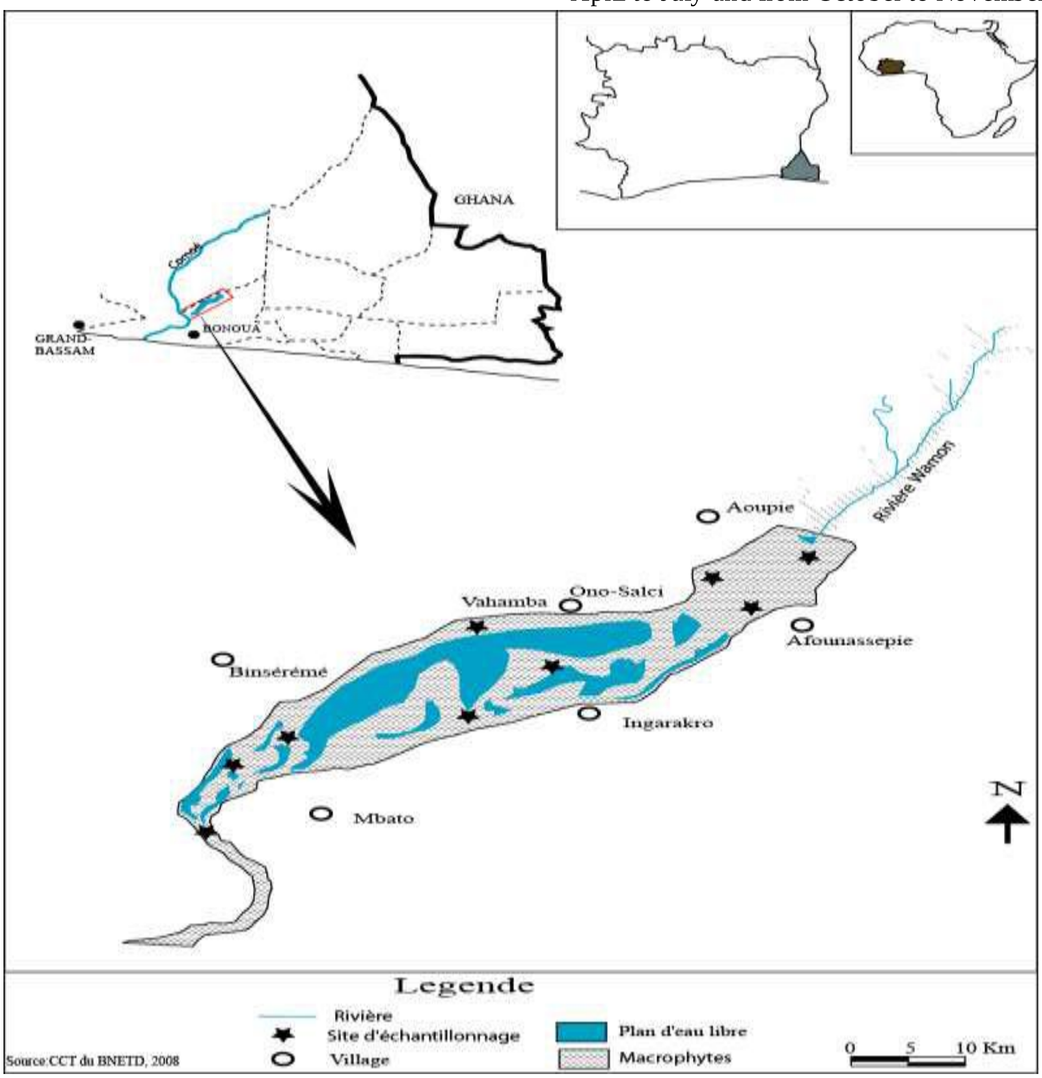

Fig.1: Map showing Ono Lagoon and the different samplings stations.

2.2. Data collection and laboratory procedure

Sampling in Ono Lagoon spanned a period of one year (September 2015 to August 2016). Samples of water and macrophytes with their associated macroinvertebrates were monthly collected in upstream, centre and downstream (Fig. 1). *Hydrilla verticillata* was sampled using a Van veen grab of 0.314 m^2 internal area. The great transparency of water allowed us to position and close the grab with a relative precision at the level of the portion to be studied. Parts of macrophytes reported in excess and overflowing the jaws of the grab were removed by cutting, to keep only those located inside. All plant material and associated macroinvertebrates of the grab were washed into a bowl, then filtered through a 0.2 mm mesh sieve. Subsequently, the samples were preserved in a 10% formaldehyde solution in a plastic container for further analysis. At laboratory, preserved samples were washed to remove formaldehyde solution and then screened through a 500 µm mesh size to collect all macroinvertebrates on white plates. They were then fixed in a 70% alcohol solution for identification, counting and weighing. Separated and washed plants were drained of excess water, weighed to estimate plant wet biomass and dried up to 105°C for 2 daysto express the dry weight. Large macroinvertebrates were sorted by the naked eye while smaller fauna was sorted under a binocular loupe. The macroinvertebrates were identified up to lowest possible taxon according to Déjoux*et al*. (1981), De Moor *et al*. (2003a; 2003b) and Tachet*et al*. (2003).

2.3.Measurement of environmental variables

Simultaneously to the biological examinations, a number of physical and chemical analyses were conducted. On each sampling site, the temperature, transparency, water depth, pH, Total Dissolved Solids (TDS), conductivity and dissolved oxygen were monthly measured *in situ* between 08.00 am and 10.00 am. Water samples were taken, stored in polyethylene bottles (500 mL) and kept at a temperature below 4°C and conducted to laboratory where analyses of dissolved inorganic nutrients (ammonium NH_4^+, nitrite NO_2^-, nitrate NO_3^- and phosphorus PO_4^{3-}) were carried using a spectrophotometer Model HACH DR 6000.

2.4. Data analysis

The macroinvertebrate density was characterised based on the total number of individuals (N) per 100 g dry weight (d.w.) of macrophytes. Invertebrate diversity was assessed as: taxon richness, Shannon-Wiener diversity and evenness indices. The total taxa were rarefied for each site for a given number of individuals drawn randomly from a sample (Magurran, 2004). The rarefaction was used to avoid any bias related to differences inabundances between samples using the lowest abundance (56 individuals for this study) found in all sites asthe target number of individuals following Oksanen *et al*., 2013.

Before performing comparison analyses, data normality was tested using Shapiro test. As the biotic and abiotic data distribution was not normal ($P<0.05$), the non-parametric test of Kruskal-Wallis was performed to compare data between sampling sites. When Kruskal-Wallis test is significant, Mann-Whitney U test was used for pairwise comparison.

Redundancy Analysis (RDA) was used to assess relationships between macroinvertebrate distribution and environmental variables. A Monte Carlo permutation test was performed to assess the statistical significance of the environment variables and the full model to arrive at the significance of the first two axes. All analyses were conducted using the R package.

III. RESULTS

3.1. Environmental variables

The mean values of Ono environmental variables for study period are summarize in TABLE 1. Significant variation in water parameters was not observed among the sampling zones (ANOVA results of Kruskal-Wallis test, $P > 0.05$), except for temperature. This parameter varied significantly among the sampling sites ($H_{2,36} = 3.37$, $p = 0.048$) with thehighest value occurring in downstream (27,91 ± 1,51°C).For the other parameters, namely water depth, transparency, dissolved oxygen, nitrate, nitrite and phosphate, the values were slightly high in downstream. The mean values of conductivity and total dissolved solids were rather high in upstream than in downstream.

*Table.1: Spatial mean values*of the measured environmental variables *(mean ± (SD))* in *Ono Lagoon*. *Means with different letters within stations differ statistically p < 0.05*

Parameters	Upstream	Centre	Downstream
Water depth (m)	2,39 ± 0,27	2,43 ± 0,11	2,55 ± 0,26
Transparency (m)	1,49 ± 0,48	1,50 ± 0,48	1,79 ± 0,67
Temperature (°C)	26,36 ± 1,40^{a}	27,27 ± 1,48^{ab}	27,91 ± 1,51^{b}
pH	6,37 ± 0,96	6,32 ± 0,67	6,28 ± 0,81

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Dissolved oxygen (mg/L)	1,70 ± 2,22	2,36 ± 1,74	2,81 ± 1,36
Conductivity (µS/cm)	19,98 ± 4,17	17,26 ± 5,87	17,01 ± 7,35
Total dissolved solids (mg/L)	10,15 ± 2,57	8,50 ± 3,00	8,53 ± 3,70
Nitrate (mg/L)	3,22 ± 0,91	2,67 ± 1,15	3,40 ± 1,63
Nitrite (mg/L)	0,18 ± 0,41	0,18 ± 0,41	0,28 ± 0,52
Ammonium-nitrogen (mg/L)	0,06 ± 0,04	0,10 ± 0,05	0,08 ± 0,10
Phosphate (mg/L)	0,43 ± 0,22	0,34 ± 0,15	0,65 ± 0,63

3.2. Macroinvertebrate Assemblages

A total of 71 taxa belonging to 28 families, 11 orders, 05 classes and 03 phyla of which 40 taxa were recorded in upstream, 45 taxa in centre and 44 taxa in downstream (TABLE 2). Aquatic Insects numerically dominated the capture, comprising 91.55% of the collected taxa with Odonata (22 taxa) and Coleoptera (18 taxa) being the most diverse and abundant groups. Libellulidae was the most represented family (08 species), followed by Corduliidae and Coenagrionidae(05 species each). Only one species of Crangonidae(*Crangoncrangon*) and Ampullariidae(*Marisa cornuarietis*)families were identified.

The density of macroinvertebrates was highest in upstream (1407 ind. per 100 g d. w.), followed those recorded incentre (1213 ind. per 100 g d. w.) and downstream (1062 ind. per 100 g d. w.) (Table 2). Insects dominated the community, with 94.44% (1325 ind. per 100 g d.w.)in upstream and 97% both in centre (1183 ind. per 100 g d.w.) and downstream (1038 ind. per 100 g d.w.) (Table2). Odonata and Coleoptera had the highest densities and were constantly present in all sites. The most abundant macroinvertebrate order was Odonata. Their density ranged from 48.54% (681 ind. per 100 g d.w.)in upstream to 44.81% (544 ind. per 100 g d.w.)in centre. The second largest group was Coleoptera with a density varying from 8.98% (96 ind. per 100 g d.w.) in downstream to 20.46% (287 ind. per 100 g d.w.) in upstream, followed by Heteroptera (from 10.76% in upstream to 17.30% in centre), Diptera (from 6.49% in upstream to 10.38% in centre) and Lepidoptera (from 3.29% in centre to 11.79% in downstream). The lowest densities were observed in Ephemeroptera, Decapoda, Pharyngobdelliformes, Architaenioglossa and Plecoptera.Libellulidae (from 19% in both centre and downstream to 24% in upstream) and Corduliidae (from 10% upstream to 16.64% in centre) exhibited the highest family densities in sampling stations.

Table.2: Density (number of individuals per 100 g dry weight) of macroinvertebrates recorded on Hydrilla verticillata at different sampling stations

Major groups			Taxa	Density (ind per 100 g d.w)		
Phyla	**Class**	**Orders**	**Familles/species**	Upstream	Centre	Downstream
Arthropoda	**Insecta**	**Ephemeroptera**	**Baetidae**	0 ± 0	45 ± 4	75 ± 5
			Cloeonaerolatum	0 ± 0	23 ± 2	36 ± 3
			Cloeonbellum	0 ±	22 ± 2	7 ± 1
			*Pseudocloeon*sp.	0 ± 0	0 ±0	32 ± 2
			Leptophlebiidae	0 ± 0	0 ± 0	8 ± 1
			Thraulusbellus	0 ± 0	0 ± 0	8 ± 1
		Plecoptera	**Perlidae**	0 ± 0	0 ± 0	5 ± 1
			Neoperlaspio	0 ± 0	0 ± 0	5 ± 1
		Odonata	**Aeshnidae**	11 ± 1	18 ± 3	0 ± 0
			*Aeshna*sp.	11 ± 1	18 ± 3	0 ± 0
			Coenagrionidae	105 ± 7	78 ± 4	94 ± 5
			*Ceriagrion*sp.	34 ± 3	0 ± 0	0 ± 0
			Ceriagriontenellum	29 ± 2	0 ± 0	38 ± 2
			*Nehalennia*sp.	0 ± 0	40 ± 3	0 ± 0
			*Pseudagrion*sp.	20 ± 2	5 ± 1	16 ± 2
			Pseudagrionwellani	23 ± 1	32 ± 3	40 ± 3

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			Corduliidae	142 ± 8	200 ± 11	145 ± 8
			Corduliaaenea	77 ± 5	54 ± 4	0 ± 0
			Epithecabimaculata	0 ± 0	91 ± 6	91 ± 4
			Hemicorduliaolympica	64 ± 3	0 ± 0	11 ± 2
			Oxygastracurtisii	0 ± 0	55 ± 3	0 ± 0
			*Somatochlora*sp.	0 ± 0	0 ± 0	44 ± 4
			Libellulidae	340 ± 18	232 ± 9	211 ± 10
			Brachythemisleucosticta	26 ± 3	50 ± 3	28 ± 4
			Bradinopygastrachani	23 ± 4	0 ± 0	20 ± 2
			Diplacodeslefebvrii	0 ± 0	0 ± 0	13 ± 3
			*Leucorrhinia*sp.	22 ± 2	0 ± 0	0 ± 0
			*Libellula*sp.	129 ± 5	114 ± 6	93 ± 3
			Palpopleuralucialucia	77 ± 7	68 ± 2	59 ± 4
			*Sympetrum*sp.	53 ± 4	0 ± 0	0 ± 0
			*Urothemis*sp.	9 ± 2	0 ± 0	0 ± 0
			Macromiidae	86 ± 3	15 ± 2	61 ± 3
			*Macromia*sp.	68 ± 4	7 ± 1	61 ± 3
			Phyllomacromia picta	17 ± 3	0 ± 0	0 ± 0
			*Phyllomacromia*sp.	0 ± 0	8 ± 2	0 ± 0
		Heteroptera	**Belostomatidae**	58 ± 3	26 ± 3	40 ± 2
			Diplonychusannulatus	36 ± 3	8 ± 2	10 ± 2
			*Diplonychus*sp.	22 ± 2	18 ± 3	29 ± 2
			Gerridae	0 ± 0	18 ± 3	8 ± 2
			*Eurymetra*sp.	0 ± 0	18 ± 3	0 ± 0
			Limnogonuschopardi	0 ± 0	0 ± 0	8 ± 2
			Naucoridae	56 ± 6	145 ± 10	62 ± 2
			Macrocorisflavicollis	31 ± 4	52 ± 4	28 ± 3
			Naucoriscimicoides	25 ± 2	93 ± 6	35 ± 4
			Nepidae	8 ± 2	0 ± 0	8 ± 2
			Ranatraparvipes	8 ± 2	0 ± 0	8 ± 2
			Notonectidae	0 ± 0	0 ± 0	9 ± 2
			Notonectaglauca	0 ± 0	0 ± 0	9 ± 2
			Pleidae	28 ± 3	8 ± 1	0 ± 0
			Plea pullula	28 ± 3	8 ± 1	0 ± 0
			Veliidae	0 ± 0	14 ± 2	0 ± 0
			Microveliapygmaea	0 ± 0	14 ± 2	0 ± 0
			Mesoveliidae	0 ± 0	0 ± 0	5 ± 1
			Mesoveliavittigera	0 ± 0	0 ± 0	5 ± 1
		Lepidoptera	**Crambidae**	116 ± 5	41 ± 5	125 ± 13
			Cataclystalemnata	21 ± 2	16 ± 3	8 ± 1
			Elophilaobliteralis	89 ± 3	8 ± 2	54 ± 5
			Parapoynxstratiotata	5 ± 1	17 ± 2	63 ± 10
		Coleoptera	**Curculionidae**	65 ± 8	13 ± 3	15 ± 2
			*Bagous*sp.	65 ± 8	13 ± 3	0 ± 0
			*Stenopelmus*sp.	0 ± 0	0 ± 0	15 ± 2
			Dryopidae	15 ± 2	0 ± 0	0 ± 0
			*Polyphaga*sp.	15 ± 2	0 ± 0	0 ± 0

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			Dytiscidae	64 ± 4	89 ± 9	48 ± 3
			*Agabus*sp.	0 ± 0	26 ± 4	0 ± 0
			Canthydrusxanthinus	11 ± 2	22 ± 3	7 ± 2
			Cybistertripunctatus	0 ± 0	10 ± 2	0 ± 0
			Cybisterfimbriolatus	37 ± 3	8 ± 2	15 ± 2
			*Hydrovatus*sp.	16 ± 2	0 ± 0	26 ± 2
			*Laccophilus*sp.	0 ± 0	22 ± 3	0 ± 0
			Elmidae	26 ± 3	0 ± 0	20 ± 3
			*Normandia*sp.	21 ± 2	0 ± 0	0 ± 0
			*Potamophilus*sp.	5 ± 1	0 ± 0	0 ± 0
			Potamophilusacuminatus	0 ± 0	0 ± 0	20 ± 3
			Hydrophilidae	119 ± 5	113 ± 7	15 ± 1
			*Amphiops*sp.	53 ± 3	67 ± 3	0 ± 0
			Anacaenaglobulus	58 ± 2	0 ± 0	0 ± 0
			*Enochrus*sp.	8 ± 1	22 ± 2	5 ± 1
			Hydrobiusfuscipes	0 ± 0	0 ± 0	10 ± 1
			*Hydrochara*sp.	0 ± 0	14 ± 2	0 ± 0
			*Hydrophilus*sp.	0 ± 0	10 ± 2	0 ± 0
		Diptera	**Chironomidae**	91 ± 7	127 ± 16	78 ± 10
			Chironomusimicola	59 ± 4	29 ± 4	0 ± 0
			Clinotanypusclaripennis	0 ± 0	16 ± 2	16 ± 2
			*Cricotopus*sp.	33 ± 4	20 ± 3	0 ± 0
			*Cryptochironomus*sp.	0 ± 0	16 ± 2	16 ± 2
			Nilodorumfractilobus	0 ± 0	20 ± 3	20 ± 3
			*Procladius*sp.	0 ± 0	25 ± 3	25 ± 3
	Crustacean	**Decapoda**	**Crangonidae**	68 ± 11	6 ± 1	6 ± 1
			Crangon crangon	68 ± 11	6 ± 1	6 ± 1
Annelida	**Achaeta**	**Pharyngobdelliformes**	**Erpobdellidae**	7 ± 1	7 ± 1	7 ± 1
			*Erpobdella*sp.	7 ± 1	7 ± 1	7 ± 1
			Haemopidae	0 ± 0	6 ± 1	6 ± 1
			Haemopissanguisuga	0 ± 0	6 ± 1	6 ± 1
	Oligochaeta	**Haplotaxida**	**Lumbricidae**	4 ± 1	6 ± 1	6 ± 1
			Lumbricusrubellus	0 ± 0	6 ± 1	6 ± 1
			*Ophidonais*sp.	4 ± 1	0 ± 0	0 ± 0
Mollusc	**Gastropoda**	**Architaenioglossa**	**Ampullariidae**	0 ± 0	6 ± 1	6 ± 1
			Marisa cornuarietis	0 ± 0	6 ± 1	6 ± 1
Total density				1407	1213	1062
Total taxa			**71**	**40**	**45**	**44**
Rarefied richness				**39.99**	**44.99**	**44**

3.3. Diversity indices

The rarefied richness was 44.99 in centre, 44.00 in downstream and 39.99 in upstream (Table.2). This richness did not show spatial variation (Fig. 2) but vary significantly between seasons (upstream and centre). In downstream, there were no significant differences amongst seasons (Fig.3 A). The Shannon diversity index showed a significant difference between sites,withhighest values recorded in centre(3.18) and lowest values in downstream (2.21). The Shannon-Weaver index is greater than 2 in all sampling sites (Fig.2). Significant seasonal variations were found and the values were significantly highest in rainy season (centre and downstream) and lowest in dry season (upstream, centre and downstream) (Fig.3 B). The Evenness

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index ranged from 0.7 in upstream to0.98in downstream and did not show spatial and seasonal variations (Fig.2&Fig.3 C).

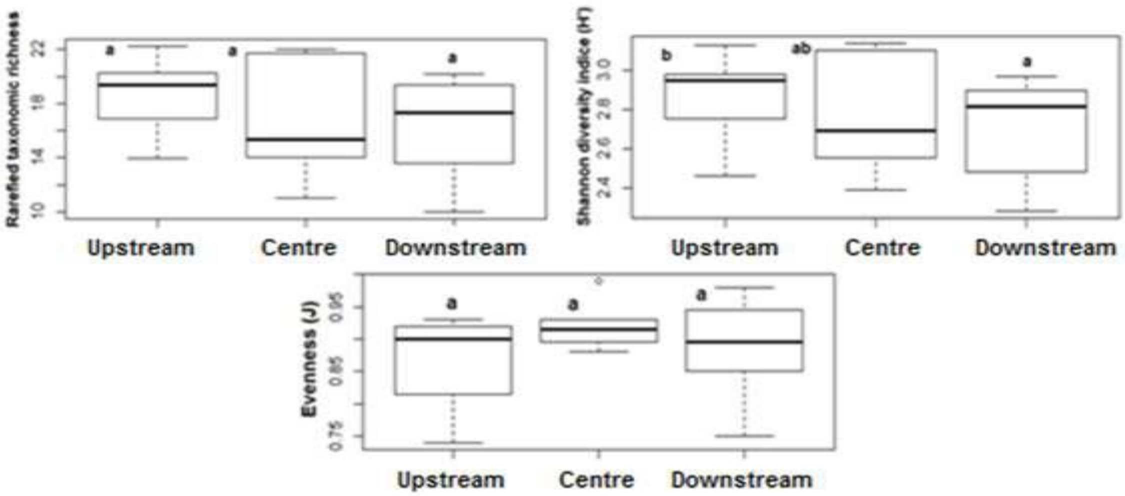

Fig.2: Spatial variation ofRarefied Taxonomic richness (Rs), Shannon diversity indices and Evenness (J) Different letters within sites indicate significant difference based on Mann-Whitney, comparison test at $p < 0.05$.

3.4. Macroinvertebrate communities and environmental factors influence

The results of the Redundancy Analysis (RDA) showed that the correlation between environmental variables and macroinvertebrate taxa was mainly explained by the first two axes with 49.96% of total variance (Fig.4). From the RDA ordination diagram, two factors (conductivity and pH) had a significant impact on the macroinvertebrate communities. The temperaturewas the only parameter positively correlated with the axis 1 and no parameters were negatively correlated with this axis. The second axis, was positively correlated with conductivity and phosphate but negatively with pH, dissolved oxygen, nitrate and nitrite.

In rainy season (RS1, RS2 and RS3), the sites were characterized by high values of pH and nitrate and low values of phosphate and conductivity. This season was associated with the presence of Odonata (Aeshnidae, Corduliidae and Libellulidae), Coleoptera (Dytiscidae and Dryopidae), Heteroptera (Gerridae and Veliidae) and Diptera (Chironomidae). The centre was characterized in Flood season (FS2) by high values of Ammonium-nitrogen (NH_4^+) and Dissolved oxygen and the presence of Heteroptera (Naucoridae and Pleidae) and Ephemeroptera (Leptophlebiidae and Baetidae). The centre and downstream were associated in dry season (DS2 and DS3) with the presence of Plecoptera (Perlidae), Heteroptera (Notonectidae and Mesoveliidae) and Decapoda as well as high values of Temperature. The upstream recorded in Flood and Dry season (FS1 and DS1), high values of Phosphate. This station was associated with the presence of Coleoptera (Curculionidae, Elmidae and Hydrophilidae), Heteroptera (Nepidae and Belostomatidae), Achaeta (Erpobdellidaeand Haemopidae), Oligochaeta (Lumbricidae) and Gasteropoda (Ampullariidae).

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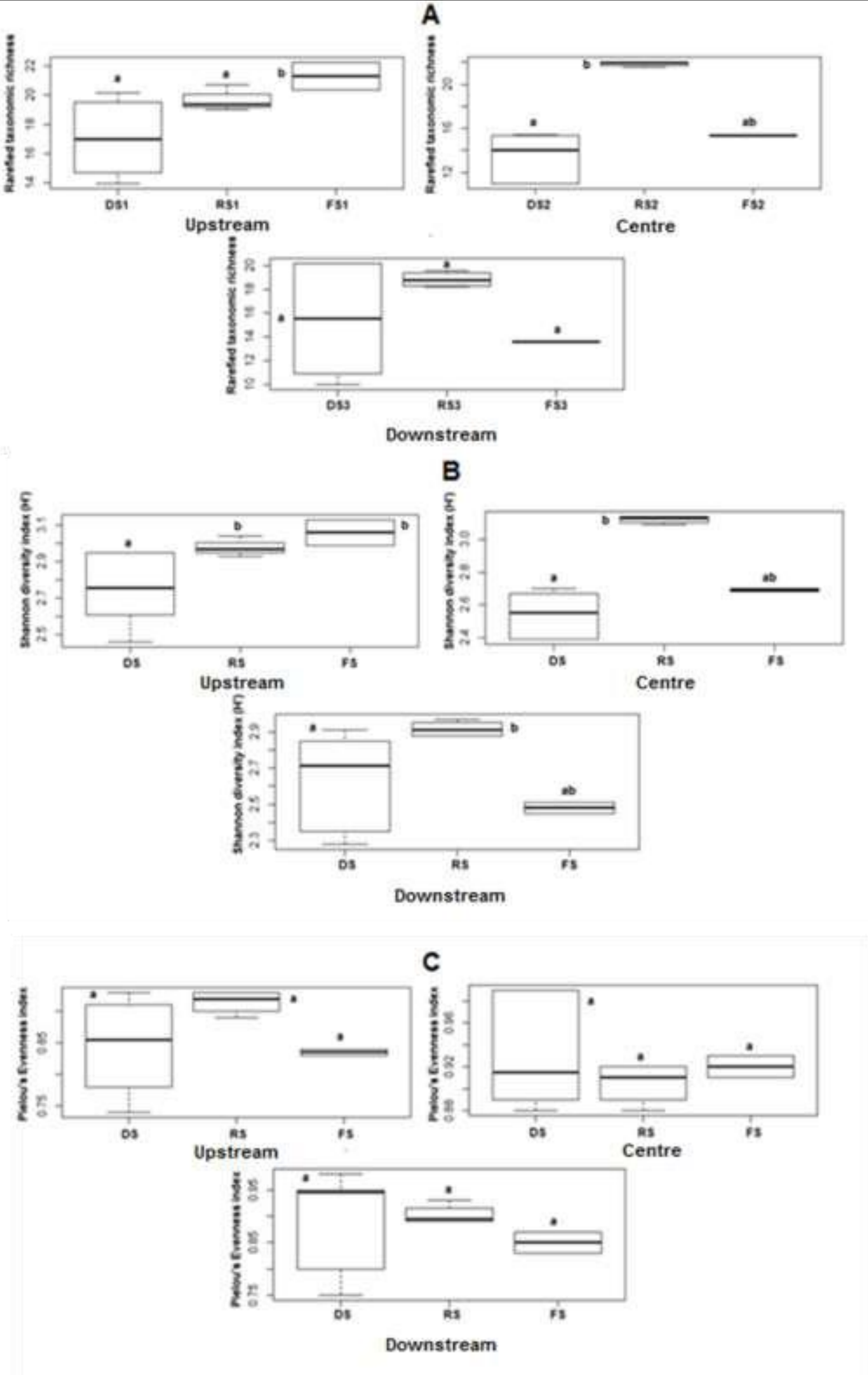

Fig.3: Box-plots showing seasonal variation of the diversity index (A, B & C) of macroinvertebrates recorded on Hydrilla verticillata at sampling stations. Different letters within seasons denote significant differences between them (Mann-Whitney, p<0.05).

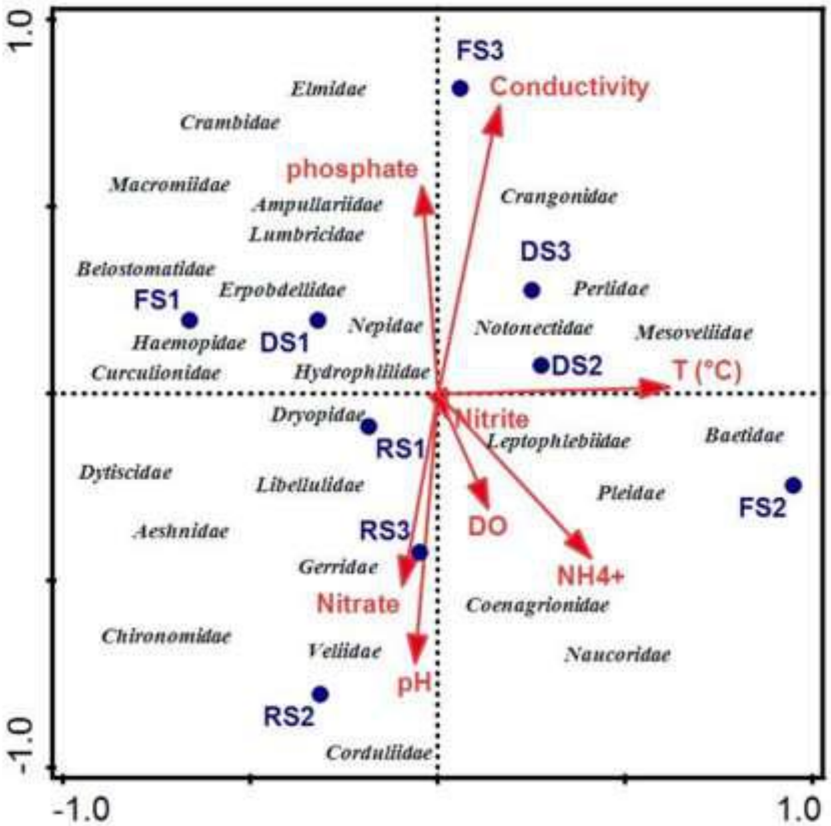

Fig.4: Redundancy Analysis (RDA) showing macroinvertebrates sampling seasons on different sampling sites in relation to environmental variables. (DO= dissolved oxygen, CND= Conductivity, T= temperature, Trans= transparency and Dpth= depth).

IV. DISCUSSION

Analysis of the physical and chemical parameters of Ono lagoon reveals that the parameters (water depth, pH, dissolved oxygen, transparency, TDS, conductivity, nitrate, nitrite and phosphate)show no significant variation between sites, except for the temperature. Temperature plays an important role in the physical and chemical characteristics of lagoon environment, affecting the rate of CO_2 fixation by phytoplankton (primary productivity) and solubility of gases such as O_2, CO_2 and NH_4^+ which on turn affect all aquatic organisms (Gawad and Abdel-Aal, 2018). Dissolved oxygen (DO) mean values were very low (1.70-2.81 mg / L), attesting that plant cover and root density influence strongly oxygen concentration in the lagoon. When *H. verticillata*forms cohesive mats, a considerable biochemical oxygen demand is created by both trapping organic matter and the decay of their own vegetative parts. Colon-Gaud (2003) noted that the dense mats of *H. verticillata* reduced water circulation and light penetration in water bodies and influenced dissolved oxygen concentrations. On the other hand, the lowest values of oxygen levels may be due to the removal of free oxygen through respiration by, macrophytes bacteria and animals as indicated by Tohouri*etal*. (2017). The pH was acidic during the study period. This acidity comes mainly from plant organic matter decomposition, with production of CO_2 in the first layers of the soil (Matini*et al*., 2009; Eblin*et al*., 2014). The nutrients represented by ammonium-nitrogen, phosphate, nitrate and nitrite values did not vary between sites. However, phosphate and nitrate values were relatively higherthan those reported in Taabo lake (Kouamé*et al*., 2011) and lower Comoé river (Kra*et al*., 2018). The contamination of surface waters by total phosphorus can be induced by leaching of cropland containing phosphate fertilizers and some pesticides. Indeed, the Ono lagoon watershed closes several industrial plantations (rubber, palm oil, pineapple) that require the use of fertilizers and pesticides over large areas.

A total of 71 macroinvertebrates taxa belonging to 28 families, 11 orders, 05 classes and 03 phyla were recorded demonstrating a relatively similar taxa to those recorded in Manasbal Lake (Sami *et al*., 2012) and Atchafalaya River Basin (Colon-Gaud, 2003). This indicates that macrophytes provide excellent microhabitats that enhance the establishment and colonisation of many invertebrates.Rakhi *et al*. (2014) reported that *H. verticillate* represents a suitable well-illuminated substrate in the water column. The dominant groups of our study were Odonata and Coleoptera whereas Diptera, Gasteropoda, Ephemeroptera, Decapoda, Amphipoda and Hemiptera dominated macroinvertebrate community of Atchafalaya River Basin. However, the number of taxafound in this study was higher than that of Scott and Osborne (1981)in Central Florida Lake (54 taxa), Heather *et al*. (2008) in Earthen experimental ponds (24 taxa) and Sami *et al*. (2012) in Manasbal lake (15 taxa). Insects numerically dominated the capture, comprising 91.55% of the collected taxa with Odonata and Coleoptera being the most diverse and abundant groups. The high insect taxonomic representativeness and abundance of this group was a pattern also observed in other studies (Tomaz*et al*., 2008; Lucca *et al*., 2010). According to Tachet*et al*. (2003), insects represent one of the most important groups of freshwater invertebrates especially due to their diversity. Some macroinvertebrate taxa (Ephemeroptera and Plecoptera) were not recorded in upstream where lowest values of dissolved oxygen were measured. Also, differences in taxon composition and abundance within the same taxonomic group (class or order) were observed. Similarly, Merritt and Cummins (1996)found that macroinvertebrate abundance and species composition was strongly influenced by water quality.

The total density of macroinvertebrates found in the microhabitat created by *H.verticillata*was higher (1407 ind. per 100 g d. w.) in upstream and lower (1062 ind. per 100 g d. w.) in downstream. The groups which had the highest densities were Insects (from94,44% to 97,45%) of all the organisms collected, with Odonata (from 44,81% to 48,54%) being the most abundant groups. Our results are similar to findings of Poi De Neiff and Carignan (1997) who observed the same situation in floodplain of the Paraná River. Odonata larvae are known to use the aquatic plants as their egg laying site (Singh, 1989) and as ambush points to capture their prey (Merritt and Cummins, 1996). Density of coleoptera was found to be the second dominant as reported in SantragachiJheel Lake by Patra *et al*. (2012), attesting that Odonata and Coleoptera are well associated with macrophyte.

The rarefied richness did not vary significantly among sites but showed a significant seasonal variation. The rarefied richness shows that in absence of any bias in samples, flood and rainyseasons were rich in the number of species. The Shannon diversity index showed significant spatial and seasonal variationsfrom a minimum of 2.2 (downstream) to a maximum of 3.18 (centre),suggesting that the centre was able to sustain a richer associated community. In addition, the lowest and highest values were respectively recorded in dry and rainy seasons, indicating that rainy and flood seasons were able to sustain a richer associated macroinvertebrates community than dry season. The maximum of Shannon diversity index takes place when species richness increases as found by (Brown and Lomolino, 1998). Concerning the Evenness values, no significant spatial and seasonal variations was observed. However, Evenness values varied from a minimum of 0, 74 in upstream to a maximum of 0, 96 in downstream. These values are high when compared with those recorded in subtropical lakes of south Brazil(Albertoni*et al*., 2007), in Central Florida Lake (Scott *et al*., 1981) and in Lake Nasser Khors of Egypt(Gawad and Abdel-Aal, 2018), showing the equitability in the distribution of individuals among the species. According to Schäfer (1980), high levels of evenness indicate an environment with heterogeneous conditions regulated by a community which is rich in the number of species and the multiplicity of their mutual relationships.

From the results of RDA analysis, macroinvertebrate communities of Ono lagoon were most influenced by water quality variables such as conductivity, pH, temperature, phosphate, ammonium-nitrogen and nitrate. However, conductivity and pH showed a strong environmental gradient and had a structuring effect on macroinvertebrate communities. These communities were similar in rainy season and different in flood season.

V. CONCLUSION

In this investigation, we collected an important number of species (71) associated with Hydrilla verticillata. Insects with 91.55% of total species was the most diverse class. This class recorded the highest density community (94.44% to 97.45%) and macroinvertebrate assemblages were qualitatively (22 taxa) and quantitatively (44.81% to 48.54% of total density) dominated by Odonata.

The centre recorded the greatest taxonomic richness (45 taxa). However, the higher density was reported in upstream (1407 ind.per 100 g d.w.). Distribution of aquatic macroinvertebrates by *H. verticillata* was best explained by conductivity, pH, temperature, ammonium-nitrogen, phosphate and nitrate. The spatio-temporal values of diversity indices were high and showed the equitably distribution of community individuals among taxa. However, low dissolved oxygen values reported are a signal of this environment degradation marked by the absence of Ephemeroptera upstream.

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Analysis of Phenotypic Variability and Correlation on Sugar Content Contributing Phenotypes of Salak (*Salacca sumatrana Reinw var.Sidempuan.*) under Various Altitudes

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Abstract— *Salak (Salacca edulis), commonly known as snake fruit, is one of Indonesia's local fruit preference with a promising commercial prospect for the development of horticultural product. This fruit is a superior fruit commodity of Padang Sidempuan which has been recognized nationally. A significant change of geographical altitudes from lowland to highland supported the salak growth when planted in South Tapanuli. This study was aimed to evaluate the phenotypic variability as well as its correlation of salak planted in three different subdistricts of South Tapanuli representing low, mid and highlands. Sampling was conducted using purposive sampling method where 30 accessions of salak were collected from all those three subdistricts in South Tapanuli. Both qualitative and quantitative traits were statistically analyzed and evaluated for its phylogenetic using NTSYS 2.02. According to the phylogenetic analysis, 37 morphological traits resulted in a similarity coefficient ranging from 0.34-0.68. Of all accessions tested, two accessions (MC4 and MC5) were closely clustered with a coefficient of 0.68. Moreover, 7 traits were positively correlated to sugar content, including plant height,number of fruit bunch, length and width of leaflet, number of leaf, fruit weight and flesh thickness.*

Keywords— snake fruit, germplasm, characterization, sugar content, correlation.

I. INTRODUCTION

Salak (*Salacca edulis*) is one of preferred fruit due to its fruit texture and taste as well as its high nutritional value. This fruit is also potential to be commercialized as the fruit itself can be processed into various food products with promising economical value. The plant can be found in most regions in Indonesia, either being cultivated purposefully or being wildly grown. Herwin (2000) mentioned that salak cultivar was categorized based on its flesh texture, peel color, scent and flesh flavor. The difference related these parameters occurred not only among different production center, but also among plant cultivated in the same area or region. This condition indicated a broad genetic diversity due to its high variability on various phenotypes, such as fruit shape, size and peel color.

Several previous studies had characterized the morphology and variability of salak cultivated in some areas in South Tapanuli. However, the correlation analysis of sugar content-related traits of this plant were still less reported. Correlation among traits is defined as the degree of linkage or connection between one certain trait with other traits. Estimation of both genotype and phenotype correlations are required in the planning and evaluation of certain plant breeding program.

Compared to salak cultivated in other regions in Indonesia, salak cultivar originating from Padang Sidempuan is known for its high sugar and water contents. Due to these unique features, salak was found to be a potential source for bioethanol (Fatima, 2013). Regarding the region of its cultivation, South Tapanuli is one of the regencies in Sumatera Utara categorized as perhumid zone whose the regional topography consists of numerous valleys and hills. These geographical features result in steep slopes with highly different altitude among areas. According to Agriculture Office (1996), such a slope topography was suitable for salak cultivation as it provided a good drainage. A striking change of altitude from lowland to highland serves a favorable environment for salak cultivation due to its shallow rooting system which is sensitive towards drought and water flooding.

This present study was aimed to evaluate the phenotypic variability and correlation of sugar content-contributing traits of salak found in several areas of South Tapanuli representing different level of altitude. The results of this study provide the useful information regarding the level of variability on the phenotypes of salak planted in different areas of South Tapanuli. These data can be used as a reference for the determination of an appropriate breeding program of salak, thus enable the development of superior varieties of salak in the future.

II. MATERIALS AND METHODS

This research was carried out using the survey method where the samples were purposively collected. This research was conducted from April to June 2017 in local salak farms located in three subdistricts of South Tapanuli which represented different altitudes. Subdistrict South Angkola (200-400 m asl) represented low land, while subdistrict West Angkola (400-800 m asl) and subdistrict Marancar (800-1100 m asl) represented mid and highlands.All collected samples were observed carefully to identify both qualitative and quantitative data. Analysis of these data were proccessed using NTSys 2.02 before being subjected into variability and similarity analysis.

Phenotypic variability among samples wasdetermined using this following formula:

$$S^2 = \frac{\sum[(xi - \dot{x})^2]}{n-1}$$

where *S2* was symbolized variability, *xi* was first observation value,$\dot{x}$ was average of observation values and *n* was number of samples observed.

The scoring of this variability was characterized according to the criteria proposed by Pinaria (1995). A phenotype with broad variability would reveal the value of variability which is two-fold higher than the value of standard deviation, vice versa. The determination of standard deviation value was performed using this following formula:

$$Standard\ deviation\ (SD) = \sqrt{S^2}$$

Similarity analysis was aimed to assess the possible genetic relationship among samples. Additionally, correlation analysis was also performed using simple correlation coefficient proposed by Pearson through this following formula:

$$r = \frac{\sum(Xi - X)(Yi - Y)}{\sqrt{\sum((Xi - X)^2(\mathrm{Yi} - \mathrm{Y})^2)}}$$

If the value of calculated *r* is lower than the value of table *r*, it means no correlation among traits, vice versa. If the table is unavailable, hence T-test could be performed using this following formula:

$$calculated\ t = \frac{r}{SE\ (r)}$$

$$SE = \frac{\sqrt{1-r^2}}{n-2}$$

If the value of calculated *t* is lower than value of table *t*, it means no correlation.

III. RESULTS AND DISCUSSIONS

Field Observation of Salak Morphology

Salak grown in three subdistricts of Tapanuli conferred different characteristic in most of morphological parameters observed (Table 1). Several parameters showed a prominent difference, such as gap among lower leaflets, number of fruit bunch and fruit weight. It indicated that the different geographical topography of these three subdistricts influenced the morphological performance of salak. Plant phenotypes were affected by both genetic and environmental (Murti et al., 2002; Mufida, 2011). Different altitude provided different climate and soil conditions, thus the quality of plant growth would depend on its compatibility with the growing location (Aydin, 2004). In addition, the performance of a morphological parameter could also depend on the performance of other parameters. For instance, the increase of fruit weight was in line with the increase of fruit age. The older the fruit age, the heavier the fruit weight (Santosa and Fauzia, 2011).

Phenotypic Variability of Salak Grown at Different Altitudes

There were 21 quantitative and 16 qualitative traits analyzed for its phenotypic variability among 30 accessions of salak. Regarding the quantitative phenotypes, the variability among those three different subdistricts in South Tapanuli showed a broad variability (Table 2). Unlike quantitative phenotypes, variability of 16 qualitative phenotypes varied according to the phenotype. Nine phenotypes showed a narrow variability, while the remaining phenotypes showed a broad one (Table 3). These results suggested that different geographical altitude altered the developed morphological characters of salak in each subdistrict, thus broadened its phenotypic variability. It also implied that the genetic of these salak plants was possibly highly variable. Moreover, this high phenotypic variability might be associated withits propagation method where salak plant in Padang Sidempuan was mostly propagated generatively through seed.

Variability is defined as the diversity among the characters or phenotype of an individual plant in each population. The variability of a population could be measured through its phenotypes and genetic variability. Phenotypic variability is measurable and clearly observed for certain characters. Unlike phenotypic variability, genetic variability requires special methods and tool to measure as it is invisible. A population showing broad phenotypic variability is not always showing a broad variability on its genetic aspect due to the influence of environmental factors on the performance of a phenotype. Genetic variability is resulted from gene interaction within the

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population (Crowder, 1983).Differ from phenotypic variability, a broad genetic variability would lead to broad phenotypic variability due to the effect of genetic-environment interaction (Swasti, 2006; Putri et al., 2017).

Based on the field observation in three subdistricts of South Tapanuli, salak grown in South and West Angkola exhibited well-developed growth with tall stems, green-colored leaves, large-sized fruit compared to the one in Marancar. It indicated that salak plant preferred the agroclimate condition in low and midland, such as found in West and South Angkola. Salak plant grown in high land (Marancar) showed shorter and smaller stem with more yellowish leaves and smaller fruit.

Table 2. Phenotypic variability of salak grown in three subdistricts of Padang Sidempuan based on the quantitative phenotypes. Salak favored a growing condition at 0 to 700 m asl and the best growth was commonly achieved when it was grown at 0 to 400 m asl. Higher altitude up to 900 m asl was still tolerable, but the growth would be troubled if the altitude was more than 900 m asl. This growth inhibition might result in the difficulty of fruit formation and development (Agrotani, 2016).

Phenotypic Similarity of Salak Grown at Different Altitudes

As seen in Fig. 1, all accessions were highly separated among each other suggesting that salak plants found in Padang Sidempuan were not closely related. This result was also in line with the result of phenotypic variability analysis as most phenotypes observed were broadly diverse. This analysis also showed that those 30 accessions exhibited similarity coefficient ranging from 34-68%based on 21 phenotypes.

Similarity analysis was commonly conducted according to both qualitative and quantitative data. This analysis was purposed to assess the relationship distance and phylogenetic among individuals from the same genus or species (Swasti et al., 2007). The higher the similarity among individuals, the closer the relationship. Supporting this statement, Syukur (2012) proposed that the higher the value of similarity coefficient, the higher the similarity level between the compared individuals.

Correlation Analysis of Salak Sugar Content-Contributing Phenotypes

Salak is known for its high sugar content, thus this commodity has a promising potency to be utilized as an alternative source of bioethanol. However, this trait is greatly influenced by environmental factor, especially the altitude. As seen in Table 4, most of salak accessions from those three subdistricts in South Tapanuli conferred high sugar content ranging from 15-20 °Bx (Brix).

Regarding the difference of altitudes where these salak accessions were found, it seemed that different altitude did not give much significant effect on the sugar content of salak grown in all locations observed (Table 4).

Moreover, although the altitude difference was significantly different, but the climate (temperature and light intensity) and soil (pH) conditions did not differ very much among those three subdistricts representing low, mid and highlands (Table 4).Sugar content in a plant part is greatly affected by the climate condition. Geographical difference is usually followed by overall climate and weather differences, particularly temperature, humidity and rainfall. These climatic elements are generally depended on the altitude, latitude position, distance from the sea, topography, soil condition and vegetation. Besides the environmental factor, the appearance or performance of a certain phenotype could be affected by the appearance or performance of other phenotypes. In this case, the sugar content of salak plant from those three areas showed low correlation with several phenotypes in other plant parts, such as fruit and leaf. As seen in Table 5, significant correlation was shown in the interaction of sugar content-number of leaf (0.805) and sugar content-number of fruit bunch (-0.667). However, some phenotypes exhibited no correlation at all with the performance of sugar content-contributing phenotypes.

Table 5 also showed that the correlation between sugar content-contributing phenotype and other morphological phenotypes were varied among locations. It indicated that different geographical topography affected the performance of those morphological phenotypes, hence its effect on the sugar content-contributing phenotype was also varied. It also implied that the performance of the sugar content-contributing phenotypes was quite dependent on the vegetative growth of salak. Value of correlation coefficient is commonly used to determine the level of resemblance in the variability among parent plants and its progenies. This value is useful as a refere

IV. FIGURES AND TABLES

Table.1. Difference of morphological characteristics of salak grown in three different altitudes in South Tapanuli.

Morphological Parameters	Location of Sample Collection		
	South Angkola (low land)	West Angkola (mid land)	Marancar (high land)
Plant height (m)	4.54	5.55	5.26
Stem color		Brown	
Leaves			
Gap among upper leaflets (cm)	3.95	3.48	2.71
Gap among middle leaflets (cm)	6.56	7.56	7.57
Gap among lower leaflets (cm)	9.31	14.54	13.43
Main color of leaf buds	Brown (8 accessions)	Brown (9 accessions)	Brown
Color of leaf upper surface		Green	
Color of leaf bottom surface		Gray	
Leaf color		Grayish green	
Inflorescence			
Position of inflorescence		Positioned in leaf axil (axillary)	
Color of flower bundle		Brown	
Inflorescence color		Pink	
Duration of flower anthesis		3-4 days	
Fruit			
Number of fruit bunch per plant	4	1	
Fruit weight (g)	113	30	
Flesh color		Yellowish white with red spots	

Table.2: Phenotypic variability of salak grown in three subdistricts of Padang Sidempuan based on the quantitative phenotypes

Phenotypes	Mean	S^2*	SD**	2 SD	Variability Spectrum
Plant height (m)	307.33	8.29	0.86	0.74	
Leaflets					
Gap among leaflets (cm)					
Upper	278.67	7.17	0.62	0.38	
Middle	532.33	39.97	0.95	0.90	
Lower	426	126.03	2.27	5.17	
Number of leaflets per leaf	761	896.89	6.65	44.28	
Leaflet length (cm)	547	1790.36	7.06	49.88	
Leaflet width (cm)	347.1	932.86	4.79	22.94	
Leaves					
Leaf length	58.63	5.51	0.53	0.28	
Number of leaf	87.73	29.43	1.24	1.53	
Spines					Broad
Spine length	91.3	44.26	1.46	2.14	
Spine width	135.77	22.57	1.11	1.24	
Female inflorescence					
Length of flower bundle	345.67	678.674	6.12	37.45	
Female inflorescence panicle	28.33	10.39	0.75	0.56	
Length of female inflorescence panicle	266	2040.19	9.69	93.98	
Length of female inflorescence	170.67	738.50	6.11	37.30	
Anthesis of female inflorescence	033.33	3.44	0.43	0.182	

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Fruits				
Number of fruit bunch	13.58	35.98	3.32	6.63
Fruit weight (g)	313.99	16858.70	78.27	156.54
Flesh thickness	7.81	473.05	0.97	1.95
Seed size	5.17	4.36	3.79	7.575
Seed weight	32.94	107.45	6.05	12.10

Table.3: Phenotypic variability of salak grown in three subdistricts of Padang Sidempuan based on the qualitative phenotypes.

Phenotypes	Range	Mean	S^{2*}	SD**	2 SD	Variability Spectrum
Stem color	Dark brown	Dark brown	0	0	0	Narrow
Leaves						
Main color of leaf bud	Brown, yellow	Brown	0	0	0	
Color of leaf upper surface	Green, dark green	Green	0	0	0	Narrow
Color of leaf bottom surface	Gray, light gray	Gray	0	0	0	
Leaf color	Green, grayish green	Grayish green	188.55	1.44	2.89	Broad
Spines						
Spine color	Black, grayish black	Black	0	0	0	
Spine position on leaf	Single, clustered into 3	Clustered into 3	0	0	0	Narrow
Spine density	Dense, quite dense	Dense	10.15	1.00	2.00	Broad
Inflorescences						
Inflorescence color	Pink	Pink	0	0	0	
Inflorescence position	Leaf axil	Leaf axil	0	0	0	Narrow
Flower bundle	Brown	Brown	0	0	0	
Fruits						
Fruit shape	Round, spherical round	Spherical round	191.34	1.36	2.73	
Peel color	Brown	Brown	56.42	2.36	4.72	
Flesh color			27.12	1.75	3.50	Broad
Seed shape			15.81	1.21	2.43	
Seed color			24.77	1.12	2.25	

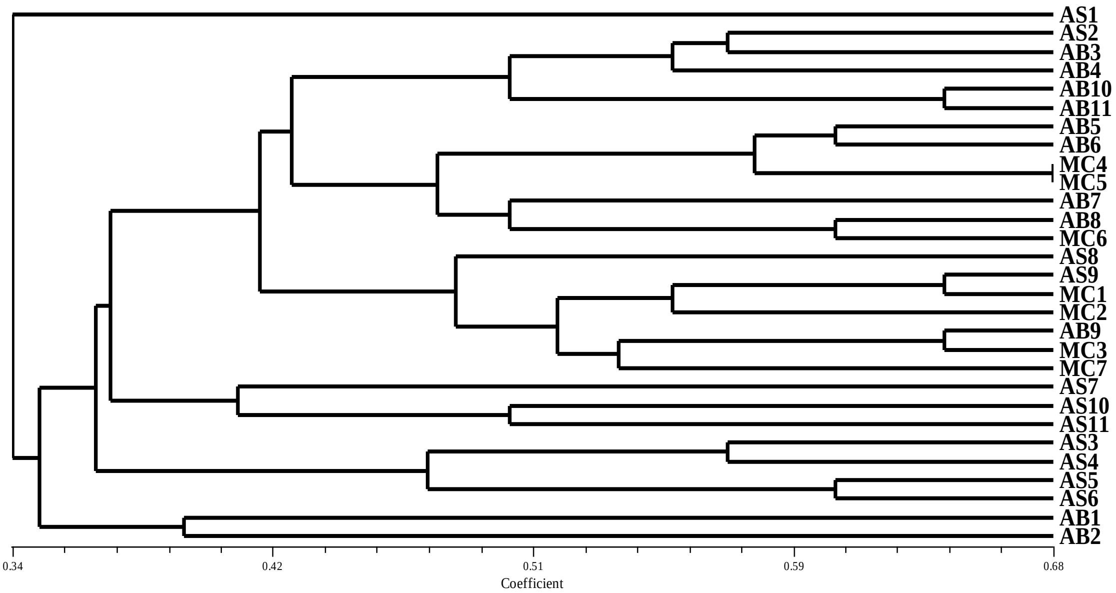

Fig.1: Dendogram of similarity based on quantitative and qualitative phenotypes of all salak accessions. AS, accessions from South Angkola; AB, accessions from South Angkola; MC, accessions from Marancar

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Table.4: Effect of the environmental condition differences in the sugar content of salak grown in different locations.

Location/Accession	Sugar content (ºBx)	Altitude (m asl)	Soil pH	Temperature (ºC)	Light intensity (%)
South Angkola					
AS1	20.0	218	6.2	29.3	69
AS2	19.0	221	6.2	29.3	66
AS3	18.0	356	5.0	31.0	68
AS4	20.0	355	5.0	32.0	68
AS5	17.0	363	5.3	30.0	69
AS6	18.0	365	5.4	30.0	69
AS7	18.4	350	6.0	27.0	68
AS8	16.3	351	6.1	28.0	70
AS9	17.1	406	6.5	29.0	68
AS10	19.1	400	6.1	29.0	67
AS11	18.3	420	6.1	29.0	74
West Angkola					
AB1	16.1	516	6.0	29.0	66
AB2	14.4	515	6.1	28.0	64
AB3	19.0	731	6.2	28.0	67
AB4	19.1	732	6.3	28.0	67
AB5	16.0	613	6.2	30.0	69
AB6	18.2	615	6.1	31.0	71
AB7	17.0	650	6.5	27.0	68
AB8	15.2	650	6.5	28.0	70
AB9	16.0	671	6.1	29.0	68
AB10	14.3	669	6.1	29.0	67
AB11	17.2	672	6.1	29.0	74
Marancar					
MC1	16.2	965	6.0	29.0	66
MC2	14.4	966	6.1	28.0	64
MC3	19.0	970	6.2	28.0	67
MC4	19.1	971	6.3	28.0	67
MC5	16.0	985	6.2	30.0	69
MC6	18.2	986	6.1	31.0	71
MC7	17.0	990	6.5	27.0	68
MC8	15.2	988	6.5	28.0	70

Table.5: Correlation between sugar content-contributing phenotype and other morphological phenotypes of salak grown in three subdistricts of South Tapanuli

Phenotypes	Correlation coefficient with sugar content-contributing phenotype in each location		
	South Angkola	West Angkola	Marancar
Plant height	0.344	0.229	-0.071
Number of fruit bunch	-0.667*	0.201	0.073
Leaflet length	0.255	0.385	0.391
Leaflet width	0.023	0.567	-0.345
Number of leaf	-0.152	-0.100	0.805*
Fruit weight	0.255	0.385	0.391
Flesh thickness	0.491	-0.314	0.089
Peel color	0	0	0
Flesh color	0	0	0

Fruit shape	0	0	0
Seed shape	0	0	0
Fruit color	0	0	0
Seed color	0	0	0

V. CONCLUSION

Based on the results obtained, the variability coefficient among salak accessions from those three subdistricts resulted in 34-68%, suggesting that salak diversity in South Tapanuli (Padang Sidempuan) was considered as broad spectrum variability. Regarding its sugar content, the difference of geographical topography where all those accessions were found did not affect the sugar content as it had been naturally high sugar content. Most accessions in all locations conferred more than 15 °Bx sugar content.

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Nematophagous fungi: *Metarhizium anisopliae*

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Abstract— *Plant-parasitic nematodes are major pests affecting many economically important crop productions throughout the world. Some chemicals are widely used against the phytonematodes. Because of hazardous effects of these compounds on human beings, animals and on the environment, there is a need to develop other control strategies. Biocontrol of phytonematodes is an important method among environment-friendly measures of nematode management. There are some soil-inhabiting fungi that have biocontrol potential on phytonematodes, which can be used for nematode management. The fungus Metarhizium anisopliae, originally is an entomopathogenic bioagent has been utilizing as bionematicides. The fungus produces some secondary metabolite which may play a role in pathogenicity. Biocontrol potential of this fungus on some phytonematodes has been reported and its utilization is a major approach towards sustainable and environment friendly agricultural production.*

Keywords— Plant-parasitic nematodes, bionematicides, nematophagous fungi, Metarhizium anisopliae, entomopathogenic fungi.

I. INTRODUCTION

Plant parasitic nematodes are one of the major factors limiting the productivity of many agricultural crops (Luc *et al.*, 2005). The majority of the synthetic chemical nematicides are being banned in the market because of their hazardous effect on human beings and animals (Ghazalbash and Abdollahi, 2011). Therefore there is a need for sustainable, effective, and environmentally acceptable nematode management options (Sikora and Fernandez, 2005). Large numbers of organisms including fungi, bacteria, viruses, insects, mites and some invertebrates have been found to invade or prey on the nematodes (Stirling, 1991). Some soil inhabiting fungi are pathogenic to some pests of plants, including insects and nematodes (Dijksterhuis *et al.*, 1994). Fungi have a significant association with nematodes in rhizosphere and thus, they can constantly reduce the population of nematodes in nearly all soils in different geographical areas (Siddiqui and Mahmood, 1996). Although more than 70 genera and 160 species of fungi have been associated with nematodes, only a few of them are known as nematophagous fungi (Duddington, 1994). Fungi can directly parasitize nematodes (Holland *et al.*, 1999; Olivares Bernabeu and Lopez-LIorca, 2002; Chen and Chen, 2003; Fatemy *et al.*, 2005) or secrete nematicidal metabolites and enzymes that affect nematode viability (Cayrol *et al.*,1989; Nitao *et al.*, 1999; Chen *et al.*, 2000). These active compounds have the potential for being applied as novel nematicides (Meyer *et al.*, 2004).

II. NEMATOPHAGOUS FUNGI: *METARHIZIUM ANISOPLIAE*

Metarhizium anisopliae, the agent of green muscardine disease of insects, formerly known as *Entomophthora anisopliae* (basionym) (Metschnikoff, 1879), is a fungus that grows naturally in soils throughout the world and causes disease in various insects by acting as a parasitoid. It is the most important entomopathogenic fungus (Richards and Rogers, 1990; Driver *et al.*, 2000; Liu *et al.*, 2007; Hoe *et al.*, 2009). *Entomophthora anisopliae*, later on renamed to *M. anisopliae* by Sorokin (1883). The fungus has mass growth on artificial culture media and produces abundant conidia, but the conidia only germinates in contact with their host (Farashiani *et al.*, 2011).

III. MODE OF ACTION AND EFFECTS ON NEMATODES

The exact mode of action of *M. anisopliae* on nematodes is still unknown but it is likely similar to other fungi with sticky spores or conidia. The conidia germinate, parasitize and kill the cadaver, by direct penetration and producing the infective hyphae inside the nematode body. Prior to any direct attack to the host, the fungus produces destruxin A and destruxin B that can kill the host (Roberts, 1966). Kershaw et al., 1999 and Hsiao and Ko (2001) reported that this fungus produces some cyclic peptides, destruxins which may play a role in its pathogenicity. There are a few reports on impact of *M. anisopliae* on nematodes. Biological control of sugarcane nematodes using *Penicillium oxalicum* and *M. anisopliae* has been studied by Zorilla (2001). He has reported the significant inhibitory effect of *M. anisopliae* on the studied nematode population. The effect of this fungus against *Rotylenchulus reniformis* have been reported by Tribhuvaneshwar *et al*., (2008). They have reported that application of this bioagent reduced the final population of this plant parasitic nematode as well as some species of free-living nematodes. In a survey in Boyer-Ahmad region in Iran, some naturally infected nematodes to *M. anisopliae* were observed (Ghayedi and Abdollahi, 2013).They purified the isolated fungus and also they showed the biocontrol potential of the isolate on J_2s of *Heterodera avenae*, with 47.1% parasitization. Biocontrol potential of *M.anisopliae* against some species of root knot nematodes has been shown (Jahanbazian *et al*., 2014; Jahanbazian *et al*., 2015). Greenhouse investigations showed that both bioagents *Trichoderma harzianum* and M. *anisopliae* caused significant decrease in nematode related factors including root gall, but the inhibition in root galling of tomato was more in case of *M. anisopliae* (Khosrawi *et al*.,2014).

IV. BIO-PRIMING EFFECTS OF *M. ANISOPLIAE*

The capability of microorganism to colonizing the roots of plant is an important factor to have the promoting power (Schroth and Hancock, 1982). Some species of *Metarhizium* are attracted to roots of certain plant species (Wang and St Leger, 2007) and has root colonization ability (Bruck, 2005). Conidial germination and different rates of root colonizing by *M. anisopliae* isolates, has been reported (Elena *et al*., 2011; Sassan *et al*., 2012). Even some isolates of *M. anisopliae* have endophytic behavior (St. Leger, 2008). Bio-priming effects of *M. anisopliae* on germination and seedling growth of flax seed have been shown by Bakhit *et al*., (2015). The number of galls, egg masses and eggs of *M.javanica* were reduced in tomato roots by soil application of *M. anisopliae* spore suspension along with oak debris. The tomato roots have been colonized by *M.anisopliae* and the rate of nematode penetration to the roots was declined. Based on their reports, the growth of infected tomato plants has been improved after application of *M. anisopliae* (Abdollahi, 2018).

V. CONCLUSION

For a sustainable nematode management we have to isolate, mass produce and formulate the virulent strains of *Metarhizium anisopliae* which are environment friendly as well as cost effective. In near future *M. anisopliae* will provide a promising bionematicide which in turn improve plant growth and increase crop yield.

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Validation and sensitivity analysis of InfoCrop simulation model for growth and yield of Indian mustard varieties at Allahabad

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Abstract— *Field experiment was carried out at SHUATS, Allahabad, to study validation and sensitivity analysis of InfoCrop model with the data sets generated respectively during Rabi season of 2016-17. The main plot treatments and sub-plot treatment consisted three dates of sowing and cultivars (D_1-25th October, D_2-5th November and D_3-15th November) and (V_1- Parasmani, V_2- Varuna and V_3- SRM 777) using split plot design. The results revealed that simulation of growth and yield parameters were compared with observed data and results concluded that the model overestimates all the parameters within the acceptable range (<15%) with significant accuracy. Sensitivity analysis results indicated that increased in maximum and minimum temperature (1 ºC above and below); increase in rainfall 10 to 20 percent; elevated CO_2 from 390 to 490 ppm shows significant increase in seed yield but after beyond it adversely affect seed yield. Therefore, the validated InfoCrop can be used for prediction of phenology, estimates potential yield and it provide management option in resilience towards changing climatic conditions.*

Keywords— ***InfoCrop model, Indian mustard, Climate change, Validation, Sensitivity analysis.***

I. INTRODUCTION

Rapeseed-mustard (*Brassica spp*.) is a major group of oilseeds crop of the world being grown in 53 countries across the six continents, Indian mustard (*Brassica juncea*) is the second important oilseed crop in India after groundnut sharing 27.8% in India's oilseed production. Indian-mustard is much sensitive to climatic variables; hence, climate change could have a significant effect on its production. One month delay in sowing from mid-October resulted in the loss of 40.6 percent in seed yield (Lallu, *et al*., 2010). Weather parameter is very important which influence growth and yield of a mustard crop, therefore, largely governed by the change in growing environment such as date of sowing and water availability. Leaf area index plays an important role for crop growth based on its interception and utilization of PAR (Photosynthetically active radiation) for producing dry matter (Kumar *et al*., 2007) and with the delay in planting date, the higher mean temperature was experienced during flowering which led to accelerating the decrease of LAI and reduction of the flowering period (Poureisa and Nabipour, 2007).

According to IPCC assessment report (AR_4), global average temperature has increased by 0.74 ^{0}C over the last 100 years and projection of an increase in temperature about 1.8 to 4 ^{0}C by 2100. Global losses may account for 1 to 5 percent of GDP, but developing countries with tropical and sub-tropical climate are likely to suffer more losses. Temperature increases are likely to be higher during winter season and precipitation is likely to decrease (IPCC, 2007). IPCC and its global studies indicate that considerable probability of loss in crop production in India with increases in temperature (IPCC, 2014). InfoCrop simulation model is one of the user-friendly systems, dynamic crop growth model developed under Indian condition. This model has the capability to estimate the actual and potential yield, yield gaps and also to assess the impacts of climate variability and climate change. The model simulates the crop growth processes viz., phenology, photosynthesis, respiration, leaf area growth, assimilates partitioning, source-sink balance, nutrient uptake partitioning and transpiration (Aggarwal *et al*. 2006). InfoCrop model has been used for simulating potential rain-fed yields. It is used to optimize management, dates of planting, variety, irrigation and nitrogen fertilizer, assessing interactions among genotype, environment, management, and pests, yield forecast, yield loss assessment due to pests and greenhouse gas emissions (Aggarwal *et al*. 2004).

Study of the impact of climate change on crops needs simulation model, as it provides a means to quantify the effects of climate, soil, and management on crop

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growth, productivity and sustainability of agricultural production. These tools can reduce the expensive and time-consuming field experimentation as they can be used to extrapolate the results of research conducted in one season or location to another season, location, or management (Boomiraj *et al*. 2007). Boomiraj *et al*. (2010) observed that model can successfully simulate growth and yield of the mustard crop across different locations in India. The simulated yield of mustard was found to be sensitive to changes in atmospheric CO_2 and temperature variation. The objectives of this study, to quantify InfoCrop model on the mustard crop at Allahabad conditions, which show considerable potential to evaluate crops, varieties, and genotypes of mustard, cropping pattern and genetic potential for yield. The scientific information on simulation of growth and yield in mustard crop using modeling in Uttar Pradesh is lacking. Hence, keeping in view the importance of the study, the present investigation was carried out.

II. MATERIALS AND METHOD

Experimental Details

The experimental field data (2016-17) of Allahabad station comprising three dates of sowing (Rabi: D_1-25th Oct., D_2-5th Nov. and D_3-15th Nov.) and varieties (V_1- Parasmani, V_2- Varuna and V_3- SRM 777) through the field experiment laid out split-plot design was used for model calibration and validation. The package and practices for Indian mustard cultivation were followed as per the Sam Higginbottom University of Agriculture, Technology, and Sciences, Allahabad. Validation of model was performed by using different data sets on such as phenology, total dry matter, grain yield, harvesting index and test weight from the field experiment conducted at Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad.

InfoCrop v.2.0 model

InfoCrop is a dynamic crop-yield simulation model. This model was developed by Aggarwal (2009) at Center for Application of Systems Simulation, IARI, New Delhi. The inputs required for InfoCrop v. 2.0 model are listed separately in Table 1.

Calibration of the model

The models were run and validated by comparing the predicted output with observed parameters. Deviation of predicted from observed was calculated and accuracy of the model to predict different crop parameters was quantified, then the simulated was for the further study. The genetic coefficient of mustard for InfoCrop model is given in Table 2.

Validation

Validation of model will be performed by using different data sets on phenology, biological yield, seed yield, harvesting index and test weight from experiments conducted at Research farm, School of Forestry and Environment, SHUATS, Allahabad. For judging the performance of the InfoCrop model, validation results on major crop growth parameters such as phenology during crop growth and grain yield will be tested using various statistical parameters viz., mean absolute error (MAE), mean bias error (MBE), root mean square error (RMSE), and error %.

$$MAE = \sum_{i=1}^{n} [1P_i - O_i 1]/n$$

$$MBE = \sum_{i-1}^{n} [P_i - O_i]/n$$

$$RMSE = \left[\sum_{i=1}^{n} (P_i - O_i)^2 / n \right]^{1/2}$$

Error % = {(P – O) / O} * 100

Where, O = observed, P = simulated.

Sensitivity analysis

Sensitivity analysis are used to simulate the impact of change in maximum temperature (T_{max}) and minimum temperature (T_{min}), seasonal rainfall and elevated CO_2 concentration within a range of ±5 °C, ±10 % and 415 to 640 ppm, respectively, on the seed yield of three varieties of Indian mustard (*Brassica juncea*) *viz.* SRM 777, Varuna and Parasmani in context of changing climatic conditions.

III. RESULTS AND DISCUSSION

Validation of Info Crop model

The model was calibrated and simulated in different plots of Parasmani, Varuna and SRM 777 in both sowing dates and season. Validation of model performed by different data sets on phenology, total dry matter, grain yield, harvesting index and test weight were simulated. Test criteria for various parameters of Mustard cv. SRM 777, Varuna and Parasmani using InfoCrop model during 2016-17.

Phenology

Test criteria of Phenology of mustard varieties using InfoCrop model during 2016-17 are presented in Table 3.

Days to start flowering (days)

The observed mean values of days to start flowering for three mustard cv. Parasmani, Varuna and SRM 777 were 37.33, 44.6 and 45.0, whereas the model simulated 39.67, 48.67 and 49.67 days respectively. Different test criteria involving difference measures to locate and quantify errors viz. MAE, MBE, RMSE, and PE computed for mustard varieties suggested that model was better for SRM 777 followed by Varuna and Parasmani for simulation of days to start of flowering. The mean percent error was observed higher for cv. SRM 777 (10.04) followed by Varuna (6.30) and Parasmani (5.06). This shows that model simulation was found better for cv. SRM 777 as compared to others in case of simulation of days to start flowering (days). Similar 41trend was observed for other test criteria for days to start flowering such as MAE, MBE, and RMSE. This clearly showed that model performance was found good for SRM 777 as compared to Varuna and Parasmani for simulation of days to start flowering. However, model overestimated the days to start flowering (days).

Days to maturity (days)

Days to maturity for Parasmani, Varuna and SRM 777 were observed as 144.33, 145.63 and 149.00 days while model simulated 150.67, 149.67 and 143.00 days, respectively. SRM 777 performed better and the model overestimated the days to maturity. The average percent error was overestimated by the model for mustard varieties. The mean percent error was observed higher for cv. SRM 777 (4.88) followed by Varuna (4.67) and Parasmani (4.71). This show that day to maturity simulation was found good for cv. SRM 777. The similar trend was observed by carrying out other tests such as MAE, MBE, and RMSE for days to maturity. The simulation performance of the model in respect of days taken to maturity was found good with an acceptable level.

Growth and yield parameter

Test criteria for growth and yield of mustard varieties using InfoCrop model during 2016-17 are presented in Table 4.

Test weight

The test weight obtained for cv. Parasmani, Varuna and SRM 777 were 4.66, 4.75 and 4.95 g, while model simulated higher values *i.e.* 5.91, 5.34 and 6.57 g, respectively. The average percent error for test weight was found 5.56 (Parasmani), 4.42 (Varuna) and 3.14 (SRM 777), respectively. The evaluation of MAE and MBE was found lower for cv. SRM 777 followed by Varuna and Parasmani except for MBE of SRM 777, respectively, but cv. Parasmani holds higher RMSE (0.57) values as compared to Varuna (0.42) and SRM 777 (0.51). The overall performance of test weight simulation was found under accepted range; however model overestimated the test weight.

Seed yield

The grain yield obtained for cv. Parasmani, Varuna, and SRM 777 were 1138.23, 121.32 and 1284.4 kg ha^{-1} while model simulated higher yield *i.e.* 1382.67, 1465.67 and 1451.67 kg ha^{-1} respectively. The test criteria computed by MAE, MBE, RMSE, and PE for both the cultivars suggested model performance was better for SRM 777 as compared to Varuna and Parasmani. The average percent error for grain yield of both the cultivars was overestimated by the model. The average percent error for grain yield was found 4.96 (SRM 777), 10.58 (Varuna) and 8.60 % (Parasmani), respectively. The mean percent error was found lower for SRM 777. The average error as computed by MAE (101.33), MBE (102.33) and RMSE (58.27) found lower for SRM 777 as compared to other cultivars. This shows that the evaluation of the model on an overall basis revealed that the yield simulation was found good with an acceptable level for mustard.

Biomass yield

The performance parameters for cv. SRM 777 was higher than Varuna and Parasmani for simulated biomass yield. The average percent error of biomass yield of all varieties was overestimated by the model. The average percent error for biomass yield was found 10.18 (SRM 777), 12.62 (Varuna) and 11.43 % (Parasmani), respectively. The average error as computed by MAE (1320.0), MBE (1320.0) and RMSE (1473.25) found lower for Parasmani as compared to other varieties. The biomass yield simulation was found good with an acceptable level for mustard.

Harvesting Index

The model performance in a simulation of Harvest Index was found good for cv. SRM 777(0.87 error %) as compared to Varuna (1.38 error %) and Parasmani (8.19 error %). More or less similar results were obtained in terms of other test criteria such as MAE, MBE, and RMSE for simulation of harvest index. Model underestimated the simulation results for cv. SRM 777 and Varuna and overestimated for Parasmani. Model performance was found good for cv. SRM 777 compared to other cultivars for HI simulation.

Sensitivity analysis

The increase in CO_2 concentration from 390 to 490 ppm enhanced the crop yield. Increase in CO_2 from 390 to 490 ppm with no change in temperature has resulted in 13–32 % increase in yield of mustard but further increase in CO_2 concentration reduced the percent increase in yield. Increase in rainfall during crop season, indicated the scope for improved dry matter production and increase in grain number.

Temperature

The increased in daily maximum temperature up to 3 °C resulted in increased in yield of mustard (figure 1). In plants, warmer temperature accelerates growth and development leading to less time for carbon fixation and biomass accumulation before seed set resulting in poor yield (Rawson, 1992; Morison, 1996). Similar results were supported by Singh *et al*. (2008), Easterling *et al*. (2007), Roy *et al*. (2005), Fischer *et al*. (2007), Mall *et al*. (2004), Long *et al*. (2006), Morrison and Stewart (2002), Chaudhari *et al*. (2009), Kumar *et al*. (2010), Bhagat *et al*. (2007) and Aggarwal *et al*. (2006).

The highest benefits in increased in yield was obtained by increasing minimum temperature from 2 °C above and -1 °C below from the crop season 2016-17. Similar results were supported by Singh *et al*. (2008), Easterling *et al*. (2007), Kumar *et al*. (2010), Chaudhari *et al*. (2009).

Rainfall

The increase in rainfall (10 to 20 percent from the crop season 2016-17). It simulated the increased yield but after beyond it adversely affected crop growth and yield (figure 1). Similar results were reported by earlier workers Mall *et al*. (2004) and Singh *et al*. (2008).

CO_2 concentration

CO_2 concentration elevated 390 to 490 ppm from the present CO_2 concentration. It showed the positive impact on yield. An increase in crop yield in mustard crop after 490 ppm of CO_2 concentration, it produced warming effect which results decline in yield (figure 1). Similar results were reported by earlier workers Uperty *et al*. (2003), Rotter and Van de Geijn (1999).

IV. CONCLUSIONS

Simulation of mustard phenology, growth and yield attributes by InfoCrop model was within the acceptable limit. Therefore, the validated InfoCrop model can further be used for prediction of crop growth, phenology, potential and actual yield of the mustard crop under changing climate scenarios.

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Table.1: List of inputs required for InfoCrop

Input variables	Acronyms	Unit
Site data		
Latitude	LAT	Degree
Longitude	Long	Degree
Altitude	Alt	Meter
Daily weather data		
Date/year	dd-mm-yy	
Station number		
Julian days	JD	Days
Solar radiation	RDD	KJ m^{-2}
Maximum temperature	TMAX	°C
Minimum temperature	TMIN	°C
Vapour pressure	VP	K Pa
Wind Speed	WDST	$msec^{-1}$
Rainfall	TRAIN	Mm
Relative humidity morning	RHMIN	%
Soil texture/district master parameters		
pH of soil	PHFAC	
Electrical conductivity	EC	ds/m (0 to 1)
Slope	SLOPE	%

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Thickness of layer	TKL	Mm
Sand content	SAND	%
Silt content	SILT	%
Clay content	CLAY	%
Saturation fraction	WCST	0 to 1
Field capacity fraction	WCFC	0 to 1
Wilting point fraction	WCWP	0 to 1
Saturation hydraulic conductivity	KSAT	mm/day
Bulk density	BDL	mg/m^3
Organic carbon	SOC	%
Soil moisture fraction at sowing	WCL	0.1 to 0.4
Initial soil ammonium	NHAPL	(1 to 40 kg/ha)
Initial soil nitrate	NOAPL	(1 to 50 kg/ha)
Crop data		
Crop name		
Input sowing depth	SOWDEP	Cm
Input seed rate	SEEDRT	kg ha^{-1}
Maximum possible crop duration		
Default sowing date	DATEB	Julian days of the year
Crop/variety management data		
Thermal time for germination	TTGERM	degree day
Thermal time for seedling emergence to anthesis	TTVG	degree day
Thermal time for anthesis to maturity	TTGF	degree day
Base temperature	TGBD	°C
Optimum temperature	TOPT	°C
Maximum temperature	TMAX	°C
Relative growth rate of leaf area	LAII	°C/d
Specific leaf area	SLAVAR	m^2/mg
Index of greenness of leaves		Scale 0.8 to 1.2
Extinction coefficient of leaves at flowering		ha soil/ha leaf fraction
Radiation use efficiency	RUE	g/MJ/day
Root growth rate	RWRT	mm/d
Sensitivity of crop to flooding	FLDLCRP	Scale 1 to 1.2
Index of nitrogen	NI	Scale 0.7 to 1.0
Slope of storage organ number/m^2 to dry matter during storage organ formation	SOPOT	Storage organ/kg/day
Potential storage organ weight	POTGWT	mm/grain
Nitrogen content of storage organ	NUPTK	Fraction
Sensitivity of storage organ setting to low temperature	TPHIGH	Scale 0 to 1.5
Sensitivity of storage organ setting to high temperature	TPLOW	Scale 0 to 1.5

Table.2: Categorization of genetic coefficient of mustard for InfoCrop v.2.0 model

Genetic constant description	Acronyms	Unit
Thermal time for germination to emergence	TTGERM	degree day
Thermal time for seedling emergence to anthesis	TTVG	degree day
Thermal time for anthesis to maturity	TTGF	degree day
Specific leaf area of variety	SLAVAR	Fraction
Maximum number of grains per hectare	GNOMAX	grains per hectare

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Table.3: Test criteria of mustard phenology using InfoCrop model during 2016-17.

Parameters	**Days to start flowering (days)**			**Days to maturity (days)**		
Variety	PARASMANI	VARUNA	SRM 777	PARASMANI	VARUNA	SRM 777
OMV	37.33	44.6	45.00	144.33	145.63	149.00
SMV	3.06	1.53	1.80	4.51	4.16	4.58
SDo	39.67	48.67	49.67	150.67	149.67	156.33
SDs	5.86	1.52	1.52	7.71	2.51	7.02
MAE	1.03	2.00	3.67	1.33	8.33	4.33
MBE	2.07	4.67	3.67	6.00	3.33	4.33
RMSE	2.10	3.43	4.00	5.52	9.76	7.42
PE	5.06	6.30	10.04	4.71	4.67	4.88

Table.4: Test criteria of yield and its attributes of mustard varieties using InfoCrop model during 2016-17.

Parameters	**Test weight (g)**			**Seed yield (kg/ha)**			**Biomass (kg/ha)**			**HI (%)**		
Variety	PARASMANI	VARUNA	SRM 777	PARASMANI	VARUNA	SRM 777	PARASMANI	VARUNA	SRM 777	PARASMANI	VARUNA	SRM 777
OMV	4.66	4.75	4.95	1138.23	1214.32	1284.4	9891.0	10067.67	13186.0	11.50	12.58	13.47
SMV	0.88	0.88	0.89	396.99	396.11	400.56	1379.74	1389.25	1388.16	1.04	0.96	0.71
SDo	5.91	5.34	6.57	1382.67	1465.67	1451.67	10211.0	11313.33	12335.67	12.63	12.76	15.15
SDs	1.09	0.63	0.46	365.84	43.24	31.0	2181.04	1470.74	1300.63	0.40	1.76	0.22
MAE	0.50	0.35	0.31	209.0	105.67	101.33	1320.0	1245.67	1449.67	0.11	0.47	-0.87
MBE	0.50	0.35	0.38	209.0	105.67	102.33	1320.0	1373.67	1449.67	1.09	1.38	0.87
RMSE	0.57	0.42	0.51	220.51	208.05	58.27	1473.25	1649.55	1463.98	1.18	1.66	0.95
PE	5.56	4.42	3.14	8.60	10.58	4.96	11.43	12.62	10.18	1.96	4.19	3.31

Where OMV: observed mean value, SMV: simulated mean value, SDo: standard deviation of observed, SDs: standard deviation of simulation, MAE: mean absolute error, MBE: mean bias error, RMSE: root mean square error, PE: Percent error.

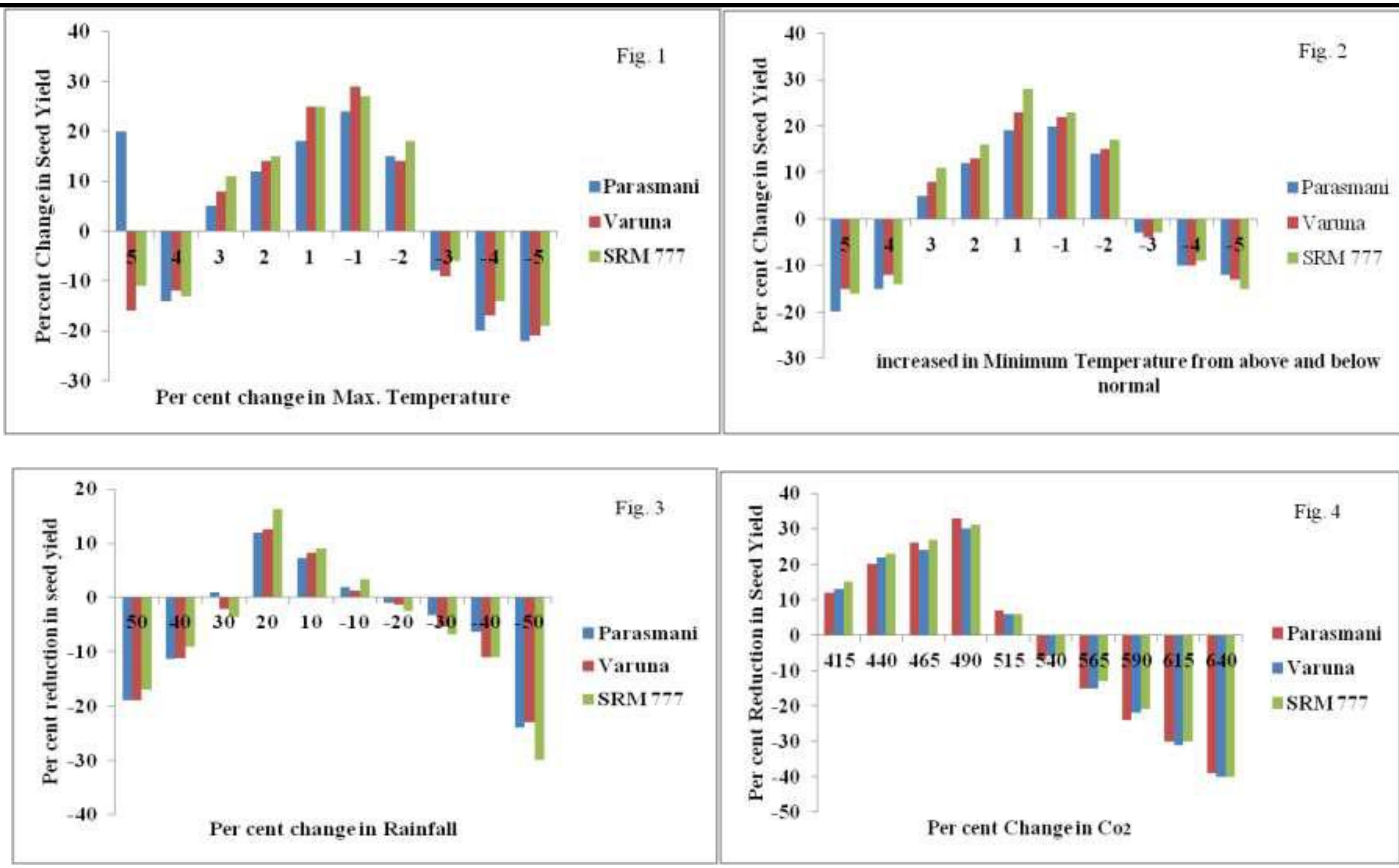

Fig.1: Depicting the InfoCrop simulation results of impact of change in (1) maximum temperature (T_{max}) (2) minimum temperature (T_{min}) (3) seasonal rainfall and (4) elevation in CO_2 concentration on the seed yield of all three varieties of mustard during the Rabi- 2016-2017.

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Floristic Diversity of the Sacred Grove of Madathody Naga Kavu, Chalavara, Palakkad District, Kerala State

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Abstract— *An exploratory survey conducted in Madathody Nagakavu is present in Chalavara Gramapanchayath, Ottapalam taluk of Palakkad district, Kerala lead to the collection of 50 species coming under 49 genera and 25 families. Among them, 6 endemic, rare, and red listed plants are represented here and also including 38 medicinal plants.*
Keywords— Diversity, Madathody Naga kavu, Palakkad.

I. INTRODUCTION

Sacred groves are the conserved forest patches, or protected areas. The sacred groves in Kerala are tightly bound with religional backgrounds. The conservation is mainly based on cultural, aesthetical, and religion aspects, and in different areas these sacred groves are devoted or dedicated for different Gods *ie*. serpentine Gods, Nagadevatha, Nagayakshi etc. Sacred groves are one of the informal approaches of conserving the biological diversity of a region and play an important role in preservation of depleting resource elements such as medicinal plants and occur in India and in other parts of Asia and Africa (Bhandary and Chandrashekar, 2003). According to Nair (1992) in sacred groves the number of herbs and shrubs are reported to be more in the disturbed zone. Due to urbanization and industrialization coupled with rationalization, scarcity of land leading to the depletion of the cover and shrinkage of these areas as a result the large chunk of the areas are diverted for other activities and only a small portion is left with especially adjacent to the temple (Devaraj., *et al* 2005). According to Rajasri Ray *et al*., (2014) sacred groves may lose their prominence nowadays, but are still relevant in Indian rural landscapes inhabited by traditional communities.

A rough estimate Kerala has about 1500 sacred groves, which are distinct and biologically unique. Sacred groves in Kerala are located mainly in Kasargod, Kannur, Kozhikode, Thrissur, Palakkad, Ernakulam and Alappuzha districts. Balasubramanyan and Induchoodan (1999) recorded a total number of 761 sacred groves in Kerala State.

In Kerala the common practice among Hindus to assign a part of their land near the Tharavadu or house as the abode of goddess Durga or serpent god Naga or Shasta and the place is called 'Kavu' or 'Sarpakavu'. People are prohibited from felling trees and even removing a twig is considered as taboo. Apart from conserving biological diversity, sacred groves that are situated in the middle of the human habitation are responsible for conserving water and soil.

II. STUDY AREA

Madathody Naga Kavu is one among this and located near Shornur, Chalavara Grama Panchayath of Palakkad district. The management of this kavu is under the control of Madhathody family. The area is about 36 cent. The deity is Nagam. A mud road splits this kavu in to two parts. The present study conducted in the Madathody NagaKavu has resulted in the collection of 50 taxa of angiosperms coming under 49 genera and 25 families. Out of these, 06 rare, endemic, red listed and taxonomically important species are enumerated here. **(Table 1)**. The voucher specimens are deposited at the Sree Krishna College, Guruvayur.

III. MATERIALS AND METHODS

The Sacred grove was visited during different seasons and two specimens were collected in each species and these were systematically numbered and tagged. Important field observation like, habit, phenology of the plant, colour, texture and smell of leaves, abundance, local names and local uses available were also noted. Each species in fresh condition was critically studied with the

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help of floras like, *Flora of Presidency of Madras* (Gamble, 1915-1936); . The plants were identified with the help of floras and finally by comparing with the reference collections available in the Herbarium of Kerala Forest Research Institute, Peechi. The species were often poisoned, processed and labeled, by standard herbarium methods given by Santapau (1955) and Jain & Rao (1977).

IV. RESULTS AND DISCUSSION

The present study conducted in the Madathody NagaKavu has resulted in the collection of 50 taxa of angiosperms coming under 49 genera and 25 families including 19 herbs, 13 shrubs 10 trees and 8 climbers. Out of 50 species 6 plants are Endemic, 8 Exotic and 38 medicinally important were collected. **(Table 1).**

Table.1: Species recorded from Madathody kavu

Sl. No	Coll. No.	Botanical name	Family	Local name	Habit	System of Medicine	Status
	105	Ichnocarpus frutescens (L.) R.Br.	Apocynaceae		Climber	A, F, S,T , U	
	196	Mikania micrantha Kunth in HBK	Asteraceae		Climber	-	
	190	Merremia vitifolia (Burm.f.) Hall.f.	Convolvulaceae		Climber	F	
	118	Luffa cylindrica (L.) M.J.Roem	Cucurbitaceae		Climber	A, S, T	
	129	Dioscorea bulbifera L.	Dioscoreaceae		Climber	A, F, S, T, U	
	131	Derris scandens (Roxb.) Benth.	Fabaceae		Climber	-	
	207	Asparagus racemosus, Willd.	Liliaceae		Climber	A, F, S, T , U	
	214	Gloriosa superba L.	Liliaceae	Menthonny	Climber	A, F, S, T, U	
	100	Andrographis paniculata (Burm.f.) Wall.ex.Nees.	Acanthaceae	Gopuramthangi	Herb	A, F, H, S, U	
	205	Ageratum conyzoidsL.	Asteraceae		Herb	A, F, S	
	215	Emilia sonchifolia (L.) DC. in Wight	Asteraceae		Herb	A, F, S, U	
	102	Tridax procumbens L.	Asteraceae		Herb	F, S	Exotic
	204	Cleome burmannii Wight &Arn.	Capparidaceae		Herb	-	
	181	Euphorbia thymifolia Linn.	Euphorbiaceae		Herb	A, F , U	
	165	Phyllanthus urinaria, Linn.	Euphorbiaceae		Herb	A, S, U	
	196	Sebastiana chamaelea (L.) Muell.-Arg.	Euphorbiaceae		Herb	F	
	103	Leucas aspera (Willd.) Spreng.	Lamiaceae	Thumba	Herb	A, F, H, S, U	
	176	Osbeckia muralis Naud.	Melastomataceae		Herb	-	Endemic
	108	Mimosa pudica L.	Mimosaceae		Herb	A, F, S, T, U	Exotic
	201	Boerhaavia diffusa Linn.	Nyctaginaceae	Thazhuthama	Herb	A, F, H, S U	
	147	Desmodium gangeticum (L.) DC.	Fabaceae		Herb	-	
	210	Desmodium scorpiurus (Sw.) Desv.	Fabaceae		Herb	-	

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	122	Panicum notatum Retz.	Poaceae		Herb	-	
	128	Sporobolus diander (Retz.) P. Beauv.	Poaceae		Herb	-	
	169	Oldenlandia umbellata L.	Rubiaceae		Herb	-	
	181	Spermacoce latifolia Aubl	Rubiaceae		Herb	-	Exotic
	133	Lindernia ciliata (Colsm.) Pennell.	Scrophulariaceae		Herb	-	
	178	Eupatorium odoratum L.	Asteraceae	Communist pacha	Shrub	F	Exotic
	203	Briedelia scandens (Roxb.) Willd.	Euphorbiaceae		Shrub	F	Endemic
	109	Sauropus androgynous (L.) Merr.	Euphorbiaceae		Shrub	F, S	
	265	Hyptis suaveolens (L.) Poit.	Lamiaceae		Shrub	F	Exotic
	134	Leea indica (Burm.f.) Merr.	Leeaceae		Shrub	A, F, S	
	149	Hibiscus hispidissimus Griff.	Malvaceae		Shrub	A	
	171	Sida rhomboidea Roxb. ex Fleming.	Malvaceae		Shrub	AFSTU	Endemic
	186	Memecylon randerianum SM & MR Almeida	Melastomataceae		Shrub	F	Endemic
	153	Chassalia curviflora (Wall ex Kurz) Thw.	Rubiaceae		Shrub	F	
	101	Ixora coccinea L.	Rubiaceae		Shrub	A, F, S U	
	163	Grewia nervosa (Lour.) Panigrahi	Tiliaceae		Shrub	F	
	166	Triumfetta rhomboidea Jacq.	Tiliaceae		Shrub	F, S, U	
	211	Clerodendrum infortunatum L.	Verbenaceae		Shrub	A, F	
	219	Mangifera indica L.	Anacardiaceae	Mavu	Tree	A, F, H, T, U	
	153	Plumeria rubra L.	Apocyanaceae		Tree	A, F	Exotic
	104	Alstonia scholaris(L.) R. Br.	Apocynaceae		Tree	A, F, H, T, U	
	213	Caryota urens Linn.	Arecaceae		Tree	A, F, S,U	
	125	Cocos nucifera L.	Arecaceae	Thengu	Tree	A, F, S, T,U	
	106	Acacia mangium Willd.	Mimosaceae		Tree	-	Exotic
	174	Artocarpus hirsutus Lam.	Moraceae		Tree	A, F	Endemic
	209	Ficus racemosa L.	Moraceae		Tree	A, F, S, T, U	
	218	Olea dioica Roxb.	Oleaceae		Tree	F, S	Endemic
	169	Gliricidia sepium (Jacq.) Kunth ex Walp.	Fabaceae		Tree	F	Exotic

A: Ayurveda, F: Folk, S: Siddha, U: Unani, H: Homoeopathy, T: Tibetan, M: Modern.

V. CONCLUSION

Sacred groves are considered as store house of rare, endemic and endangered plants because of floristic wealth and biodiversity conservation. Some sacred groves are still remaining in undisturbed state and they help to conserve biodiversity and ecological balance. Medicinal and economically important plants are also present in sacred groves. Due to several construction works in sacred groves, a wide range of flora is disturbed; their extensive population in nature is gradually diminishing.The total area of this kavu is unprotected due to this, exotic weeds are invading to this area. Here endemic plants *Artocarpus hirsuta*, *Bridelia scandens, Memecylon malabaricum, Osbeckia muralis, and Olea dioica* are present. Out of 50 plants 38 are medicinal. Large number of herbs and shrubs are present, but numbers of trees are very less. This shows the disturbance inside the grove. In this circumstance suitable management measures and awareness programmes about the importance of sacred groves are necessary for sustainable utilization of the valuable bioresources. Chalavara Grama panchayath proposed suitable plans to protect these sacred groves.

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Effect of Inorganic Fertilization on the Zooplankton Production in Fresh Water Pond

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Abstract— *Zooplankton production in newly constructed fish pond fertilized with Nitrogen, Phosphorus and Potassium (N: P: K) and urea fertilizer were compared with unfertilized ponds. Zooplankton production was significantly more ($P \leq 0.05$) in fertilized system than in the unfertilized systems. The Zooplankton fauna was generally dominated by rotifers and copepods. Also the fertilization had no significant effect ($P \leq 0.05$) on the water chemistry.*
Keywords— Inorganic Fertilization, Water Pond.

I. INTRODUCTION

Fertilization is as important for fish cultivation as it is in agriculture because of the increasing mineralization of the pond system, which provides adequate nutrients for plankton growth. The photosynthesizing micro-organisms of the plankton are referred to as the phytoplankton while the non photo-synthesizing component is the zooplankton.

Zooplankton form the most valuable food resource in any aquatic system for fish production. It is produced at almost no cost, replaces costly supplementary feed and it is rich in protein and vitamins (Hepher and Pruginin, 1981). It is worthwhile, therefore to increase the production of this natural food (zooplankton) in the pond as such as possible to allow for an increase in total yield. This can be achieved with the use of fertilizers (inorganic or organic). However care has to be taken with the application i.e. strictly according to the standard dosage so as not to foul up the system.

The study is aimed at investigating the effect of inorganic fertilizers on zooplankton production in fresh water ponds.

II. MATERIALS AND METHODS

Pond fertilization: Six 0.2ha newly ponds of Nigerian Institute for Oceanography and Marine Research out station at Sapele Delta State Nigeria were used for the experiment. Three of the ponds (A, B and C) were fertilized initially with N:P:K (15:15:15) at a rate of 125kg/ha and followed a week later with urea fertilizer 250kg/ha (Charkroff, 1976).while pond (D, E and F) were not fertilized which serves as control.

Zooplankton Sampling: Zooplankton sampling commenced two weeks after the first fertilization. Plankton samples were collected daily for two weeks with fine meshed nets of 154ym. Twenty millimeters (20ml) of the concentrate volume was then preserved by adding few drops of 4% formalin. Three drops of lugol solution was then added to the plankton sample and left for twenty four hours. After which the sample was reduced to ten millimeters (10ml) by decanting. The supernatant aliquot (Adeyemo, 1991).

The physico-chemical parameters (temperature, turbidity, hydrogen ion concentration, and dissolved oxygen nitrate concentration and phosphate concentration of the sampled ponds were also taken (Table 1)

Zooplankton Analysis: The 1ml Sedgwick-rafter counting chamber was filled with the concentrate sample, covered with a cover slip and examined under a calibrated microscope at low power. For rotifers, zooplankter observed was counted, and recorded. Counting was done five times per sample to ensure that all the plankton were counted. For the crustaceans (Cladocera and copepod), micropipette was used in transferring them into glycerol on a clean glass slide. Fine tungsten needle was used to dissect cut parts that are of taxonomic importance. The dissected crustacean was later examined under a calibrated compound microscope and recorded.

Identifications and Estimation of Abundance: Identifications of the zooplankton species were made by reference to Green (1960, 1962); Imevbore (1965): Egborge (1972, 1981); Pontin (1978); Jeje and Fernandi (1986); and Adeyemo (1991). The average abundance of each species of zooplankton was estimated using the formula;

$$: A \ \frac{YZ}{ax}$$

A. = Average number of zooplankton species per liter

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Y. = Average number of zooplankton species per sample
Z. = Concentrate volume (ml)
a. = Original volume (liter)
x. = Volume of counting chamber (ml).

III. RESULTS

Checklist of the zooplankton. Fourteen zooplankton species were identified. These consist of one species of Cladocera, three species of Copedpda and ten species of Rotifera. The checklist of the species is as follows:

Phylum Arthopoda
Class Crustancea
Subclass Branchiopodia
Family Daphnidae
Dsphnialongispina Muller
Order Copepoda.
Family Cyclcpoida

MicrocyclopsrubellusLilljeberg
MicrocycolopsvaricansSars
Thermocyclopscrassus Fischer
Phylum Rotifera
Class Monogononta
Family Asplanchnidae

Asplanchnspriodonta G00se
Family Branchionidae
Branchionusangularis Goose
Branchionuscalycifiorouscalyciflorousfall as
Branchionusleydigirotundus (Rousselet)
Branchionusurceolatrisbennini (Leissling)
Branchionusfalcatusfalcatus Zacharias
Notholcasquamula (muller)
Family Lecanidae
Lecane (Monostyla) lunaris Ehrenberg
Lecane (monostyia) bulla Gosse
Lecaneluna Muller

Abundance. The data on mean zooplankton abundance is presented in Table 1. The abundance ranged from 100 org/liter to 8,000 org/liter. Rotifers were more abundant than Copepods and the Cladocera. Zooplankton was more abundant in fertilized ponds (A, B and C) than the unfertilized ponds (D, E and F). Zooplankton abundance was significantly more ($P \leq 0.05$) in the fertilized ponds than in the unfertilized ponds.

Table.1: Estimated Mean Abundance of Zooplankton Species in the Sampled Ponds.

		Fertilized Ponds			Unfertilized Ponds		
S/NO	Species	Pond A (org/I)	Pond B (org/I)	Pond C (org/I)	Pond D (org/I)	Pond E (org/I)	Pond F (org/I)
1.	Daphnia longispina	100±20	1,100±100	600±435.9	200±173.2		
2.	microcyclops ribellus	400±70	800±264.5				
3.	Microcyclops varicans		300±264.5	900±360.5		100±34.6	
4.	Thereocyclops crasuss			200±100		100±34.6	
5.	Asplanchua priodosta	600±1802.7	5,000±178.2	1,000±264.6	300±173.2	400±200	100±34.6
6	Branchionus angularis	7,000±1732.1	8,000±1732.1	3,000±26496	1,000±400		
7.	Branchonus scalycilorusca	4,000±2645.7				680±173.2	
8.	B. Leydigi rotundus		1,400±400	1,600±360.6			200±173.2
9.	B. Urceolaris beanini	1,800±1216.5		1,000±264.6			
10.	B. Falcatus falcatus	1,800±200	5,000±1,000	3,000±264.6	400±264.6		100±34.6
11.	Notholca squamulas	800±173.2					
12.	Lecane(Nonontyla lunaris			400±200			
13.	Lecane (Nonostyla) balla	700±435.8					
14.	Lecane luna	1,300±416.3	100±264.6		200±100	200±100	300±100

$P \leq 0.05$.

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Species Occurrence. Table 2. Shows the occurrence of zooplankton species in the sampled ponds. The number of species per pond varied from four to ten and these values respectively corresponds to about 28.6% and 71.4% of the total number of recorded species. The highest, was recorded from a fertilized pond (Pond IA) while the least (four) occurred in an unfertilized pond (Pond F)

Table.2: The Occurrence of zooplankton Species in the Sampled Ponds.

S/NO.	Species	POND A	POND B	POND C	POND D	POND E	POND F	Frequency of Occurrence of Species
1.	Daphnia longispna	X	X	X	X			66.7%
2.	Microcycl0psrubellus	X	X					33.3%
3.	Microcycliosvaricans		X	X		X		50.0%
4.	Theraocyclops crassuss			X		X		33.3%
5.	Asplanchnap riodonta	X	X	X	X	X	X	100%
6.	Branchionus angularis	X	X	X	X	X		66.7%
7.	Branchionus Calyciflorous	X				X		33.3%
8.	B. Leydigi rotundus		X	X			X	50%
9.	B. urceolaris beaniti	X		X				33.3%
10.	B. falcatus falcatus	X	X	X	X		X	83.3%
11.	Notholens quajula	X						16.7%
12.	Lecane (Nonostyla) lunaris			X				16.7%
13	Lecane (Nonostyla) balla	X						16.7%
14.	Lecane luna	X	X		X	X	X	83.3%
	Frequency of occurrence of zooplankton per pond	71.4%	57.1%	54.3%	35.7%	35.7%	28.6%	

Water Chemistry: Table 3 shows the physic-chemical characteristics of the ponds. However, the parameters were not significantly different ($P \leq 0.05$) as a result of the application of fertilizers.

Table.3: Mean Values of the sampled physic-chemical parameters.

Pond	Water temperature 0C	pH	Dissolved oxygen (mg/L)	N0 3 mg/L	P04 mg/L
A	31.0±0.82	6.5±0.25	9.45±0.47	0.04±0.03	0.14±0.11
B	31.0±1.41	65±0.45	10.8±0.47	0.02±0.02	0.13±0.01
C	30.0±2.10	6.7±0.50	7.05±0.01	0.02±0.01	0.11±0.09
D	31.0±0.82	6. 1±0.08	6.2±0.23	0.002±0.003	0.09±0.12
E	31.5±1.41	5.8±0.50	6.1±0.03	0.003±0.002	0.10±0.09
F	29.7±0.21	6.0±.42	6.5±0.25	0.004±0.002	0.10±0.16

IV. DISCUSSION

The use of fertilization in fish ponds is not new. It has been used for centuries to provide basic nutrient components needed for rapid development of plankton. The increase in primary productivity following fertilization usually results in greater zooplankton abundance (Boyd, 1982). This is evident in the zooplankton population that was significantly more ($P \leq 0.05$) in the fertilized system than the unfertilized system in the study. The same finding was also reported by McIntire and Bond (1962) using inorganic fertilizer and Dendy *et al* (1968) recorded maximum density of zooplankters in fertilized ponds of Alabama. Similar

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observations include that of Hall *et al*. (1970) with high turnover ratio of zooplankton in fertilized ponds than the unfertilized and Sharma *et al*. (1990) with a record of significant zooplankton production (P ≤ 0.05) after fertilization with inorganic fertilizer.

The observed zooplankton fauna was dominated by the rotifers followed by the copepods and with only one species of Cladocera. This confirms the findings of Jeje and Fernando (1986) that rotifers and copepods are the most widely distributed of all the zooplankton and O'Brien and De Moyeis 1974, cited by Sharma *et. al*. (1990) found that mineral fertilizers (N:P:K and Urea have inhibiting effects on the plank tonic Cladocera. Also from the observed physic-chemical parameters. Its evident that there was no significant difference (P ≤ 0.05) between the fertilized and unfertilized system. Although, there was a slight increase in the pH of the fertilized system, an increase like this was observed by Lewkowicz and Lewkowicz (1976) and Sharma *et.al* (Op.cit.) using inorganic fertilizer generally inorganic fertilizer increases pH (Sharma *et.al*. 1987). Again, no significant influence was seen in the orthophosphate and nitrate concentration of the pond as a result of the application of the fertilizers. Similar result were observed by Wrobel (1962), Sharma et al. (1990) and Delince (1992). The insignificant influence of the fertilizers on the orthophosphate concentration in the pond after fertilization has been attributed to the sorption of the excess into the sediment (Marsden, 1989). Also short lived peaks of ammonium and nitrate in the pond following fertilization results in the insignificant effects of the fertilizers on the nitrate concentration (Bouldin *et. al:* 1974).

In conclusion, it can be inferred that N.P.K. and Urea fertilizer when applied strictly according to the standard dosage increases production of zooplankton without a significant effect on the water chemistry.

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Multi Element Analysis of Cow Milk: Geographical Origin Determination and Potential Health Risk Assessment

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***Abstract*—** *Milk consumption rendering the proof of geographical provenance is a vital issue in food and consumer protection. The present study deals with discrimination of Bangladeshi cow milk according to their region of production using multi element compositions. The concentration of Pb, Cd, Cr, Cu, Co, Ni, As, Mn, Zn, Fe, Ca, Mg, Na and K in fresh cow milk from four climatic zones (South-Central, South-Western, Western and North-Western) were measured by flame and graphite furnace atomic-absorption spectroscopy (FAAS and GFAAS). The reliability of measured analytical data were validated by certified reference milk powder (IAEA-153). Statistical Canonical discriminate analysis indicated clear regional individuality based on some element that can contribute to protect geographical indication. The correlation coefficient matrix showed positive correlation among metals except copper. In addition, health risk assessment by the calculated values of daily intake of analyzed metals, health risk index and hazard index were lower than reference values, indicating that the consumers are not likely to be metal toxicity due to milk consumption from four studied region.*

Keywords*— *Cow's milk, Trace elements, Daily Metal Intake, Health risk assessment.

I. INTRODUCTION

Food authentication validates that a food is in compliance with its label information which may include the food origin and production method. It is an emerging field in recent year because of increasing public awareness about food safety and quality aspects and also essential to prevent mislabeling and adulteration problems. Declaration of basic information such as name of food, ingredients, net content and origin in value added food products is of particular interest since these products are often target of fraudulent labeling. Proof of provenance is highly encouraged as an emerging criterion in the context of food safety and quality and protection of the consumer's right in accordance with national and international regulation and guidelines. Milk is a high value-added product, rich source of natural nutrients for human being which contains more than twenty different trace elements. Many of them are essential trace elements and play important roles in biological systems in human body [1]. Some of them form an integral part of several enzymes. Although they are essential, they can be toxic when taken in excess; both toxicity and necessity vary from element to element and from species to species. Concentration of trace elements in milk is influenced by genetics of individual animal species, lactation stage, farm management (nutritional regime) and environment factors such as season, farm location, and nature of soil, fertilizer application and industrial activities [2]. Industrial and other anthropogenic activities could also be influenced the levels of toxic elements such as Cd, Ni, Co, Pb, Cr, Hg in milk, through the food chain [3,4]. Toxic metals can be transferred from contaminated soil to plants and grass, causing accumulation of toxic metals in grazing ruminants, particularly in cow milk [5]. Recently, metal residues in milk are of particular concern because milk is largely consumed by infants and children. To determine the concentrations of metals in milk could be an important indicator of milk hygiene status as well as an indicator of the degree of pollution in environment where the cattle raise. Milk as led to its high consumption worldwide, but increased demand has also made it prone to fraudulent activity. Typically, milk is adulterated either for financial gain or due to poor hygiene conditions of processing, storage, transportation, and marketing. Milk adulteration has been widely reported in developing countries. Milk is most susceptible to be mislabeled and their country of origin can sometimes be in question. In this regard, the use of multi elemental analysis could be a promising tool for origin authentication purposes. Elemental profiling has also been applied for authenticating the origin of different foods such as onion [6,7], tea [8], and tomato [9]. Multi elemental analysis has also been used for instance cow vs buffalo milk [10].

Bangladesh has immense prospects of expanding the dairy sector. People in Bangladesh usually consumed cow's milk buy directly from nearby farms or from market as both liquid and powder form. Milk is produced all over the country. The main milk pocket areas are situated in West and North western part of Bangladesh. Milk production was 6.9 million tons in 2013-14. Thus, there is a production deficit of 7.12 million tons [11,12]. Growth in demands for milk and dairy products 10 % per year and growth of local production is 7-9% per year [13]. So there is a good opportunity for the local dairy industries to contribute to this gap. Despite holding great potential for the sustainable development of the country the dairy industry is facing different challenges in ensuring food safety aspects such as fraud and adulteration, provenance and authentication, toxic metal and microbial contamination, fake labelling etc. Addition of water in liquid milk is a fairly common practice in Bangladesh. In most cases contaminated water from nearby water bodies is used to add and thus milk becomes contaminated especially with heavy metals. Sometimes dubious milk traders increased milk supply by mixing low quality powder milk in liquid milk and selling those as fresh cow milk [14]. Jolly et al. [15] studied the level of heavy metals (Cr, Ni, As, Cd, Hg, Pb, Mn, Cu, Zn and Fe) in commercial powder milk and fresh cow's milk collected from different farms from Dhaka and Barisal district of Bangladesh. They found that powder milk showed significantly higher concentration of heavy metals compared to liquid milk samples and metal pollution index showed heavy metal contamination in powder milk. Muhib et al.[16] investigated a total of 90 samples (33 packaged cow milk , 30 dairy farm milk and 27 milk from small household farmers) from different areas of Savar, Dhaka, Bangladesh to analyse the content of selected metals (Cd,Cr, Pb,Mn, Cu and Fe). The research revealed that Cr exceeded the highest Estimated Daily Intake (EDI) rate (for brand cow milk: 0.413 mg/day, dairy farm cow milk: 0.243 mg/day, domestic cow milk: 0. 352 mg/day)out of the six metals. Kabir et al.[17] studied heavy metal presence in cow milk of different dairy farms near Karnafuli paper mills, Chittagong, Bangladesh.

Mislabeling and adulteration are other serious issues in the dairy industry in Bangladesh; these not only cause major financial losses but also pose a significant risk to human health. Generally, high quality products from certain geographical locations can be sold at premium prices. Nonetheless some lower quality products are nowadays mislabeled and sold at higher prices, resulting in an unfair food market. But, in recent years consumers have begun to notice the geographical origin of their product due to its relation with quality and authenticity of the food product. So, the geographical origin of food product plays a vital role in analyzing the quality of food. Moreover, authenticity and detection of adulteration are the increasing challenges for researchers, consumers, industries, and regulatory agencies in Bangladesh. But to the best of our knowledge there has not been any report of identifying the geographical origin of milk in Bangladesh. Considering the importance of milk authenticity the present work intended to provide an extensive overview for discriminating the milk according to geographical regions (South-Central, South-Western, Western and North-Western) in Bangladesh based on elemental composition. Though government and commercial dairy enterprises collect milk from smallholders from across the country and then process and distribute the milk to all major cities in the country hence it is vital to know the quality of the milk along with the product origin. Thus, the levels of various essential and toxic trace elements have also been investigated for determining the daily intake of metals (DIM), health risk index (HRI) and hazard index (HI).

II. MATERIALS AND METHODS

Sampling sites

Bangladesh is located in subtropical monsoon region having seven distinct climatic zones. In this study, fresh cow milk was collected from different dairy farm of four climatic zones: South-Central (n= 12), South-Western (n=10), Western (n=9) and North-Western (n=6) shown in Fig.1.

Elemental analysis of milk

Instrumental,Chemicals, and Sample digestion

A Varian AA240FS Atomic Absorption Spectrometer (AAS) was used for the determination of Pb, Cd, Cr, Cu, Co, Ni, Mn, Zn, Fe, Ca, Mg, Na, K. Only, As was determined using

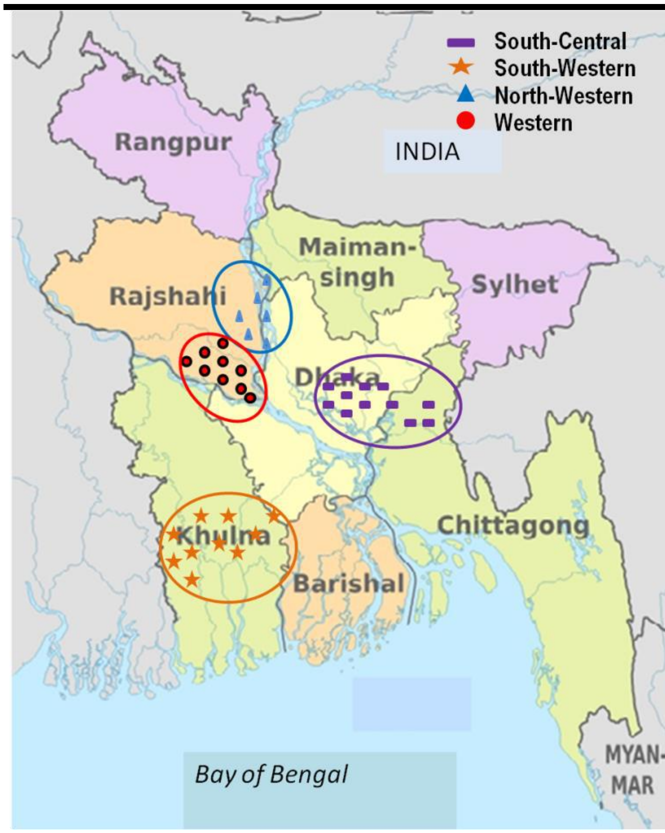

Fig. 1 Map showing sampling areas of four climatic regions of Bangladesh

hydride generation AAS (HG-AAS) techniques using a Varian AA240 equipped with hydride vapor generator (VGA 77). The purity of argon and acetylene gases was 99.999% and 99.99% respectively. Hollow cathode lamps were used for the rest of the metals analyzed. Individual standard solution (Spectropure, USA) of target element was supplied by Varian Inc, USA with highest purity level (99.98%).

Supra pure HNO_3 and all other Chemicals was purchased from E. Merck, Germany and all solutions were prepared using deionized water (18 MΩ/ cm) produced using an E-pure system (Thermo Scientific, USA). Milk samples were mixed with concentrated HNO_3 in a XP vessel, then digested in a microwave accelerator reaction system (MARS'5, CEM Corporation, USA) following US EPA procedure 3051A. After digestion, the solution was made up to 10 mL using ultra-pure water following AAS measurement for metal estimation.

Calibration and Accuracy measurement

The method was validated for linearity range, detection and quantification limits, accuracy, and precision. Instrument detection limit (IDL) at 99% confidence limit is calculated using following formula: IDL = t (0.01,df) s; Where, df= degree of freedom, s= standards deviation and t= critical value for the student t-Test at 99% confidence level. Here, t value is 2.821 (for df 9). Therefore, IDL = 2.821*s; Instrument Quantification limit (IQL) = IDL*10; Method detection limit (MDL) = 4* IDL; and Limit of Quantification (LOQ) =10* IDL.

The linearity range for each metal was estimated by five points calibration curve using different concentration of stock standards. The calibration points for Pb, Cr, Cd, Cu, Co, K, Mn, Ni, Zn, Mg, and Na were ranged from 0.1 to 1 mg/L; whereas for As, Ca, and Fe that was from 1.0 to 10 mg/L. The accuracy of the method was evaluated by analyzing a certified reference milk material IAEA153, provided by International atomic Energy Agency. Mean recoveries of the analyzed metals were between 92.09% to 99.89%, indicated accuracy between certified and measured values (Table 1).

Table 1: Method validation by Reference material (IAEA 153)

Heavy metals	Certified value (mg/kg)	Measured value (mg/kg)	Mean Recovery (%)
Ca	12870	12555±1130	97.55
Cu	0.57	0.56±0.04	98.25
Fe	2.53	2.33±0.21	92.09
K	17620	17600±1584	99.89
Mg	1060	1020±82	96.23
Mn	0.19	0.18±0.01	94.74
Na	4180	4030±363	96.41
Zn	39.56	37.95±3.03	95.94

Health Risk Assessment

The Daily intake of metal (DIM) was calculated by the following equation:

DIM = (C metal × D food intake)/ B average weight; where C_{metal}, $D_{food\ intake}$, and $B_{average\ weight}$ represent the metal concentrations in milk (mg/L), daily intake of milk (L) and average body weight respectively. The average milk intake

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of population of Bangladesh is 30.56 ml/person/day [18], the average body weight ($B_{average\ weight}$) is 70 kg for adults [19].

The Health Risk Index (HRI) of analyzed metals was calculated by the following equation [20]: HRI= DIM/ Rf_D(safe limit of a metal per day having no hazardous effect during life time). Oral Reference Doses used for calculating HRI for Cr, Ni, Cu, Pb, Cd, Mn and Zn were followed by USEPA IRIS [21], for Co followed by Food and Nutritional Board (2004) and for Fe followed by Friberg et al.[22]. To evaluate the overall health risk through more than one heavy metal of an individual food item, the Hazard Index (HI) was developed [23] as the sum of the hazard quotients (Health Risk Index):

$HI= \sum HQ = HQ_{Cr}+ HQ_{Co}+ HQ_{Cd}+ HQ_{Pb}+ HQ_{Ni} +HQ_{Mn} +HQ_{Zn} +HQ_{Cu} +HQ_{Fe}$

Like HRI, HI<1 indicates that the predicted exposure is unlikely to pose potential health risks.

Statistical analysis

Statistical software (SPSS 24) was used for data analysis. Three multivariate techniques including hierarchical cluster analysis (HCA), canonical discriminate analysis (CDA) and correlation matrix analysis were carried out using multi element data milk. To investigate similarity and dissimilarity in metal concentration between sampling sites (both spatial and temporal variations), HCA analysis was employed on the metal data treated by Ward's method of linkage with the squared Euclidean distances to determine distance between clusters. CDA was employed by using the standard, stepwise mode to examine the differences between two or more groups with respect to predictor variables (multi-elements) in milk samples. In the current study, sampling sites were treated as spatial grouping, meanwhile metal concentrations were considered as temporal grouping. In discriminant analysis, only a minimal number of selected variables would be sufficient to provide the maximum separation of the data into groups. A correlation closet to 0 means no linear relationship between them at a significant level of $p < 0.05$

Table 2: Concentration of toxic heavy metals and nutritional trace elements (mg/L) in raw milk of different geographic origin in Bangladesh

Element (µg/L)	South-Central (n=12)	South-Western (n=10)	Western (n=9)	North-Western (n=6)
Pb	2.14±0.754	0.79±0.013	0.79±0.097	0.82±0.076
Cd	0.44±0.15	0.09±0.012	0.13±0.076	0.092± 0.07
Cr	0.99±0.029	0.49±0.012	0.49±0.052	0.52±0.02
Cu	0.09±0.008	0.29±0.011	0.21±0.133	0.21±0.04
Co	0.56±0.11	0.39±0.012	0.39±0.015	0.39±0.14
Ni	1.59±0.085	0.39±0.011	0.39±.007	0.39±0.01
As	0.21±0.012	0.02±3.66E-18	0.02±0.001	0.02±0.006
Mn	0.24±0.025	0.14±0.007	0.15±0.01	0.16±0.01
Zn	4.06±1.95	2.30±0.54	2.91±1.36	3.13±0.34
Fe	5.46±0.19	0.48±0.015	0.49±0.014	0.50±0.01
Ca	1335.31±319.11	913.3±41.28	750.78±58.92	715 ±100.8
Mg	249.17±59.43	86.9 ±7.15	84.27±10.14	69.82 ±10.32
Na	468.98±250.67	234.5 ± 28.37	191.33±10.22	208.33±14.61
K	1280.23 ±227.91	876.5 ± 24.49	997.22±80.89	883.67±12.48

III.RESULTS AND DISCUSSION

Trace metal concentrations

Trace metals concentration in milk might be influenced by lactation stage, feed, pollutants present in the environment.Thus, among the multi element compositions of cow's milk examined in this study (Table 2), South-Central zone possess higher concentration (except Cu)compared to the other. Most of the farms of South-Central zone are situated in industrial areas and were exposed to various sources of pollution either directly or indirectly such as discharged wastes into nearby water bodies, locating beside roads with heavy traffic results in pollutant

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accumulation in farm areas. Similarly, Dhanalakshmi & Gawdaman [24] and Iftikhar et al. [25] also found higher heavy metals concentration in industrial or urban areas compared to those of rural areas.

Discriminant analysis (CDA)

A stepwise canonical discriminant analysis was applied to elemental abundances to discriminate raw milk samples from the four different climatic zones of Bangladesh (Fig.2). Among the 14 elements, Ca, Mg, Na, K, Mn, Zn and Cu were selected for canonical discriminant analysis. Milk samples from South-Central and South-Western were well separated in the graph displaying in the Fig.2A based on macro elements while samples from West and North-West were overlapping. The powerful differentiating dimension was function 1(96.3%) and then function 2(3.7%). Fig 2B showed canonical discrimination according to microelement level of milk samples among the four regions. The Wilks' Lambda test indicated significant contributing variables to the discriminant models at *p-level*<0.001.

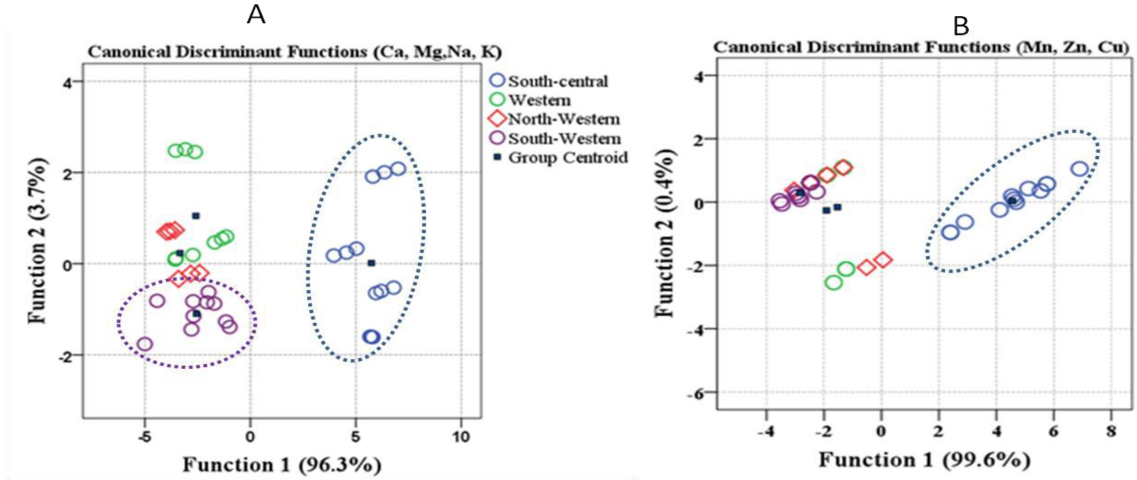

Fig. 2. Canonical Discrimination among geographic regions using significant multi element parameters

Hierarchical Cluster and Correlation analysis

Hierarchical Cluster Analysis (Ward's method) was used to show group distribution according to variables (14 elements) with significant differences (p<0.05).The Squared Euclidian distance and coefficient of similarity were used to group the cases in clusters in term of their similarity. The nearest distance suggested the highest degree of relationship, therefore, those objects are considered to belong to the same group. Fig. 3 revealed the dendogram representing clusters of the observations

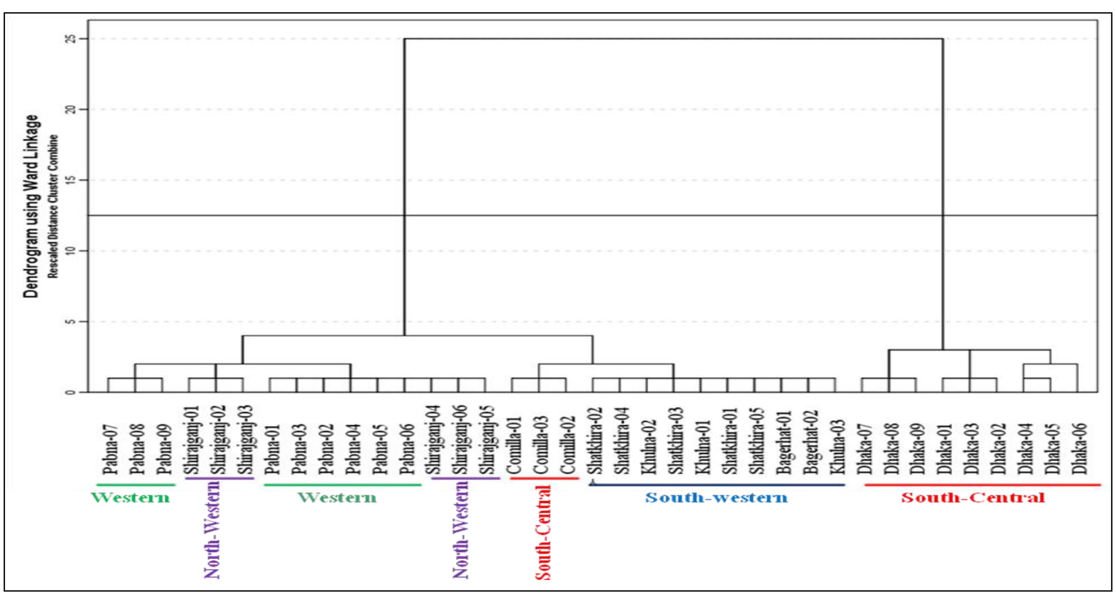

Fig. 3 Dendogram using elements in raw milk

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corresponding to each geographical origin of the milk samples. The first cluster was comprised of Western (n=9), North-Western (n=6), South-Western (n=10) and three sample of South-Central. The second cluster was composed of nine samples of South-Central. The cluster analysis byusing 14 elements revealed that HCA did not enable for a well determination of the geographical origin of cow milk. The Pearson's correlation coefficient matrix (Table 3) revealed inter-metallic association at the differentsignificant levels. All metals showed positive and strong significant correlation with other metals except Copper.

Table 3: Correlation coefficients between milk elements

	Pb	Cd	Cr	Cu	Co	Ni	As	Mn	Zn	Fe	Ca	Mg	Na	K
Pb	1													
Cd	.922**	1												
Cr	.811**	.673**	1											
Cu	-.634**	-.507**	-.765**	1										
Co	.960**	.892**	.826**	-.667**	1									
Ni	.825**	.691**	.987**	-.765**	.857**	1								
As	.775**	.653**	.979**	-.737**	.797**	.966**	1							
Mn	.655**	.543**	.939**	-.686**	.676**	.925**	.940**	1						
Zn	.653**	.596**	.572**	-.459**	.495**	.525**	.541**	.536**	1					
Fe	.816**	.682**	.990**	-.765**	.841**	.998**	.972**	.936**	.538**	1				
Ca	.881**	.771**	.820**	-.626**	.801**	.814**	.802**	.711**	.746**	.819**	1			
Mg	.853**	.791**	.709**	-.564**	.739**	.692**	.708**	.620**	.806**	.704**	.942**	1		
Na	.719**	.627**	.674**	-.510**	.613**	.637**	.686**	.622**	.782**	.657**	.868**	.895**	1	
K	.858**	.806**	.807**	-.661**	.800**	.786**	.809**	.748**	.710**	.802**	.853**	.926**	.824**	1

** Correlation is significant at the 0.01 level (2-tailed).

Health Risk Assessment

The estimated daily intakes of metals for adults (Table 4) through milk consumption were less than tolerable daily intake limit set by several authorities [21, 26-28]. Muhib et al.[16] found that DIM values of Cd, Pb, Mn, Cu and Fe for adult in raw milk (collected from one area of South Central region of Bangladesh) were within permissible limits which agreed well with our findings. The present study revealed that the DIM values were below the recommended values, indicating that the dweller in the four studied regions are not likely to be exposed to significant

Table 4: Estimated Average Daily intake of metal (DIM) by consumption of milk from different climatic regions of Bangladesh

Element	DIM (mg/person/day)				Oral reference doses (mg/kg/day)	References
	South-Central	South-Western	West	North-West		
Pb	0.001085	0.000829	0.000349	0.000349	0.004	US EPA IRIS, 2006
Cd	0.000137	5.24E-05	4.37E-05	4.37E-05	0.001	
Cr	0.000463	4.37E-05	0.000218	0.000218	1.5	
Cu	1.83E-05	4.37E-06	0.000131	0.000131	0.04	
Zn	0.001854	0.000974	0.001268	0.001366	0.30	
Mn	0.000349	6.55E-05	0.000349	6.55E-05	0.033	
Ni	0.00074	0.000175	0.000175	0.000175	0.02	
Co	0.000298	0.000174629	0.000175	0.000175	3.01	Food and Nutritional Board, 2004
As	4.37E-05	8.73E-06	4.37E-05	8.73E-06	0.0003	US EPA,1998
Fe	0.002832	0.000218286	0.000218	0.000218	40	FAO/WHO, 2002

health risk due to milk consumption. Thus the values for health risk index and hazard index (Table 5), that have been recognized as a useful indicator for assessing risks associated with the consumption of metal contaminated food, recognized the milk of 4 studied regions of Bangladesh as safe for human consumption. This result corroborates that of Jolly et al. [15] who also found lower values for Cr, Ni, Mn, Cu, Zn and Fe in fresh cow's milk (collected from Dhaka and Barisal district in Bangladesh).

Table 5: Health Risk Index (HRI) and Hazard Index (HI) for heavy metals in raw milk from different climatic regions

Element	Health Risk Index (HRI)				Safe limit (USEPA, 2002)	References
	South-Central	South-Western	West	North-West		
Pb	0.233293	0.041474	0.087314	0.087314	≥ 1	(USEPA, 2002)
Cd	0.130971	0.002619	0.043657	0.043657		
Cr	0.000298	0.002183	0.000146	0.000146		
Cu	0.000109	0.000218	0.003274	0.003274		
Zn	0.006734	0.048678	0.004225	0.004555		
Mn	0.003076	0.003274	0.001984	0.001984		
Ni	0.036672	0.008731	0.008731	0.008731		
Co	8.68429E-05	0.008731429	5.80161E-05	5.80161E-05		
As	0.014552	0.000437	0.00291	0.00291		
Fe	6.11609E-05	0.010914286	5.45714E-06	5.45714E-06		
Hazard Index (HI)						
	0.378034	0.127261	0.132572	0.13752	≥ 1	(USEPA, 1989)

IV.CONCLUSION

The chemo metric approach using elemental profile of raw milk indicated clear discrimination among the selected regions of Bangladesh. This might due to geographical difference and the feeding practices of the animals. Moreover, the values for daily intake of the metals investigated were less than the safe limit as defined by recognized authorities and thus the results revealed no association of health risk and/or hazard with the consumption of cow milk in Bangladesh.

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Yield Response of Tea to Integrated Soil Fertility Management in Timbilil Tea Estate in Kericho, Kenya

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Abstract— *Poor crop productivity, high cost of inorganic fertilizers and low crop response to inorganic fertilizers are major problems that affect sustainability of crop production in Kenya. Application of inorganic fertilizers at rates much below the recommendation, which is mainly due to the limited economic capacity of smallholder farmers, has become the underlying cause of poor crop productivity along with the worsening soil acidity. Hence, the present study was carried out to find out the effect of integrated soil fertility management on the productivity of tea Timbilil tea estate. Kericho, Kenya. The trial was set up in a Randomized Complete Block Design (RCBD) with three replicates. Forty-two composite soil samples were collected randomly from each of the experimental plots. The data collection process included soil sampling during the short rain season in 2017 and annual tea yield sampling. The samples were analyzed for total organic matter, nitrogen content, bulk density, porosity, soil pH, porosity, particle density and soil moisture content. The data obtained were subjected to analysis of variance (ANOVA) using MSTAT-C programme package. SPSS version17.0 was used to analyse Pearson correlation and all the data presented in tables and figures. The tea yields determined showed a weak positive correlation between SOM and yields.The tea yields determined showed a weak positive correlation between SOM and yields. Results showed that fertilizer types significantly (p≤0.05) affected SOM with enriched sheep manure giving the highest values. Fertilizer rates had no significant (p≤0.05) difference on SOM. Fertilizer application at the highest rate of 240 kg N/ha had the lowest SOM content, which means high fertilizer application, causes more harm than good.From the results obtained it can be concluded that enriched manures tend to increase SOM content in soil which improve productivity and is recommended especially in the tea industry.*

Keywords— ***Productivity, Soil, Tea,Manure, Fertilizer.***

I. INTRODUCTION

Tea (*Camellia sinensis*) is one of the leading cash crops in Kenya. It is the second largest foreign exchange earner hence contributes significantly to the Kenyan economy. Fertilizer is the second largest tea production cost item after plucking with significant bearing on both yield and quality of tea (TBK, 2010). Thus, cost-effective investment in fertilizer is necessary for sustainable tea production. The growth and productivity of tea like many other crops, mainly depends on the nutrient availability in the soil as well as their utilization by the plant. Sustainable agriculture plays a significant role in sustainable development and particularly in curbing environmental degradation and climate change and population density. Soil is a major and important component in ensuring this and therefore, optimizing fertilization strategies is becoming an urgent need for sustainable crop productivity (Fan et al., 2011).

Fertilizers increase the growth rate and density of harvested shoots thereby increasing yields.However, the fertilizers applied to the soil either is lost, by being bound by soil or are washed out of the soil (Njogu et al., 2014). Additionally, imbalances in the soil occur in terms of nutrients, causing the soils to be moribund hence unsustainable for tea production (Ayiemba&Nyabundi, 2010).

Fertilizer recommendations for tea are primarily based on field trials that determine the crop response to various rates of fertilizer applications and must optimize crop yield and quality, maximize profitability and reduce the risk of environmental pollution (Belanger et al., 2000).

Just like most crops, tea depends on the nutrient availability in the soil for increasing yield. Inorganic fertilizer NPK (nitrogen, phosphorus and potassium) 25:5:5 are recommended generally for optimum yield and quality of tea. Modern agriculture depletes large amounts of nutrients from the land in form of yield, such that nutrient losses must be balanced by the addition of fertilizer, either inorganic or organic (Mafongoya et al., 1998). However, many tea growers prefer the use inorganic fertilizers because they are easily available. Inorganic fertilizers have easily available macro and micronutrients, which enhance growth; however, long-term use of inorganic fertilizer on the fields causes soil and environmental degradation (Phukan et al.,2008). The application of nitrogenous fertilizers in rates that exceed the optimal recommended may be uneconomical and may induce the acidification of the soil to levels that adversely affect tea quality and absorption of other nutrients (Anon, 2000). These negative impacts of chemical fertilizers coupled with escalating prices have led to growing interests in the use of organic fertilizers as a source of nutrients (Mahajan et al., 2008).

On the other hand, Integrated soil fertility management (ISFM) which involves the combined use of organic and inorganic fertilizer is good for improved tea yield and soil health (Tabu et al., 2015). Organic manure is available from farmers in form of sheep, cattle, chicken or compost. In some instances, big companies can produce their own compost. James Finlay's, for example, produces organic manure from composted instant tea waste, which is consistent in its chemical composition as noted by Wanyoko et al, 2003. Patterson (2015) states that nutrients in sheep manure provide adequate plant nutrients because of the sheep's feeding regime. It is high in both phosphorus and potassium, essential elements for optimal plant growth. These nutrients help plants to establish strong roots, defend against pests and grow into vibrant and productive plants. Because of its low odor, it is easy to handle and apply sheep manure (Patterson, 2015). Against this background, the present study sought to determine the effect of amended soils on tea yield. The results of this study are of great importance to several stakeholders especially tea growers both locally and around the globe. From the data obtained, the study was able to generate information on the most efficient types and rates of fertilizer necessary to optimize yield and most importantly one that does not cause soil degradation.

II. MATERIALS AND METHODS

Study Area

The research used an existing experiment, which started in 1985 at Tea Research Institute, Timbilil Estate in Kericho as shown in figure 3 below. The site is situated at an altitude of 2178 m above sea level, latitude 0^0 22'S and longitude 35^0 21' E. The total annual rainfall during the study period was 1954.4mm and the mean temperature was 17.1^{o}C.

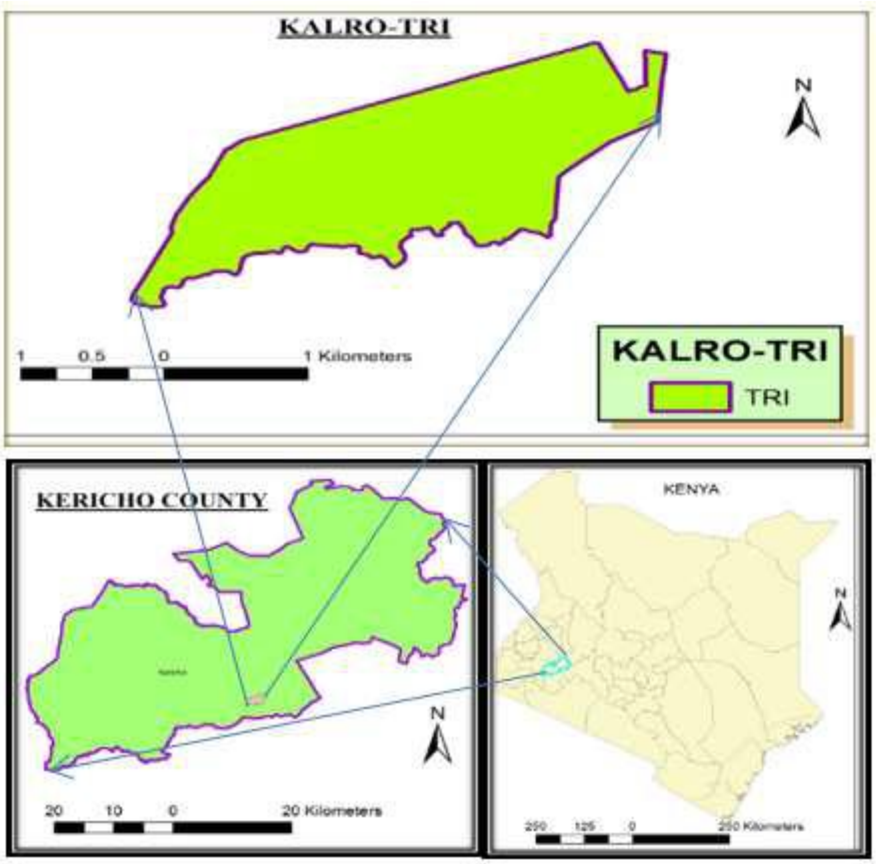

Fig.1: Study area

The manures were initially applied at 20, 40, 60 and 80 kg N/ha/year till the year 1992 after which the rates were changed to 60, 120, 180 and 240 kg N/ha/year. The long-term average yields for the trial as from the year 1999 to the year of this study are as shown in the Figure 2.

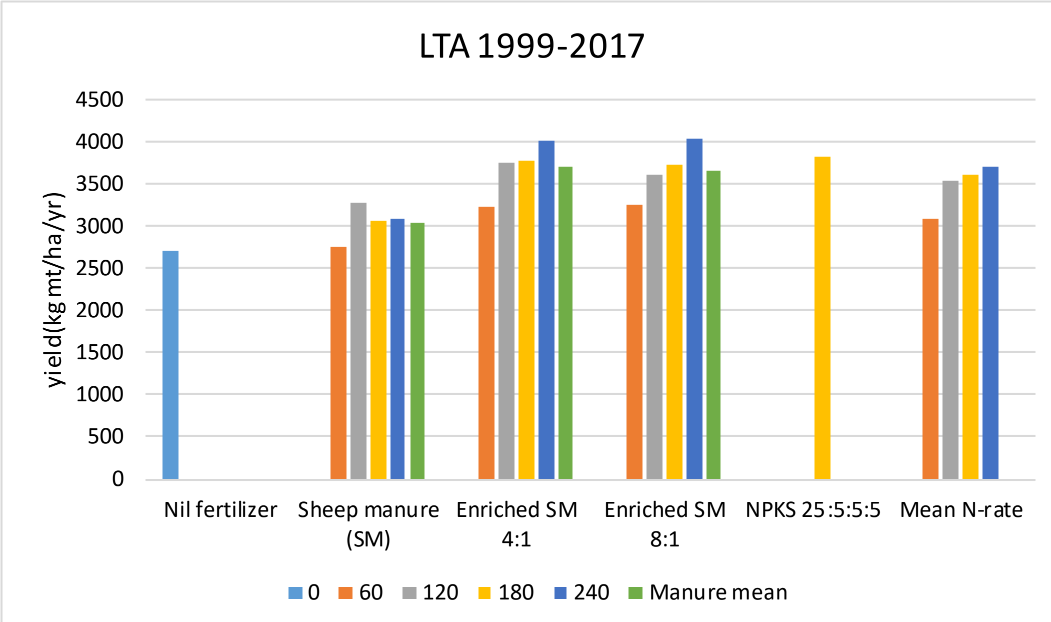

Fig.2: Long-term average yields of the experimental plot

Source: TRFK (2017)

Sample and Sampling Procedure

Soil Sampling

Soil sampling was done once during the short rain season and this is because the seasons affect SOM content and this season represented all the seasons. Soil samples were obtained from predetermined sampling depths of 0-15, 15-30 and 30-45 cm using a post-hole auger. 3 samples from each treatment were collected and mixed together to get a composite sample. The soils samples were then put in well labelled bags and transported to the laboratory where a field-moist subsample was scooped and set aside for determination of pH. The remaining samples were then air dried to remove excess moisture then sieved in preparation for the analysis of the different elements.

Leaf Sampling

Fifty pieces of mature two leaves and a bud from each plot were plucked once in June and put in well-labelled bags. The samples were then taken to the laboratory where they were oven dried at 80ºc and milled for nitrogen status analysis.

Tea Yield Collection

Tea leaves were plucked at intervals of 7–10 days when the shoots had developed two mature leaves and a bud. The green leaf weight per plot was recorded for every plucking round for the entire study period. The green leaf yield was converted into kg made tea per hectare per year (KG MT ha^{-1} yr^{-1}) using the conversion factor of 0.225 (Pan et al., 2002). The monthly and consequently annual tea yields for the year under study period (2017) were recorded and input to a Microsoft Excel sheet.

Statistical Analysis and Presentation

Data obtained was subjected to analysis of variance using MSTAT-C programme package. The means were separted using Duncan's Multiple Range Test ($P \geq 0.05$) and the analysed data presented in tables and figures. Pearson correlation analysis was done using SPSS version 17.0 and data presented in tables.

III. RESULTS AND DISCUSSION

Yield is an important component in tea farming as the sole purpose of tea farming is to maximize yield for better economic benefits. Table 2 shows that there was a significant($p \leq 0.05$) difference in fertilizer types with NPK alone recording the highest yields and this can be attributed the fact that the N content is more available.

Treatments	SOM	SN	pH	Yield
No fertilizer	5.95	0.15	5.90^{ab}	2505.67^{ef}
SM at 60 kg N/ha	6.69	0.09	6.10 ^{ab}	2420.67^{f}
SM at 120 kg N/ha	5.58	0.06	6.27 ^{ab}	2997.67^{de}

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SM at 180 kg N/ha	6.02	0.08	6.57[a]	2872.00[def]
sheep manure at 240 kg N/ha	6.05	0.06	6.23 [ab]	2613.67[ef]
enriched SM at 4:1 at 60kg N/ha	9.61	0.05	5.97 [ab]	2925.33[def]
enriched SM at 4:1 at 120kg N/ha	9.58	0.06	5.57[abc]	3797.00[abc]
enriched SM at 4:1 at 180 kg N/ha	7.63	0.06	5.73[abc]	3809.67[abc]
enriched SMat 4:1 at 240 kg N/ha	7.03	0.07	4.73[c]	3852.00[abc]
enriched SM at 8:1 at 60kg N/ha	6.96	0.06	5.77[abc]	2703.67[ef]
enriched SM at 8:1 at 120 kg N/ha	7.60	0.05	5.60[abc]	3647.67[bc]
enriched SM at 8:1 at 180 kg N/ha	6.98	0.07	5.53[bc]	3332.00[cd]
enriched SM at 8:1 at 240 kg N/ha	6.99	0.07	5.23[bc]	3907.67[ab]
NPK at 180 kgN/ha	7.62	0.04	4.67[c]	4070.00[a]
P-value	0.45	0.87	0.04	0.00

Sheep manure (SM); soil organic matter (SOM); SN; soil nitrogen

The enriched fertilizers also recorded high yields and it could be because of the improved nutrient release. Similar finding has been reported using a mixture of NPK 2:2:0 and cattle manure (Shisanya et al., 2009). This further emphasizes the need for ISFM however these results varied from Kekana et al. (2014) who found the highest yield in enriched fertilizer followed by NPK alone.Adediran et al. (2003) specifically investigated the effect of different organic amendments on crop yield. They used poultry litter with organic wastes, maize residues, leaf litter, urban waste, weed biomass, and soybean residue and applied these to amaranthus and tomato crops. They found that for optimal crop yield different amendments were required for different crops: while urban waste was best and soybean residue worst for amaranthus production, maize and soybean residues proved to be best for tomato production.

Table 2 further indicates that there were significant ($p \leq 0.05$) differences in fertilizer rates and tea yields where fertilizer application at the recommended rate of 180 Kg N/ha had the highest means. The results showed that adding very little or too much fertilizer results in low yield production.Increasing the N fertilizer rate resulted in increase in crop yield. Similar findings were reported in other experiments on different N rate in Kenya (TRFK, 2002). The highest N rate of 240Kg N/ha however showed a decrease in yield which emphases the fact that too much fertilizer application is in fact detrimental.

Correlation between SOM and soil physical and chemical parameters and tea yields

Increases in SOM are seen as desirable in agriculture as higher levels are viewed as being directly related to improved plant nutrition, greater aggregate stability, reduced bulk density, improved water holding capacity, enhanced porosity and earlier warming in spring (Lal, 2002).

According to Pearson's correlation as shown in Table 3 the results indicate that there was a negative relationship between SOM and soil nitrogen, bulk density, porosity, particle density and soil pH, $p= \leq 0.01$. Where there were increased SOM there were reduced bulk density and porosity hence influencing water retention properties of soil. This reason further explains the positive relationship between SOM and soil moisture content, $r=.008$, $p= \leq 0.01$. This is where there was an increase SOM there was also an increase in soil moisture content. It is well established that addition of SOM can not only reduce bulk density and increase water holding capacity, but also effectively increase soil aggregate stability Angers and Carter (1996).

Additionally, where there were increased SOM there were reduced soil pH indicating that high SOM could cause high acidity in soil.Oades et al. (1989) noted that too much addition of organic residues could result in acidification due to increased nitrification of N and addition of lime would be required to maintain a steady-state pH.The effect of different organic materials on soil pH was investigated by Wong et al. (2000). They incubated an Oxisol and an Ultisol with pruning's of young tree shoots and observed an increase in pH and decreased exchangeable Al content during the first 14 days.

In other studies, Pocknee and Sumner (1997) incubated an acid topsoil with different types of plant materials to study the effect of type of SOM and rate of amendment on soil pH. All treatments increased pHwithin a matter of days or weeks, however, the magnitude of change and the duration of the effect varied with SOM type and rate of application as greater application always resulted in greater pH shifts.

From the study carried out a negative correlation was observed between SOM and soil N as shown in Table 3 The opposite effect was observed in studies done by Baldock and Nelson (1999) where they noted thatwith the exception of fertilizers, SOM provides the largest pool of macro-

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nutrients with greater than 95% of N and S and 20 to 75% of P found in SOM.

SOM is an important source of nutrients for plants in general and tea in particular. Nitrogen, phosphorus and sulphur are the essential macronutrients needed by the tea bush. Most of the nutrients in SOM are derived from the mineralization of SOM and become available for plant uptake during decomposition and for this reason, the particulate organic matter fraction is often considered the most important proportion of SOM in providing nutrients to plants (Wolf and Snyder, 2003). Losses of nutrients might however, occur due to leaching or conversion to gaseous forms or as a result of immobilization. The negative correlation found here may be attributed to that.

The effect of inorganic fertilizer as well as FYM, compost and green manure on the soil fertility status in general was tested by Tolanur and Badanur (2003). Their data confirmed the results from other studies by Agbenin and Goladi, 1997 that NPK alone was not able to arrest the decline of C and N, and only a combination of NPK together with organic amendments increased and sustained soil productivity. Further, the results showed that there was a weak positive relationship between soil organic matter and soil moisture content. As SOM increased soil moisture also increased and this can be explained because SOM improves the water holding capacity in the soil.

The Table 3 shows that there is a weak positive relationship between tea yields and SOM, r=+.177. Variation in tea yields can be explained by organic matter content up to 17.7%. This implies that even though organically rich soils enhance tea yields, the magnitude of influence is not statistically significant at $p \leq 0.05$. Approximately 82% variation in tea yield can possibly be explained by other factors such as rainfall, air temperature, seasons, soil type, soil temperature among others.

Table.3: Pearson Correlation table between SOM, yield and different soil properties

	Yield	SOM	SN	BD	P	SNC	PD	LN	pH
Yield	1.000								
SOM	0.177	1.000							
SN	-0.171	-0.183	1.000						
BD	-0.142	-0.087	0.120	1.000					
P	0.096	-0.251	0.179	0.307	1.000				
SMC	-0.143	0.009	-0.164	0.046	-0.016	1.000			
PD	0.030	-0.220	0.168	0.701	0.879	0.020	1.000		
LN	0.088	0.045	0.137	-0.084	0.143	-0.186	0.056	1.000	
pH	-0.546	-0.242	0.046	0.008	-0.037	0.128	-0.049	0.070	1.000

soil organic matter (%) (SOM); soil nitrogen (SN); bulk density(g/cm^3) (BD); porosity(P); soil moisture content (%) (SMC); particle density(g/cm^3) (PD), leaf nitrogen (%) (LN)

IV. CONCLUSION

The relationship between SOM and soil functions that define soil quality and health is, however, not always linear. The relation may vary with the method used to measure stability and other soil and environmental properties that influence structural behaviour.There was a positive correlation between tea yields and SOM, however it was a weak relation. The results suggest that increasing SOM increases tea yields. However, to observe actual significant yield increase other factors such enough rainfall, optimum temperatures among others should also be included. Therefore, in order to maintain or enhance tea yields increasing SOM content alone is not recommended. Ensuring other factors such as other good agricultural practices and weather factors are at the required levels is also of importance when in a bid to increase tea yields.

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Floristic Diversity of Puliyanamkunnu, Chalavara Grama Panchayath, Palakkad District, Kerala State

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Abstract— *Botanical exploration in Puliyanamkunnu, Chalavara Grama Panchayath of Palakkad district yielded a total of 80 wild taxa of angiosperms. These taxa belong to 65 genera covering 38 families including 36 herbs, 12 climbers, 14 Shrubs and 18 trees. Among them 12 species are endemics and 10 species are rare and red listed. Out of these 80 taxa, 69 species are recorded to be used in different systems of medicines like Ayurveda, Siddha, Unani, Tibetan, Homeopathy, Folk and Western or Modern system. The data will provide information on herbs, Shrubs, climbers and trees that exist in the Puliyanamkunnu, Chalavara Grama Panchayath and about the natural condition under which these plants grow. Such studies will provide reliable information on the presents and distribution of plants in general. This data coupled with studies on threat assessment and trade can also guide focused. Conservation actions like species recovery for each species its local uses are provided. Voucher specimens are deposited in the Sree Krishna college herbarium, with the correct botanical identity and medicinal uses recorded in brief.*

Keywords— Diversity, Chalavara, Palakkad.

I. INTRODUCTION

A botanical exploration was carried out in the Puliyanamkunnu, Chalavara Grama Panchayath, Ottapalam taluk, Palakkad district, Kerala state to collect and study the rare and endemic plants of the region. The Puliyanamkunnu is a hill area located in Puliyanamkunnu water shed near Anangan mala ecotourism project, Palakkad district of Kerala. During the survey, a local guide (Member of Panchayath level Peoples Biodiversity Register Committee) and a medicine man belonging to Mannan community, accompanied us for helping in locating the medicinal plants. Since ages the Mannan and Peruvannan community has been using these plants to treat a number of ailments and diseases. However, due to lack of proper documentation, the knowledge is getting lost. The present paper is an effort to focus attention on the documentation and preservation of the traditional knowledge on some of the endemic, rare, red listed and medicinal plants. This is especially important because the last couple of decades have brought the plant-based medicines back into focus of research as well as development of value added products (Alagesaboopathi & Balu 1999).

Mannan is the minor scheduled community living in the Palakkad district and their lives and economy are intimately interlinked with the nature. They depend mostly upon the forest flora and fauna for their livelihood. This community collects and utilizes many plants for food, fibre, fuel and medicines and their very survival depends on the non-wood forest produce of the region. The present paper deals with the information gathered from an old Mannan vaidyar and the local healer of the community about the medicinal plants used in the health care of the tribe is given. Eighty such plants are included this paper.

II. STUDY AREA

Puliyanamkunnu is a moist deciduous forest element with a low altitude plains area covering three wards of Chalavara Grama Panchayath, Ottapalam taluk, Palakkad district (Champion & Seth, 1968). The Puliyanamkunnu watershed starting from Pulinchimala and ending in Angadithodu. Two major roads passing through this area, 23 ponds, 2 kanals, 7 sacred groves are there. The present study conducted in the Puliyanamkunnu watershed area has resulted in the collection of 80 taxa of angiosperms coming under 65 genera and 38 families. Out of these, 22 rare, endemic, red listed and taxonomically important species are enumerated here with updated nomenclature, local name,

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family, brief description, distribution and habitat, phenological data, specimen examined and notes for better understanding of these taxa. The voucher specimens are deposited at the Sree Krishna College, Guruvayur.

III. MATERIALS AND METHODS

The study area was visited during different seasons and two specimens were collected in each species and these were systematically numbered and tagged. Important field observation like, habit, phenology of the plant, colour, texture and smell of leaves, abundance, local names and local uses available were also noted. Each species in fresh condition was critically studied with the help of floras like, *Flora of Presidency of Madras* (Gamble, 1915-1936); *Flowering Plants of Kerala* (Sasidharan, 2004). The plants were identified with the help of floras and finally by comparing with the reference collections available in the Herbarium of Kerala Forest Research Institute, Peechi. The species were often poisoned, processed and labeled, by standard herbarium methods given by Santapau (1955) and Jain & Rao (1977).

IV. RESULTS AND DISCUSSION

The present study conducted in the Puliyanamkunnu watershed area has resulted in the collection of 80 taxa of angiosperms. These taxa belong to 65 genera covering 38 families including 36 herbs, 12 climbers, 14 Shrubs and 18 trees. Among them 12 species are endemics and 10 species are rare and red listed. Out of these 80 taxa, 69 species are recorded to be used in different systems of medicines like Ayurveda, Siddha, Unani, Tibetan, Homeopathy, Folk and Western or Modern system. (Ravikumar *et al*., 2000; Udayan & Indira Balachndran, 2009).

In the present paper a total of 80 species were collected and they are arranged alphabetically. Information provided includes botanical name, family, habit, systems of medicine and status. **(Table 1)**

Table.1: List of species collected

A: Ayurveda, **F**: Folk, **H**: Homeopathy, **M**: Western or Modern, **S**: Siddha, **T**: Tibetan and **U**: Unani.

Sl. No.	Botanical name	Family	Habit	Systems of medicine	Status
1	**Anamirta cocculus** (L.) Wight & Arn.	Menispermaceae	Climber	F,H,M,S,U	Medicinal
2	**Abelmoschus moschatus** Medik.	Malvaceae	Herb	A,F,S,U	Cultivated
3	**Abrus precatorius** L.	Fabaceae	Climber	A,F,H,S,T	Medicinal
4	**Acalypha indica** L.	Euphorbiaceae	Herb	A,F,H,S,U	Medicinal
5	**Acanthospermum hispidum** DC.	Asteraceae	Herb	-	-
6	**Aegle marmelos** (L.) Correa	Rutaceae	Tree	A,F,H,T,U	Red listed
7	**Alstonia scholaris** (L.) R. Br.	Apocynaceae	Tree	A,F,H,T,U	Medicinal
8	**Artocarpus hirsutus** Lam.	Moraceae	Tree	A,F	Endemic
9	**Alysicarpus vaginalis** (L.) DC.	Fabaceae	Herb	F	Red listed
10	**Bambusa bambos** (L.) Voss	Poaceae	Tree	A,F,S,U	Medicinal
11	**Bougainvillea spectabilis** Willd.	Nyctaginaceae	Shrub	F	Cultivated
12	**Breynia retusa** (Dennst.) Alston	Euphorbiaceae	Shrub	A,F,S	Medicinal
13	**Breynia vitis-idaea** (Burm. f.) C.E.C. Fisch.	Euphorbiaceae	Shrub	F,S,U	Medicinal
14	**Canscora pauciflora** Dalz	Gentianaceae	Herb	-	Red listed
15	**Canthium rheedei** DC.	Rubiaceae	shrub	F	Red listed
16	**Catharanthus pusillus** (Murr.) G. Don	Apocynaceae	Herb	F,S	Red listed
17	**Curcuma neilgherrensis** Wight	Zingiberaceae	Herb	-	Red listed
18	**Cynanchum tunicatum** (Retz.) Alston in Trimen	Asclepiadaceae	Climber	-	Red listed
19	**Cycas circinalis** L	Cycadaceae	Tree	A,F,S,U	Red listed
20	**Dipteracanthus prostratus** (Poir.) Nees	Acanthaceae	Herb	F	Red listed
21	**Drosera burmannii** Vahl	Droseraceae	Herb	F	Red listed
22	**Elephantopus scaber** L.	Asteraceae	Herb	A,F,S,U	Medicinal
23	**Eleusine indica** (L.) Gaertn.	Poaceae	Herb	A,S	Medicinal
24	**Emilia sonchifolia** (L.) DC.	Asteraceae	Herb	A,F,S,U	Medicinal

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25	**Eragrostis viscosa** (Retz.) Trin.	Poaceae	Herb	-	-
26	**Ficus tsjahela** Burm. f.	Moraceae	Tree	F	-
27	**Gomphrena celosioides** Mart.	Amaranthaceae	Herb	F	-
28	**Gomphrena globosa** L.	Amaranthaceae	Herb	S,F	Cultivated
29	**Hemidesmus indicus** (L.) R.Br.	Periplocaceae	Climber	A,F,S,T,U	Red listed
30	**Heteropogon contortus** (L.) P. Beauv. ex Roem. & Schult.	Poaceae	Herb	F	-
31	**Hibiscus hispidissimus** Griff.	Malvaceae	Herb	A	-
32	**Holigarna arnottiana** Hook. f.	Anacardiaceae	Tree	F,S	Red listed
33	**Holostemma ada-kodien** Schult.	Asclepiadaceae	Climber	A,F,U	
34	**Hoppea fastigiata** (Griseb.) Clarke	Gentianaceae	Herb	-	Red listed
35	**Hybanthus enneaspermus** (L.) F. Muell.	Violaceae	Herb	A,F,S	Medicinal
36	**Hyptis suaveolens** (L.) Poit.,	Lamiaceae	Herb	F	-
37	**Impatiens chinensis** L.	Balsaminaceae	Herb	F	-
38	**Indigofera colutea** (Burm. f.) Merr.	Fabaceae	Herb	-	-
39	**Indigofera linnaei** Ali.	Fabaceae	Herb	A,F,S	Medicinal
40	**Ipomoea hederifolia** L.	Convolvulaceae	Climber	F	Cultivated
41	**Ipomoea obscura** (L.) Ker-Gawl.	Convolvulaceae	Climber	A,F,S	Medicinal
42	**Ixora coccinea** L.	Rubiaceae	Shrub	A,F,S,U	Medicinal
43	**Jasminum sambac** (L.) Ait.	Oleaceae	Climber	A,F,S,T,U	Medicinal
44	**Leucas aspera** (Willd.) Link	Lamiaceae	Herb	A,F,H,S,U	Medicinal
45	**Lindernia ciliata** (Colsm.) Pennell	Scrophulariaceae	Herb	F	-
46	**Macaranga peltata** (Roxb.) Muell.-Arg.	Euphorbiaceae	Tree	F,S	-
47	**Memecylon umbellatum** Burm.f.	Melastomaceae	Tree	F	Endemic
48	**Moringa pterygosperma** Gaertn.	Moringaceae	Tree	A,S,T,U	Cultivated
49	**Murraya koenigii** (L.) Spreng.	Rutaceae	Tree	A,F,S,U	Cultivated
50	**Mussaenda frondosa** L.	Rubiaceae	Tree	A,F,S,U	Red listed
51	**Murdannia spirata** (L.) Brueck.	Commelinaceae	Herb	-	-
52	**Naregamia alata** Wight & Arn.	Meliaceae	Herb	A,F	Red listed
53	**Ocimum americanum** L.	Lamiaceae	Herb	A,F,H	Medicinal
54	**Olea dioica** Roxb.	Oleaceae	Tree	F,S	Endemic
55	**Osbeckia muralis** Naud.	Melastomaceae	Herb	-	Endemic
56	**Piper longum** L.	Piperaceae	Climber	A,F,S,T,U	Red listed
57	**Pseudarthria viscida** (L.) Wight & Arn.	Fabaceae	Herb	A,S,U	Red listed
58	**Rhynchoglossum notonianum** (Wall.) Burtt	Gesneriaceae	Herb	-	Red listed
59	**Ricinus communis** L.	Euphorbiaceae	Shrub	A,F,S,T,U	Medicinal
60	**Saraca asoca** (Roxb.) de Wilde	Caesalpiniaceae	Tree	A,F,H,S,U	Red listed
61	**Sida cordata** (Burm. f.) Borss.	Malvaceae	Herb	A,F,S,U	Medicinal
62	**Sida fryxellii** Sivar. & Pradeep	Malvaceae	Herb	A	Endemic
63	**Sida mysorensis** Wight & Arn.	Malvaceae	Herb	A	Medicinal

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64	**Smithia blanda** Wall.ex Wight & Arn.	Fabaceae	Herb	-	Red listed
65	**Solanum violaceum** Ortega	Solanaceae	Shrub	A,F	Medicinal
66	**Spermacoce mauritiana** Osea Gideon ex Verdc.	Rubiaceae	Herb	-	Red listed
67	**Syzygium caryophyllatum** (L.) Alston	Myrtaceae	Tree	A,F,	
68	**Tabernaemontana alternifolia** L.	Apocynaceae	Shrub	A,F	Red listed
69	**Tamarindus indica** L.	Caesalpiniaceae	Tree	A,F,S,T,U	Endemic
70	**Tecoma stans** (L.) HBK	Bignoniaceae	Shrub	F,S	Cultivated
71	**Tectona grandis** L.f.	Verbenaceae	Tree	A,F,S,T,U	Cultivated
72	**Terminalia bellirica** (Gaertn.) Roxb.	Combretaceae	Tree	A,F,S,U	Medicinal
73	**Terminalia cuneata** Roth	Combretaceae	Tree	A,F,H,S,T,U	Red listed
74	**Thevetia peruviana** (Pers.) Merr.	Apocynaceae	Shrub	F,T	Cultivated
75	**Tragia involucrata** L.	Euphorbiaceae	Climber	A,F,S,U	Red listed
76	**Trichosanthes cucumerina** L.	Cucurbitaceae	Climber	A,F,S,U	Medicinal
77	**Vigna radiata** (L.) Wilczek var. **sublobata** (Roxb.) Verdc.	Fabaceae	Climber	A	Medicinal
78	**Vitex negundo** L.	Verbenaceae	Shrub	A,F,S,T,U	Medicinal
79	**Woodfordia fruticosa** (L.) Kurz	Lythraceae	Shrub	A,F,S,T,U	Medicinal
80	**Ziziphus rugosa** Lam.	Rhamnaceae	Shrub	F,S,U	Medicinal

5 medicinal plants were assessed in Conservation Assessment Management Plan Workshop (CAMP) as Red Listed Medicinal Plants were collected from the present study site. *Drosera burmanni* Vahl (Droseraceae); *Holostemmaada-kodien* Schult. (Asclepiadaceae); *Pseudarthria viscida* (L.)Wight & Arn. (Fabaceae); *Trichosanthes cucumerina* L. (Cucurbitaceae) and *Vigna radiata* (L.) Wilczek var. *sublobata* (Roxb.) Verdc. (Fabaceae). 6 medicinal plants were assessed in Conservation Assessment Management Plan Workshop (CAMP) as Red Listed Medicinal Plants were collected from the present study site. *Aegle marmelos* (L.) Correa (Rutaceae); *Artocarpus hirsutus* Lam. (Moraceae); *Cycas circinalis* L. (Cycadaceae); *Piper longum* L. (Piperaceae); *Saraca asoca* (Roxb.) de Wilde (Caesalpiniaceae) and *Terminalia cuneata* Roth (Combretaceae). 2 species are endemic to Western Ghats *Canscora pauciflora* Dalz. (Gentianaceae) and *Osbeckia muralis* Naud. (Melastomaceae). 4 species are endemic to Peninsular India *Alysicarpus vaginalis* (L.) DC. (Fabaceae); *Curcuma neilgherrensis* Wight (Zingiberaceae) and *Naregamia alata* Wight & Arn. (Meliaceae). 2 species are endemic to India *Dipteracanthus prostratus* (Poir.) Nees (Acanthaceae) *Smithia blanda* Wall. ex Wight &Arn. (Fabaceae). 4 species are endemic to Western Ghats *Artocarpus hirsutus* Lam. (Moraceae); *Holigarna arnottiana* Hook.f. (Anacardiaceae); *Mussaenda frondosa* L. (Rubiaceae) and *Tabernaemontana alternifolia* L. (Apocynaceae). 1 species are endemic to Peninsular India *Canthium rheedei* DC. (Rubiaceae). 9 Species Endemic to India and Sri Lanka *Catharanthus pusillus* (Murray) G. Don (Apocynaceae), *Cynanchum tunicatum* (Retz.) Alston (Asclepiadaceae), *Hemidesmus indicus* (L.) R.Br. (Periplocaceae), *Hoppea fastigiata* (Griseb) Clarke (Gentianaceae), *Polygala rosmarinifolia* Wight &Arn. (Polygalaceae), *Pseudarthria viscida* (L.) Wight & Arn. (Fabaceae), *Rhynchoglossum notonianum* (Wall.) Burtt. (Gesneriaceae), *Spermacoce mauritiana* Oseagideon ex Verdc. (Rubiaceae) and *Tragia involucrata* L. (Euphorbiaceae).

V. CONCLUSION

Out of 80 plants 69 plants are medicinal. Here endemic plants *Artocarpus hirsutus, Memecylon malabaricum, Osbeckia muralis,* and *Olea dioica* are present. When compare to habit of species more number of herbs and shrubs are present, but less numbers of trees. This shows the disturbance inside the natural habitat. In this circumstance suitable management measures and awareness programmes about the importance of sacred groves are necessary for sustainable utilization of the valuable

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bioresources. Chalavara Grama Panchayath proposed suitable plans to protect this area.

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Effect of Crude Oil and Carbofuran on Insect Pests, Nematodes, Growth and yield of Nsukka Yellow Pepper (*capsicum annum*) in Enugu Area of Southeastern Nigeria

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***Abstract*— *A field experiment to evaluate the effect of crude oil and Carbofuran on insect pests, Nematodes, growth and yield of Nsukka yellow pepper (capsicum annum) was conducted in the Faculty of Agriculture and Natural Resources Management Teaching and Research Farm, Enugu State University of Science and Technology Enugu during the 2018 cropping season. The experiment was carried out using a 4 x 3 factorial in a complete randomized design (CRD) with twelve (12) treatments replicated three (3) times. The result of the experiment showed a significant interaction effect (p=0.05) of crude oil and carbofuran on the number of aborted fruits per plant, number of root knot nematodes per plant and fruit yield (kg)per pot. The result of the experiment also showed non-significant interaction effect (p=0.05) of crude oil and Carbofuran on the number of dead plants, plant height, number of leaves per plant, number of curled leaves per plant, insect infestation and number of fruits per plant. Furthermore, there was non-significant main effect (p=0.05) of both crude oil and carbofuran on the number of plants that died 73 and 86 days after planting, plant height, number of grasshoppers per plant, whereas the main effect of both crude oil and Carbofuran on the number of root knot nematodes was significant (p=0.05). The result of the experiment further showed a significant main effect of crude oil on the number of aborted fruits per plant while the main effect of carbofuran on the number of aborted fruits was non-significant (p=0.05). Again, the result of the experiment showed a non-signification main effect (p=0.05) of crude oil and carbofuran on fruit yield (kg) per pot.*

Keywords*—*Nsukka yellow pepper (Capsium annum) crude oil, carbofuran, Interaction effect, main effect.

I. INTRODUCTION

Nsukka yellow pepper belongs to the family *solanaceae* and the genus *capsicum* (Uguru and Obieri 2008). Nsukka yellow pepper is a vegetable fruit consumed either fresh or dehydrated/dried. It is an indispensable commodity and an integral component of many cuisines in the world due to its appealing flavour, taste and pungency, (Bosland and Votava 2000). *Capsicum* species is grown in most countries of the world such as China, Turkey, Mexico, Spain, U.S.A., among which Nigeria is ranked third producer of pepper in the world (Uguru andObieri 2008). Pepper occupies the third position of importance among cultivated vegetables after onion and tomatoes (Uzo, 1983). Pepper is an ancient vegetable crop whose production is presently on the increase (Uzo, 1983). *Capsicum anuum* is an indigenous vegetable of Nigeria and as such, its production is an important component of both subsistence and commercial farming system generally practiced in Nigeria especially Enugu State (Tanko, 1995). In Nigeria, Pepper accounts for 20 percent of the average daily vegetable intake either as soups or as condiments in the diets of Nigerians. Nigeria is one of the most important countries in the world for Pepper genetic resources since it accounts for 50% out of million tonnes believed to be produced in Africa, following the world estimated area of 1.6 million hectares with China being the largest producer and 1 million tonnes believed to be produced in Africa (FAOSTAT 2013).

Nsukka yellow pepper is characterized by its yellow colour at fruit ripening and a unique aroma, which distinguish it from other pepper varieties. It is very nutritious and has medicinal value and is a recognized source of vitamin A, C and E. In addition, it is a sources of antioxidants, nutrients, as well as bioactive compounds such as flavonoids, phenolic acids, carotenoids and also rich in natural colour and aroma. The key bioactive compounds in peppers such as flavonoids, capsaicinoids and capsicinoids have been linked to biochemical and pharmacological effect including anti-oxidation and anti-inflammation activities. Capsaicinoids provide the pungent sensation in hot peppers whereas capsicinoids are non-pungent compound present in sweet peppers. Capsicinoids have been reported to have anti-inflammatory activities as well as to promote energy consumption and to suppress fat accumulation, increase body temperature in humans. The activities of capsicinioids and their lack of pungency, make them attractive for potential application in food and pharmacology.Other major bioactive compounds of peppers include ascorbic acid, carotenoids, and other antioxidants. The culinary properties and biological effects of bioactive compounds make them extremely important not only for nutrition, but also as pharmacological substrate that are used in prevention of cardiovascular diseases, cancers and cataracts. In addition it is used for preservation of cowpea and other grains against weevil attack (Echezona, 2006).

In Nigeria, pepper production has not attracted the same research patronage like other crops such as cassava, cocoa, Rice, Cowpea etc. (Awoke and Okorji 2004). As a result, a few or no research has been conducted to find out why Nsukka yellow pepper is not grown in many parts of Nigeria especially in oil producing states.

Again, a lot of pests and diseases attack peppers at various stages of growth and development which motivated me to carry out a research work that aimed at evaluating the effect of crude oil and carbofuran on nematodes, insect pests, growth and yield of Nsukka yellow pepper in Enugu area of Southeastern Nigeria.

II. MATERIALS AND METHODS

A field experiment to evaluate the effect of crude oil and carbofuran on insect pests, nematodes, growth and yield of Nsukka yellow pepper (*Capsicum annum*) was carried out during the 2018 cropping season at the Faculty of Agriculture and Natural Resources Management Teaching and Research Farm of Enugu State University of Science and Technology Enugu, Southeastern Nigeria. The University lies between latitude $06^0 50$'N -$06^0 57$'N and longitude $07^0 15$'E - $07^0 15$'E with a mean elevation of 450 m above sea level.

Experiment design

The experiment was carried out using a 4 x 3 factorial in a complete randomized design (CRD) with twelve (12) treatments replicated three (3) times. Each experimental pot/unit (replicate) contained 10kg soil. The pepper seedlings were raised in a nursery before they were transplanted into the various experimental pots. Each pot contained one pepper plant.

Treatments

Treatments were; Four (4) rates of crude oil viz; 0ml, 20ml, 40ml and 60ml (Factor A). Threerates of carbofuran viz, 0g, 10g and 20g (Factor B)

Treatment Combinations

0ml crude oil + 0g carbofuran - - - - -	A_1B_1
0ml crude oil + 10g carbofuran - - - -	A_1B_2
0ml crude oil + 20g carbofuran - - - -	A_1B_3
20ml crude oil + 0g carbofuran - - - -	A_2B_1
20ml crude oil + 10g carbofuran - - - -	A_2B_2
20ml crude oil + 20g carbofuran - - - -	A_2B_3
40ml crude oil + 0g carbofuran - - - -	A_3B_1
40ml crude oil + 10g carbofuran - - - -	A_3B_2
40ml crude oil + 20g carbofuran - - - -	A_3B_3
60ml crude oil + 0g carbofuran - - - -	A_4B_1
60ml crude oil + 10g carbofuran - - - -	A_4B_2
60ml crude oil + 20g carbofuran - - - -	A_4B_3

Data Collection

Data were collected on the number of plants that died 73 and 86 days after planning (DAP), plant height, number of leaves per plants, number of fruits per plant, number of aborted fruits per plant, curled leaves per plants, insect pests infestation per plants, number of root knot nematodes per plant and fruit yield(kg) per pot.

Data Analysis

The data collected were subjected to analysis of variance for factorial experiment as outlined by Obi 2001 using Genstat Release 10.3DE (PC windows) 2012 software. Differences between treatment means were detected using Fisher's least significant difference (F-LSD) as outlined by steel and Torrie (1980).

III. RESULTS

Effect of crude oil and carbofuran on the number of plants that died 73 and 86 Days After Planting (DAP).

The result of the experiment showed a non-significant interaction effect (p=0.05) of crude oil and carbofuran on the number of plants that died 73 and 86 days after planting. Also there was a non-significant

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(p=0.05) main effect of both crude oil and carbofuran on the number of plants that died 73 and 86 days after planting. This result however shows that Nsukka yellow pepper can survive crude oil pollution up to 60ml per 10kg of soil (Table 1). However, 20ml crude oil + 0g carbofuran, 40ml crude oil + 0g carbofuran and 60ml crude oil + 0g carbofuran each recorded the highest number of 1.052 dead plants 86 days after planting.

Table.1: Effect of crude oil and carbofuran on the number of plants that died 73 and 86 days after planting (DAP).

Treatments	Number of plant that died 73 days after planting	Number of plant that died 86 days after planting
0ml crude oil + 0g carbofuran	0.707	0.707
0ml crude oil + 10g carbofuran	0.707	0.707
0ml crude oil + 20g carbofuran	0.707	0.707
20ml crude oil + 0g carbofuran	0.880	1.052
20ml crude oil + 10g carbofuran	0.707	0.880
20ml crude oil + 20g carbofuran	0.880	0.880
40ml crude oil + 0g carbofuran	0.880	1.052
40ml crude oil + 10g carbofuran	0.880	0.880
40ml crude oil + 20g carbofuran	0.707	0.880
60ml crude oil + 0g carbofuran	0.880	0.880
60ml crude oil + 10g carbofuran	0.707	0.707
60ml crude oil + 20g carbofuran	0.880	1.052
F – $LSD_{0.05}$	**NS**	**NS**

Effect of crude oil and carbofuran on plant height (cm) and number of leaves per plant 73 DAP.

The result of the experiment showed a non-significant interaction and main effect (p=0.03) of crude oil and carbofuran on plant height and number of leaves per plant 73 days after planting. However, 20ml of crude oil and 10g of carbofuran produced the highest mean plant height of 71.30cm whereas 60ml produced the highest mean number of 207 leaves per plant (Table 2).

Table.2: Effect of crude oil and carbofuran on plant height and number of leaves per plant 73 DAP.

Treatment	Plant height (cm)	Number of leaves per plant
0ml crude oil + 0g carbofuran	58.40	154.00
0ml crude oil + 10g carbofuran	49.70	69.00
0ml crude oil + 20g carbofuran	46.30	119.00
20ml crude oil + 0g carbofuran	48.20	155.00
20ml crude oil + 10g carbofuran	71.30	201.00
20ml crude oil + 20g carbofuran	45.00	134.00
40ml crude oil + 0g carbofuran	45.00	135.00
40ml crude oil + 10g carbofuran	58.38	139.00
40ml crude oil + 20g carbofuran	65.60	191.00
60ml crude oil + 0g carbofuran	47.00	120.00
60ml crude oil + 10g carbofuran	67.70	207.00
60ml crude oil + 20g carbofuran	61.30	204.00
F – $LSD_{0.05}$	**NS**	**NS**

Effect of crude oil and carbofuran on the number of fruits per plant and aborted fruits per plant 73 days after planting.

The result of the experiment showed non-significant interaction effect (p=0.05) of crude oil and carbofuran on the number of fruits per plant 73 days after planting, whereas the interaction effect of crude oil and carbofuran on the number of aborted fruits per plant was significant (p=0.05). There was non-significant main effect (p=0.05) of crude oil and carbofuran on the number

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of fruits per plant. Again, there was a significant main effect (p=0.05) of crude oil on the number of aborted fruits per plant, whereas the main effect of carbofuran on the number of aborted fruits was non-significant (p=0.05). However, 0ml of crude oil and 0g of carbofuran produced the least number of 11.00 fruits per plant while 60ml of crude oil and 20g of carbofuran produced the highest number of 1.386 aborted fruit per plant (Table 3).

Table.3: Effect of crude oil and carbofuran on the number of fruits and aborted fruits per plant 73 days after planting.

Treatments	**Number of fruits per plant**	**Number of aborted fruits per plant**
0ml crude oil + 0g carbofuran	11.00	0.707
0ml crude oil + 10g carbofuran	10.70	0.880
0ml crude oil + 20g carbofuran	18.00	0.707
20ml crude oil + 0g carbofuran	33.00	0.707
20ml crude oil + 10g carbofuran	33.00	1.052
20ml crude oil + 20g carbofuran	24.00	0.707
40ml crude oil + 0g carbofuran	16.70	0.707
40ml crude oil + 10g carbofuran	12.30	0.707
40ml crude oil + 20g carbofuran	13.30	0.998
60ml crude oil + 0g carbofuran	33.90	1.179
60ml crude oil + 10g carbofuran	33.00	0.998
60ml crude oil + 20g carbofuran	14.00	1.386
F – $LSD_{0.05}$	**NS**	**0.638**

Effect of crude oil and carbofuran on the number of grasshoppers and curled leaves per plant.

Statistical analysis of the experiment showed a non-significant effect (p=0.05) of crude oil and carbofuran on the number of grasshoppers and curled leaves per plant. The result of the experiment further showed a non-significant main effect (p=0.05) of both crude oil and carbofuran on the number of grasshoppers and curled leaves per plant. However, 20ml of crude oil + 0g of carbofuran and 40ml of crude oil + 0g of carbofuran recorded the highest number of 3.06 and 2.09 curled leaves respectively, whereas 20ml of crude oil + 0g of carbofuran and 40ml of crude oil + 0g of carbofuran recorded the highest number of 1.179 and 1.171 grasshopper per plant respectively (Table 4).

Table.4: Effect of crude oil and carbofuran on the number of grasshoppers and curled leaves per plant.

Treatments	**Number of grasshopper per plant**	**Number of curled leaves /plants**
0ml crude oil + 0g carbofuran	0.707	1.89
0ml crude oil + 10g carbofuran	0.880	1.57
0ml crude oil + 20g carbofuran	0.880	1.54
20ml crude oil + 0g carbofuran	1.179	3.06
20ml crude oil + 10g carbofuran	0.707	0.71
20ml crude oil + 20g carbofuran	0.707	1.10
40ml crude oil + 0g carbofuran	1.171	2.09
40ml crude oil + 10g carbofuran	0.707	1.65
40ml crude oil + 20g carbofuran	0.707	0.71
60ml crude oil + 0g carbofuran	0.707	0.71
60ml crude oil + 10g carbofuran	0.880	1.32
60ml crude oil + 20g carbofuran	0.707	1.00
F – $LSD_{0.05}$	**NS**	**NS**

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Effect of crude oil and carbofuran on the number of root knot Nematodes per plant and fruit yield (kg) per pot.

The result of the experiment showed a significant interaction effect (p=0.05) of crude oil and carbofuran on the number of root knot Nematodes per plant and non-significant interaction effect (p=0.05) on fruit yield (kg) per pot. Plants treated with no crude oil + no carbofuran recorded the highest mean number of 3.794 root knot Nematodes, which differed significantly from all the treatment combinations. This was followed by plants treated with 0ml crude oil + 10g carbofuran that recorded a mean number of 0.998 root knot Nematode which did not differ from the remaining treatment combinations.

Furthermore, there was significant interaction effect (p=0.05) of crude oil and carbofuran on fruit yield (kg) per pot. Plants treated with 60ml crude oil + 10g carbofuran recorded the highest yield of 0.0874kg per pot which differed significantly (p=0.05) from the other treatment combinations which were statistically the same. There was a significant main effect of both crude oil and carbofuran on the number of root knot Nematodes per plant and fruit yield (kg) per pot of Nsukka yellow pepper (Table 5).

Table.5: Effect of crude oil and carbofuran on the number of root knot Nematodes per plant and fruit yield (kg) per pot.

Treatments	Number of root knot Nematodes per plant	fruit yield (kg) per pot
0ml crude oil + 0g carbofuran	3.794	0.0130
0ml crude oil + 10g carbofuran	0.998	0.0145
0ml crude oil + 20g carbofuran	0.707	0.0152
20ml crude oil + 0g carbofuran	0.707	0.0211
20ml crude oil + 10g carbofuran	0.707	0.0383
20ml crude oil + 20g carbofuran	0.707	0.0232
40ml crude oil + 0g carbofuran	0.707	0.0368
40ml crude oil + 10g carbofuran	0.707	0.0276
40ml crude oil + 20g carbofuran	0.707	0.0564
60ml crude oil + 0g carbofuran	0.707	0.0441
60ml crude oil + 10g carbofuran	0.707	0.0874
60ml crude oil + 20g carbofuran	0.707	1.0127
F – LSD ($_{0.05}$)	**0.452**	**0.0747**

IV. DISCUSSION

A non-significant effect of crude oil and carbofuran on the number of plants that died 73 and 86 DAP therefore means that crude oil and carbofuran could not have a negative interaction effect on the life of Nsukka yellow pepper, so also, the main effect of crude oil and carbofuran. Therefore, Nsukka yellow pepper could be used as a photoremedial plant in oil polluted areas. The result also showed that Nsukka yellow pepper could survive in crude oil polluted areas having not more than 60ml of crude oil per 10kg of soil. Odu in 1981 had almost the same observation when he stated that crude oil pollution up to 1% could easily be degraded by natural rehabilitation in soils, as the oil could be expected to increase organic matter in the soil and improve the fertility, physical and chemical properties of the soil. A significant main effect (P=0.05) of crude oil on fruit yield per pot tends to supports the observation of Agbogidi and Akparobi (2007) who stated that small amount of crude oil in the soil is not harmful but could actually help the plant. However, the result of this experiment disagrees with the observation of Ohanmu*et al* (2014) who reported that crude oil polluted soil adversely affected the growth and survival of *capsicum annum* plant at various concentrations of treatments, and that the pepper plants that survived were stunted, chlorotic and leafless.

A non-significant main effect (p=0.05) of carbofuran on the mean plant height and number of leaves per plant supports the observation of Jada (2011) who stated that carbofuran had no significant effect on plant height and number of leaves per plant when he applied it to control nematodes in Bambara groundnut. Therefore, farmers should not apply carbofuran to crops if the aim is to improve vegetative growth. Crude oil having a significant main effect on the number of aborted fruits per plant may be due to stoppage of water and minerals supply to some fruits as a result of death of some plant roots emanating from anaerobic condition produced by crude oil. This result supports the report of Ohanmu*et al*. 2014 who stated that spillage of crude oil on soil makes it unsatisfactory for plant growth as a result of insufficient aeration of the soil as air is displaced from the space between the soil particles by crude oil. This study therefore reveals that Nsukka yellow pepper could survive various concentrations of crude oil pollution up to 60ml per 10kg of soil, but a high rate of fruit abortion may be recorded during fruiting. Therefore there is need to protect arable farm land from crude oil spillage to avoid economic fruit waste during crop production.

V. RECOMMENDATION

I recommend a further investigation on the effect of crude oil on the growth and yield of Nsukka yellow pepper (*Capsicum annum*) where higher volumes of more than 60ml of crude oil per 10kg of soil will be applied to be sure if Nsukka yellow pepper can be recommended as a photoremedial plant in oil polluted areas. I also recommend crude oil to be used as a nematicide in crop production.

In order to improve photoremedialactivities of Nsukka yellow pepper in oil polluted soils, carbofuran could be applied to the soil. Farmers are advised not to apply carbofuran to the soil if the aim is to improve vegetative growth of crops.

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Evaluation of Maize (Zea Mays L.) to Application of Arbuscular Mychorrizal Fungi in Coal Mining Tailings

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***Abstract*—*The purpose of this study was to obtain The best dose of Arbuscular Mycorrhizal Fungi (FMA) and the best maize varieties for the growth and high yield of plants in coal mining tailings. This research was conducted using a completely randomized factorial design with 2 treatments. The first factor was the dose of arbuscular mycorrhizal fungal (6 treatments). The second factor was 4 varieties of corn. Data was analyzed statistically using the F-test at the 5% significance level. Significant differences were further tested using Duncan's Multiple Range Test also at the 5% level. Parameters measured were: percentage of roots infected with the Arbuscular mycorrizal fungi during growth and at the time of harvest, kernel with per plant. A dose 25 grams of FMA was the best dose for growth and yield of Bisi-2 with avarage production 179,8 gram per plant in coal mining tailings.*

Keywords*—*Application Doses, Maize Varieties, Arbuscular Mycorrhizal Fungi, Coal Mining Soil.

I. INTRODUCTION

Food needs continue to increase while the availability of agricultural land is getting smaller. This is due to the conversion of agricultural land to activities outside of agriculture. One of the critical lands that has the potential to be converted into potential agricultural land is coal mining tailings. Sawahlunto City is a city that has coal mining tailings. The total coal mining area in Sawahlunto City reaches 1,000.03 hectares which has turned into unproductive land (Subowo, 2011; Sari, 2012; Dinas Energi Sumber Mineral, 2013). The Problems in coal mining tailings used as agricultural areas are low fertility rates, damage to physical structures and nutrient degradation (Qomariah, 2003; Personal 2012). The problem is an obstacle if the land is used as agricultural land because it can inhibit plant growth.

In terms of technical aspects, coal mining areas can be used for agricultural cultivation if soil conditions have been improved by reclaiming the coal mining tailings (Subowo, 2011). So that it can minimize the negative impacts of mining that have been carried out (Sheoran et al., 2010).

Based on the results of experiments that have been carried out, plants with a dose of 0 gram AMF treatment were infected by FMA. This is presumably because the watering of plants does not use sterilized water so that mycorrhizal spores can be carried away by watering water from groundwater found around the trial area. Similar to Akmal's (2014) study that the effect of giving AMF and the frequency of watering on corn plants showed infection with a moderate category of 40.33%. Another factor that causes is the carrying of AMFspores by wind. In accordance with Coyne (1999) that AMF can be spread actively (growing with mycelium in the soil) and spread passively where AMF is spread through wind, water or microorganisms in the soil.

One of the coal mining tailings that has been reclaimed with the use of Arbuscular Mycorrhizal Fungi (AMF) is coal mining land in Nagari Sikalang, Sawahlunto City, West Sumatra Province. Simarmata (2004) mentions one strategy and effort that can be done to restore soil quality is by utilizing Arbuscular Mycorrhizal Fungi (AMF).

Mycorrhiza plays an important role in increasing plant tolerance to toxic metal elements, resistance to drought and can increase plant growth by releasing P which is fixed by Al and Fe so that P can be available to plants (Cho et al., 2006; Subramanian, 2006; Setiadi and Setiawan, 2015). In addition to the use of Arbuscular Mycorrhizal Fungi (AMF), a suitable type of plant is needed to be cultivated on coal mining tailings. One of the plants that can be used is maize.

Maize are plants that have high phenotypic plasticity and are one of the most important world food crops besides wheat and rice. Maize production in Indonesia continues to increase every year. However, this production has not been able to keep up with market demand. Based on the Central Statistics Agency (2017), maize production in 2016 was 23.58 million tons, while in 2017 there were 26 million tons.

Several maize varieties have been produced in both free-range varieties and hybrid varieties. At present, only Sukmaraga free-range varieties are resistant to acidic land (Balitsereal, 2010). At present there are no commercial hybrid varieties that are reported to be resistant to acidic land conditions. Various varieties of corn have been produced by companies such as: Sygenta, Dupont, and Bisi International. But the resulting variety is still unknown in response to coal mining tailings. This present study was aimed to evaluate the accurate dose of AMF application that stimulated the best growth performance of coal mining tailings adaptive maize varieties.

II. MATERIALS AND METHODS

This research was conducted from February to Mei 2018 in the experimental garden and plant physiology laboratorium of Agriculture Faculty, Andalas University, Padang. Selection of several maize varieties with the application of various AMF doses in coal mining tailings was performed by observing the agronomical performances followed by root staining assay in the laboratorium (Philip and Heymen, 1979).

This study was conducted factorially with completely randomized design using two treatment factors, consisting of AMF doses and maize varieties. Six doses of AMF ranging from 0, 5, 10, 15, 20 and 25 g per polybag were evaluated to observe its effect on the growth performance of four marginal land-adaptive maize varieties (Bisi-2, NK-99, P3.2 and Sukmaraga). AMF inoculants used in this study were multispore type composed of *Glomus sp*., *Gigaspora sp.* and *Cytospora sp.* and collected from Laboratorium of Soil Biology, Faculty of Agriculture, Andalas University. Resulted data of this AMF application was further analyzed using regression and correlation analysis. Data were statistically analyzed using two way anova and significance among treatments was further evaluated using DMRT with a $p<0.05$.

III. RESULT AND DISCUSSION

3.1 Analysis of used soil coal pH after giving various doses of AMF

Based on the analysis of soil pH that has been done, there is an increase in soil pH value after administration of AMF treatment. The results of the statistical analysis with the F test at the level of 5% showed that the AMF dose had a significant effect on soil pH. The results of further tests with DMRT are shown in Table 1.

Can be seen in Table 1, giving AMF to each treatment has an effect on soil pH. The effect can be seen by doing a comparison between the pH value of the soil without the administration of AMF treatment and the pH value on AMF treated soil. The average pH value is 4.7 (tertolon. A dose of 25 grams of AMF is the best dose with an average pH value of 6.7 which is classified as neutral when compared to the dose of AMF 5 grams and 10 grams which results in a rather acidic soil pH value. However, AMF dosage of 15 grams and 20 grams also produces a soil pH that is classified as neutral, but not as high as the pH value produced by giving a dose of AMF 25 grams. One indicator of soil fertility is soil pH.

The higher the AMF dose given, the higher the pH on the soil. $Y = 4.81 + 0.08x$ which shows a positive regression value. From the equation, it is explained that every addition of 10 grams of AMF dose can increase pH on the soil. Giving FMA can increase soil pH. This is because the presence of AMF activity and metabolism produces and releases organic compounds which play a role in increasing metal cations that cause acidity of the soil so that the soil pH increases.

Nature of soil pH has a direct or indirect relationship with other soil chemical properties. With increasing soil pH, nutrients such as N, P and K available in the soil will also increase. Plants need balanced nutrients for the growth process. N deficiency causes disruption of P and K absorption for plant growth phases. Nutrient P is needed in large quantities after nutrient N, because nutrient P plays a role for plant growth from the vegetative phase to the genarative phase (Sufardi, 2012).

3.2 Percentage of Root Infected by AMF (Arbuscular Mycorrhizal Fungi)

The results of the statistical analysis with the F test at the level of 5% showed that the interaction of AMF doses and varieties and single dose factors significantly affected the percentage of roots infected with AMF at 8 MST and at harvest.

The AMF 25 gram treatment is the best dose obtained (Table 2). This can be seen from the percentage of roots infected with AMF in the treatment of AMF 25 grams. The NK-99 variety is a variety that has the highest percentage of root infection, which is 92.5%. This is in line with the growth in the vegetative and generative period of each corn plant variety that the best growth is found in the treatment of AMF 25 grams. In contrast to the 0 gram AMF treatment the criteria for infection are low.

Different responses in a plant to mycorrhizal infection are caused by differences in the dosage given and infection from spores, arbuscular and vesicular development, speed of spread of infection and growth of hyphae that emerge from the roots on a mycorrhiza with various hosts (Sastrahidayat, 2011). AMF will form spores in the soil and will develop well if associated with the host plant.

The percentage of maize infection at the time of harvesting the best FMA dose was also found in the 25 gram AMF treatment (Table 3). The administration of various AMF doses was significantly different from the percentage of root infections by AMF in all tested varieties. All varieties showed a greater percentage of infections during harvesting compared to the percentage of infections during vegetative growth. However, the highest percentage of roots infected by AMF at harvest was found in Bisi-2 and NK-99 varieties.

In the Bisi-2 variety the percentage of roots infected by AMF was 96.0% while in the NK-99 variety it was 94.6%. Unlike the case with varieties P 3.2 and Sukmaraga which have a lower percentage of infections compared to the Bisi-2 and NK-99 varieties but still belong to the percentage of root infection by high AMF which is 92.3% in varieties P 3.2 and 92.5% on the Sukmaraga variety. The highest percentage of infections when the corn plant is 8 MST and when harvesting is the same, it is found at 25 grams of AMF.

In each variety the percentage of infections was greater than the percentage of roots infected with AMF during vegetative growth. This is in line with the very strong correlation value between the AMF percentage at the vegetative growth of corn plants and the FMA percentage at harvest time, ie $r = 0.97$. There is a very strong correlation between the two observed variables indicating that the more and the longer the mycorrhizae applied to the roots of the maize plant, the higher the root association level and the higher colonization between the mycorrhizae and the roots of the corn plants.

The linear regression results of the percentage of root infected by FMA during the vegetative growth period yielded an equation $Y = 21.58x + 2.89x$ whereas at harvest yielded the equation $Y = 23.41 + 3.00x$ this showed a positive regression value. From the equation, it can be explained that each addition of 10 grams of AMF dose can increase the percentage of roots infected with AMF both when the corn plant is 8 MST and at the time of harvest. Correlation analysis also shows that there is a strong correlation value $r = 0.97$ between the AMF dose and the percentage of roots infected with FMA. This is caused by the presence of mycorrhizal infectivity. Effectiveness is the ability of the fungus to infect and colonize plant roots. Mycorrhizae used are derived from the rhizosphere of maize plants so that there is compatibility between the maize plants evaluated with the given mycorrhizae.

3.3 Kernel weight per plant

In Table 4 we can see the kernel weight per corn plant of each variety. Giving various doses of AMF has a significant influence on seed weight in the varieties tested. Can be seen in Table 4 the higher the dose of AMF given the higher the kernel weight per plant produced. However, the lowest kernel weight per plant was found in the treatment without administration of AMF (0 grams).

The highest kernel weight per maize plant was found in the Bisi-2 variety, 179.8 grams per plant significantly different from the varieties NK-99, P 3.2 and Sukmaraga. The Bisi-2 variety has the highest kernel weight per plant compared to other varieties due to the higher number of cobs per plant than other varieties, the longest cob length compared to other varieties, and a large cob diameter compared to other varieties. This indicates that the more the number of cobs per plant, the longer the cobs and the bigger the cobs they have, the higher the weight of the beans produced.

Kernel weight in non-treated varieties is lower when compared with kernel weight in varieties given AMF. This is presumably because AMF can help plants absorb nutrients such as nutrient P, which plays a role in replenishing seeds. This is in line with what was said by Napitupulu et al., (2013) which states that the role of phosphorus for plants is to accelerate and strengthen the growth of young plants in general, can accelerate flowering and ripening of fruit, kernel or grain, and can increase grain production.

The linear regression results of kernel weight per maize in each variety with the equation of value $Y = 9.22 + 3.22$ with a correlation between AMF doses and corn varieties is very strong at 0.97. This is due to the dose of AMF given to the growing media of each variety capable of increasing nutrient absorption such as P which can increase seed production per maize plant. While the value of determination obtained is equal to $R2 = 0.95$.

These results indicate that for seed weight per corn plant 95% is influenced by the AMF dose given while 5% is influenced by other factors such as abiotic factors. In addition to these factors, the most influential environmental conditions are temperature at the time of growth. Temperature can affect the maximum seed size so that later it can affect seed weight per plant. The maximum seed size can be reached at an average temperature of 25 ^{o}C.

Table.1: Analysis of Used Soil Coal Coal pH after Giving Various AMF Doses

AMF Doses (g)	Maize Varieties				
	Bisi-2	NK-99	P 3.2	Sukmaraga	Rata-rata
0	4,7	4,7	4,7	4,7	4,7 a
5	5,4	5,2	5,4	5,2	5,2 b
10	5,6	5,5	5,7	5,5	5,5 c
15	6,1	6,2	6,2	6,1	6,1 d
20	6,4	6,4	6,4	6,4	6,4 e
25	6,8	6,6	6,6	6,8	6,7 f
CV = 2,4 %					

Numbers followed by the same in the same lowercases column were insignificantly different according to DMRT with a $p<0.05$.

Table.2: Percentage of Root Infected Arbuscular Mycorrhizal Fungi (AMF) at the time of Corn Plant Aged 8 MST

AMF Doses (g)	Maize Varieties			
	Bisi-2	NK-99	P 3.2	Sukmaraga
	-----------(%)----------			
0	21,3a A	20,5 a A	20,5 a A	21,6 a A
5	37,3 b A	34,5 b A	36,6 b A	39,3 b A
10	44,5 c A	50,5 c B	44,0 c A	42,5 b A
15	61,8 d A	67,0 d B	60,6 d A	70,6 c B
20	78,8 e A	79,0 e A	80,0 e A	81,1 d B
25	89,0 f A	92,5 f B	88,6 f A	88,8 e A
CV = 5,1 %				

Numbers followed by the same in the same lowercases column and the same uppercases in the same row were insignificantly different according to DMRT with a $p<0.05$.

Table.3: Percentage of Infected Root Arbuscular Mycorrhizal Fungi (AMF) After Harvesting

AMF Doses (g)	Maize Varieties			
	Bisi-2	NK-99	P 3.2	Sukmaraga
	-------------(%)-------------			
0	26,3 a B	21,6 a A	21,0 a A	19,8 a A
5	38,0 b A	42,0 b A	48,8 b B	46,3 b B
10	46,8 c B	49,0 c B	43,8 c A	43,3 c A
15	72,1 d B	72,0 d B	72,0 d B	67,6 d A
20	89,8 e B	92,3 e B	91,6 e B	87,6 e A
25	96,0 f B	94,6 e B	92,3 e A	92,5 f A
CV = 3,3 %				

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Numbers followed by the same in the same lowercases column and the same uppercases in the same row were insignificantly different according to DMRT with a p<0.05.

Table 4. Effect of various doses of AMF application on kernel weight of four maize varieties grown in coal mining tailings.

AMF Doses (g)	Maize Varieties			
	Bisi-2	NK-99	P 3.2	Sukmaraga
		------------(%)-----------		
0	99,9 a	92,4 a	93,2 a	93,03 a
	B	A	A	A
5	125,7 b	118,2 a	117,4 b	113,6 a
	B	A	A	A
10	128,0 b	135,9 b	136,2 c	128,6 b
	A	B	B	A
15	143,6 c	150,3 c	152,7 d	152,9 c
	A	B	B	B
20	167,6 d	169,8 d	158,3 d	167,4 d
	B	B	A	B
25	179,8 e	175,0 e	174,5 e	173,2 e
	B	A	A	A
CV = 2,6 %				

Numbers followed by the same in the same lowercases column and the same uppercases in the same row were insignificantly different according to DMRT with a p<0.05.

IV. CONCLUSION

Giving mycorrhizae at a dose of 25 grams per plant is the best dose to increase the growth and yield of corn plants in coal mining tailings. Bisi-2 varieties is a that has high growth and yield with an average production of 179.8 per plant to be planted in coal mining tailings.

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Needs Assessment of Barangay Tanawan, Dingalan, Aurora towards a Proposed Oplan Development Program

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Abstract— *This quantitative research determined the help needed by two hundred households resettled in Barangay Tanawan in Dingalan, Aurora after they were devastated by flashfloods in 2004. The road networks of the Barangay were underdeveloped. It also has vast idle lands and unused concrete structures. During difficult times, many among its people go to nearby towns for part-time work. Findings of the study revealed that the resettlement needs help from Nueva Ecija University of Science and Technology Graduate School in terms of Beautification and Sanitation, development of Garden Tourism, Barangay Management and Administration, Development Education and Citizen's Productivity.A 3-year development program with a budget of P400, 000 was proposed by the researchers to address the needs.*

Keywords— *Barangay*, Beautification, Development needs, Sanitation

I. INTRODUCTION

Barangay Tanawan is a resettlement area for more than two hundred households devastated by flashfloodsin 2004. Currently, Tanawan has underdeveloped road networks and backyards. It also has idle lands and structures which can be turned into something productive.

Tanawan boasts of its water falls. It is also popular for its gardens that sell ornamental plants to tourists from lowlands. Likewise, its forest farm and fresh-water produce, though mostly insufficient to sustain a living, have become the main sources of income for most of the locals. During difficult times when harvest is scarce and income does not suffice for household needs, many among the people of Tanawan go to nearby towns for part-time work.Besides its natural resources, the hardworking people are the strength of the Barangay.

With the foregoing, the researchers from the Nueva Ecija University of Science and Technology (NEUST) Graduate School (GS)believed that Tanawanwas a potential recipient of its extension services.

The NEUST, established in 1908, is one of the most sought-after state universities in the province of Nueva Ecija, Region III, Philippines. It offers quality and Level 3 accredited graduate education programs [1] to its clienteles. Its research goals focus on effective extension services [2] and in producing responsible and productive citizens who are skilled in research [3].

One of the NEUST missions is to transform human resources into productive citizenry to bring about development impact especially to local communities. In connection with this, the Graduate Studies through its Extension Department chose Barangay Tanawan, in Dingalan, Aurora as its adopted Barangay.

The proponents believed that Tanawan might turn into a model barangay and a tourist destination if provided with a needs-based technical assistance. It is where this needs analysis finds meaning and significance.

II. METHODS AND PROCEDURES

This study utilized the descriptive survey and evaluation research. According to [4] as cited in [5], "descriptive survey can systematically describe a situation, problem, phenomenon, service or programs, or provide information or describe the attitude towards an issue". On the other hand, "evaluation research aimed to enhance knowledge and decision making and lead to practical applications" [6] as mentioned by [7]. The respondents of the study who were chosen purposively were 10 barangay officials, 3 local government unit (LGU) representatives and 30 household representatives. They answered questionnaire-checklists that pertain to the needs of Barangay Tanawan. These and other pieces of information gathered through observation and interview served during the first quarter of 2018served as basis in the development of Oplan Development Program for Barangay Tanawan.

III. RESULTS AND DISCUSSIONS

1. Needs Assessment Results

Based on the answers of the respondents and the observation made by the researchers in Barangay Tanawan, the needs were categorized in the following major areas: a. Beautification and Sanitation; b.Garden Tourism; c.

Barangay Management and Administration Development; d. Development Education and; e. Citizen's Productivity.

1.1. Barangay Beautification and Sanitation (BBS)

Based on the results of the survey conducted, the top 3 needs of the respondents were roadside and backyard beautification with tree-planting (Rank 1, f=100%, n=43), sanitation and waste segregation (Rank 2, f=95.35%, n=43) and water safety (Rank 3, f=90.7%, n=43).

1.2. Garden Tourism (GT)

As to the garden tourism, priority of the respondents was the development of their gardening skills. The households also requested that they be provided with gardening tools, and at the same time be provided with modern trainings and seminars related to propagation, production, and marketing of ornamental plants, vegetablesand root crops so that they could sustain their income even without leaving the barangay for part time work somewhere.

1.3. Barangay Management and Administration Development (BMAD)

In terms of the Barangay's political, leadership and managerial needs, it was found out that Barangay Tanawan respondents needed to be oriented on risk reduction, prevention and management (Rank 1, f=100%, n=43), parliamentary procedures (Rank 2, 88.37%, n=43) and transparency and accountability (Rank 3, f=81.40%).

1.4. Development Education (DE)

The household leaders identified that their children including some of the adults were in needof remedial and special lessons on core subjects such as English, Mathematics and Science.

1.5. Citizen's Productivity (CP)

The respondents claimed that Barangay Tanawan residents were in need of livelihood trainings (Rank 1, f=100%, n=43), seminars on establishment and operation of mini-cooperatives (Rank 2, f=93.02%, n=43) and monthly socialization for the elderlies (Rank 3, f=76.74%, n=43).

2. Oplan Development Program

The researchers proposed theOplan Development Program with the vision of "Barangay Tanawanas a model barangay and a tourism pride of Dingalan, Aurora" and a mission to "Transform Barangay Tanawan into economically sufficient barangay and idyllic tourist destination in Dingalan, Aurora". The implementation of the project will be from the 3rd quarter of 2018 to December of 2020.

2.1.Program onBarangay Beautification and Sanitation (BBS)

The Engineering and Technology Department of the NEUST Graduate School (GS) takes charge of the barangay beautification and sanitation program. The objectives of the program are the following:

1. to improve the roadsides within the barangay and Tanawan falls;
2. to plant trees and decorative plants along networks;
3. to ensure installation of compost pits among household;
4. to ensure every household has acceptable comfort rooms; and
5. to improve water system.

Table.1: GanttChart on the Activities of the Program on BBS

	1st Quarter (2018)	2nd Quarter (2018)	3nd Quarter (2019)	4th Quarter (2020)
A. Barangay Beautification and Sanitation (BBS)				
Activities				
1. Household Survey	/			
2.Dissemination of Survey Results	/			
3. Roadside and backyard beautification (with tree-planting)		/		
4. Seminar on sanitation, waste segregation and water safety		/		
5. Search for the Best Household Awardee			/	/
6. Project evaluation				/

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2.2. Program on Garden Tourism (GT)

For the garden tourism program, the NEUST GS Department of Business Administration takes charge. The following are the objectives of the program:

1. to encourage every household to grow ornamental plants for marketing;
2. to encourage every household to grow mushroom for marketing;
3. to train the locals in plant propagation and production of organic fertilizers;
4. to facilitate marketing of plant produce in the barangay; and
5. to train the locales in hydroponics.

Table.2: Gantt Chart on the Activities of the Program on GT

	1st Quarter (2018)	2nd Quarter (2018)	3nd Quarter (2019)	4th Quarter (2020)
B. Garden Tourism (GT)				
Activities				
1.Survey on garden plants and people's gardening skills	/			
2.Dissemination of Survey Results	/			
3. Seminar-Workshop on garden plant growing		/		
4. Seminar-Workshop on mushroom growing		/		
5. Garden ko, Tapatko, Linisko project		/	/	/
6. Seminar-Workshop on Organic Fertilizer Productions		/		
7. Seminar-Workshop on Hydrophonics		/		
8. Mushroom Growing and Marketing		/	/	/
9. Mass Production & Marketing of Organic Fertilizers		/	/	/
10.Mass Production & Marketing of Hydrophones		/	/	/
11.Mass Production & Marketing of Mushroom		/	/	/
12. Search for Best in Sales Awardee			/	/
13. Project evaluation				/

2.3. Program on Barangay Management and Administration Development (BMAD)

The NEUST Graduate School Public Administration Department takes charge of the barangay management and administration development program. The objectives of the program are the following:

1. to train barangay officials in good governance;
2. to assist the barangays in parliamentary processes;
3. to facilitate effective land use in the barangay;
4. to provide survival skill, risk reduction and risk prevention training; and
5. to facilitate or assist in the identification and establishment of barangay evacuation site.

Table.3: GanttChart on the Activities of the Program on BMAD

	1st Quarter (2018)	2nd Quarter (2018)	3nd Quarter (2019)	4th Quarter (2020)
C. Barangay Management and Administration Development				
Activities				
1.Survey on barangay management and administration capability	/			
2.Dissemination of Survey Results	/			

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3. Seminar on risk reduction, prevention & management		/		
4. Putting up of an evacuation area		/		
5. Training-workshop on first aid administration		/		
6. Seminar-Workshop on forest and river conservation		/		
7. Seminar on parliamentary procedures		/		
8. Seminar on transparency and accountability		/		
9. Monitoring of forest and river conservation			/	/
10.Monitoring of application of parliamentary procedures			/	/
11.Installation and use of transparency board		/	/	/
12. Project evaluation				

2.4. Program on Development Education (DE)

The Master of Arts in Teaching and Master of Arts in English of NEUST GS take care of the development education program. The following are the objectives of the program:

1. to provide consultative service for the effective teaching of Math, Science and English;
2. to provide training on needs areas;
3. to provide assistance on the development of SIP;
4. to improve the reading proficiency of pupils via “adopt a non-reader “scheme”; and
5. to facilitate establishment of reading center through “bayanihan” scheme.

Table.4: Gantt Chart on the Activities of the Program on DE

	1st Quarter (2018)	2nd Quarter (2018)	3rd Quarter (2019)	4th Quarter (2020)
D. Development Education				
Activities				
1. Identifying learners with difficulty in reading, writing & arithmetic	/			
2.Dissemination of Survey Results	/			
3.Remedial lessons for learners with difficulty in Math, Science and English		/	/	/
4.Teachers' training based on Needs' Area		/		
5."Adopt-a-non-reader Program"		/	/	/
6. Put up a reading center		/		
7. Project evaluation				/

2.5. Program on Citizen’s Productivity (CE)

The Education Management and the Vocational-Technical Education Departments of NEUST GS are in charge of the program on citizen’s productivity program. The objectives of the program are the following:

1. to train unemployed male and female for alternative sources of livelihood;
2. to organize and train indigenous people for maximum community adaptation;
3. to organize and provide socialization for the senior citizens;
4. to introduce parenting and family planning to young couples; and
5. to turn idle areas in Tanawan into something productive.

Table.5: Gantt Chart on the Activities of the Program on CE

	1st Quarter (2018)	2nd Quarter (2018)	3rd Quarter (2019)	4th Quarter (2020)
E. Citizen's Productivity				
Activities				
1. Identification on IP and Aged in the Community	/			
2. Identification of unemployed male and female	/			
3. Livelihood training		/		
4. Development & full utilization of the abandoned housing		/	/	/
5. Seminar on parenting and family planning		/		
6. Monthly socialization for the elderlies		/	/	/
7. Project evaluation				/

The overall program and activities to be properly implemented at Barangay Tanawan, Dingalan, Aurora, from the first quarter of 2018 to the fourth quarter of 2019 requires a total budget of P400, 000. The said amount will be utilized for transportation, computer, trainer's fee, supplies and materials, sound system, electricity, gardening equipment and materials for initial mushroom and hydrophone propagation, and for other related miscellaneous expenses. .

IV. CONCLUSIONS

This study was conducted to look into and to assess the needs of the people living in Barangay Tanawan, Dingalan, Aurora.

The study found out that Barangay Tanawanwas in need of assistance and would want to undergo training to ensure development and upgraded quality of life, particularly in terms of water safety, backyards improvement, sanitation, waste segregation, gardening, and operations of small cooperatives. Likewise, they would want training on proper leaderships and management, risk reduction and livelihood skills. They also requested that their children be given remedial and special lessons on English, Mathematics and Sciences.

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Variability of Microclimate Daily Dynamic in Small Island

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Abstract— *Microclimate variables are very sensitive to changes in environmental conditions. Microclimate variables change temporally following changes in solar radiation and vary spatially due to differences in ecological features. Micro climate parameters are the quantity of microclimate variables which characterize ecosystems. Micro climate parameters are used in monitoring the condition of natural resources and environmental. Small island ecosystems are easily disturbed by natural factors such as storms, waves and currents, droughts, floods and surface erosion etc. Small island ecosystems also experience degradation and even sudden changes due to resource use such as forest reshaping, groundwater extraction, expansion of residential areas etc. Characterization and monitoring of micro-climates of small island ecosystems are needed for resource and environmental management. Spatial and temporal variations of microclimate in residential locations, forests and coastal waters can characterize ecosystems and are used to monitor changes in environmental conditions. Climate data is needed as a reference for environmentally friendly spatial use such as reforestation, cultivation of plants in the yard. This article discusses the results of research on the diversity of air temperature and humidity in three small islands in the Sangihe District. In each village area, four research sites were selected, namely in residential areas, forested beaches, coastal waters in front of settlements, and coastal waters in front of forested beaches. At each location, measurements are made at six points in the vertical direction. The results showed that micro-climate parameters differed significantly between the location of settlements and forested beaches.*

Keywords— micro-climate, dynamics, settlements, forests, coastal waters.

I. INTRODUCTION

Life on a small island has more severe challenges than in the large land area. Hurricanes, abrasions, droughts and lack of water are serious problems faced by people on small islands. The use of land with limited size causes pressure to reduce the quality and usefulness of land as shown in Figure-1:

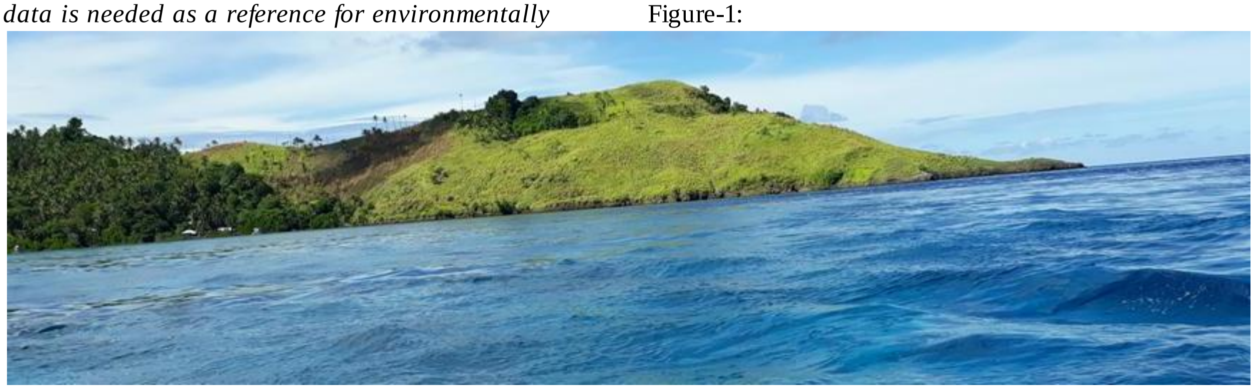

Fig.1: Unproductive land on Kahakitang Island, Sangihe Regency

The land conditions as shown in Figure-1 are a series of problems: environmentally unfriendly land use - increased surface erosion - top soil quality degradation and decreased land quality, the survey conducted in 2016-2017 showed that in Tatoareng Sub-district, weeds can reach 28%. Land degradation in the Tatoareng area has the potential to increase due to population growth and reduced land for plantations and settlements. Small island management must be carried out comprehensively and systemically by analyzing the influence of natural and human factors on natural and environmental resources. Management of small island resources must be based on a comprehensive and systematic analysis according to the characteristics of small islands (Mercer et al., 2007). The components studied include biophysical, socio-cultural and economic components as a whole. Existing condition analysis is needed to predict global impacts such as climate change (van Aalst, 2006) and sea level rise (Rodolfo and Siringan, 2006). Pelling and Uitto (2001) suggest that the management of small islands needs to examine the interaction between global pressure and local dynamics that contribute to increasing environmental vulnerability. Mercer et al., (2007), suggested that the assessment of resource and risk vulnerability is a focus of resource management. Mapping critical and vulnerable areas is carried out as a focus of ecosystem studies which include biophysical, socio-cultural and economic elements (Bengen et al. 2003; White et al, 2006). Pregiwati et al. (2015) suggested that ecosystem elements became the criteria in determining protection areas in the sea area. Mapping and geographic information systems are seen as comprehensive tools in presenting ecosystem conditions and their management (Guinau et al, 2005; Corbett et al., 2006).

Microclimate is defined as the climate condition of the localized area as a different zone with surrounding environment (Chen *et al*. 1999; Medellu, 2012). Microclimate variables characterize ecosystem conditions. Changes in the magnitude of micro-climate parameters indicate changes in ecosystems and the environment (Medellu, 2012, 2013; Medellu and Tulandi, 2018). Microclimate variables were studied by experts are the intensity of solar radiation, air temperature and air humidity (Hennenberg*et al*., 2008; Medellu, 2012; de Lima *et al*. 2013, Medellu and Tulandi, 2018). The microclimate variables change temporally following the changes of solar radiation intensity (Newmark. 2001; Medellu, 2012). Microclimate variables varies spatially due to local conditions or the earth surface (Medellu, 2012, de Paula *et al*, 2016, Medellu and Tulandi, 2018). Spatial variation of forest microclimate influenced by the structure of the forest such as variation of tree high, the patch and the gap in the forest (Pinto *et al*., 2010; Zulkiflee and Blackburn, 2010). The spatial variation of microclimate on small islands is very high between forest areas and densely populated residential areas. Changes in land conditions such as deforestation and environmental change are very significant causing changes in microclimate (Godefroid et al., 2006; Berger et al. 2008, Gradstein, 2008). Micro-climate parameters are quantitative quantities that characterize ecosystem and environmental conditions (Medellu, 2013; Medellu and Tulandi, 2018). Microclimate parameters often used by experts were: the maximum difference of edge – interior, the depth of edge effect, and the maximum edge. This parameter is a microclimate variable magnitude based on the measurement and analysis of data in the horizontal direction, for example from the edge of the forest to the inside of the forest. The depth of edge effects canindicate the fragmentation or gaps in the forest or changes in the structure of the forest (Harper *et al*. 2005, Medellu*et al*, 2012; Magnago*et al*. 2015). Edge gradient associated with the flow of thermal energy between the environment and forest ecosystems (Heithecker and Halpern, 2007; Medellu, 2013; Chatterjea, 2014).

Measurement, analysis and modeling of microclimate daily data in vertical directions, can adopt analysis and modeling data in the horizontal direction. Analysis and modeling of daily data in the vertical direction describe the thermal interactions on the surface of the land and on the surface of the water. Referring to the pattern of daily changes in the horizontal direction, the micro-climate parameters used can be adopted for vertical profile analysis. The vertical profile of the daily changes of microclimate variable at several locations on small islands is very important as a reference for the use of natural resources. This article describes the micro-climate parameters in twelve measurement positions on three islands in the village area in Tatoareng District, Sangihe Regency.For each village area, measurements were carried out in four locations. Two locations are located on land, namely at the center of the settlement and in the forested beach of same the village area. The other two locations are in the coastal waters, at 60 m to 70 m away from the coastline. One position is located in front of the settlement and one position is located in front of a wooded beach. The purpose of this measurement is to analyze differences in the micro-climate conditions of residential areas and forests, where forest areas are a source of drinking water for communities in residential areas. The parameters of micro-climate data are also complemented by examples of temporal changes graphs of air temperature at three locations with different ecological features. Utilization of research results includes: (1) reference to the cultivation of vegetables and spices in the yard to prevent the conversion of forest functions as a source of water, (2) to become a reference for comfort analysis related to the development of this region as the main tourism destination of Sangihe Regency 3) becomes a reference for determining reforestation areas that have the potential to increase infiltration and control of surface erosion.

II. RESEARCH METHOD

The study was conducted on three adjacent islands in the area of TatoarengSubdistrict, Sangihe Regency, North Sulawesi Province. Tatoaremng sub-district consists of small islands with a density reaching 42 people/ha (Sangihe in numbers, 2013). Population density has slowed grow but is projected to increase sharply due to the increase in tourist arrivals in several tourist attractions in the region. The location of measurements is carried out in three villages, each in two positions with different ecological features. The first village to be measured was the village of Para Lele, located on the island of Para. Measurements at the first location were carried out at residential sites and forested beache located west of the residential area. Measurements are also carried out above sea level, each at 60 m - 70 m in front of the coastline at residential locations and forested beaches. The second location is Mahengetang village on Mahengetang island. Measurements were made in residential areas and forest areas located in the eastern part of the settlement. Measurements in coastal waters as done on the island of Para. The third location is the Behongang village area, located on Kahakitang island. Measurements were made in the residential center of Behongang Village, and the forested beach of Kundaha sub-village. Measurements in coastal waters are the same as in Para and Mahengetang island. The reason for choosing two measurement positions, namely residential and plantation areas is to produce data on the existing condition of the ecosystem as a reference in resource use and environmental management, especially related to the guarantee of water availability. The measurement location, which is a forested beach adjacent to the settlement, is a water source used by the community, especially during the dry season. Measurements in each position are carried out for one day with an hourly measurement interval. Measurements in two positions on land in the same village area are carried out simultaneously. Measurements in two locations on coastal waters within the same village area were carried out simultaneously. Two measurement locations in the Behongang village area are shown in Figure-2 and Figure-3. Kundaha village children become suppliers of fresh water for the community in the parent village of Behongang.

Figure-2. Behongang village, Kahakitang island

Figure-3. Kundaha, sub village of Behongang

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Micro climate variables measured and analyzed are air temperature and air humidity in the vertical direction at each measurement location. The measurement points for each vertical transect use logarithmic distance to the boundary plane, namely: 0, 1 m, 2 m, 4 m, 8 m and 16 m. The logarithmic measurement method is based on the assumption that changes in thermal energy per unit distance are greater near the medium boundary (Medellu, 2012, Medellu and Tulandi, 2018). Adaptation of measurement methods and analysis of measurement data in the horizontal direction for measurement data in the vertical direction is based on the assumption of energy diffusion between the layers of the medium (air, soil and water), and thermal interactions between the air-water and air-ground boundaries.The stages of data analysis and modeling to produce temporal and spatial functions and micro-climate parameters are as follows (Medellu, 2013; Medellu and Tulandi, 2018)

1. Arrange data in a data matrix, based on time and position, for example for temperature: T (y, t), where x is the distance to the boundary plane and t is time. The data matrix is adjusted to the data input format of the micro climate data analysis and modeling software
2. Determine the temporal function as a periodic function or Fourier function. Temporal function modeling produces output in the form of maximum and minimum quantities, and the time to reach that quantity.
3. Synchronizsation of data between positions, by inputting the difference of measurement time data between positions, into temporal functions. This procedure is carried out as a requirement for spatial function modeling, where the data used must have the same time base
4. Modeling spatial functions using exponential function models. Modeling assumes greater absorption of energy and changes in variable microclimate occurring near the boundary plane. Modeling of spacial function will produce parameters: maximum gradient, highest daily difference between vertical measurement points, and depth of edge effects (the farthest distance of the microclimate magnitude becomes constant, time for achieving thermal equilibrium (gradient has zero value)
5. Comparing the magnitudes of micro climate parameters and vertical profiles of air temperatures between locations and measurement positions

III. RESEARCH RESULTS AND DISCUSSION

Quantity of micro climate parameters: variable air temperature above ground

Measurements carried out in normal weather conditions where light rain occurs three to four times a week, producing micro climate parameter data as shown in Table-1. Codes P1, M1, and B1 are measurement positions in the center of the settlement and above the sea in front of settlements in the villages of Para, Mahengetang and Behongang. Code P2, M2, and B2 are measurement positions on wooded beaches and above the sea in front of forested beaches in the villages of Para, Mahengetang and Behongang. Table-1 presents the quantity of micro-climate parameters and local time for achieving this quantity. The maximum air temperature occurs at a distance of 0 to 20 cm above the land surface. The air temperature during the day including the maximum value, is quite significant different between the location of the settlement and the forested beach. The maximum temperature difference in settlements with adjacent forested beach ranges from 5.5°C to 7.72°C. This variation is caused by differences in ecological conditions such as land material (sand or soil), the presence or absence of land cover, the structure and the dense of canopy etc. The earlier maximum temperature is reached in residential locations compared to the location of the forested beach adjacent to the settlement. The highest maximum temperature difference occurred between Behongan village and Kundaha sub-village. Variation in the difference in time to reached the maximum temperature between location of the settlement and the forest area in the three village areas ranged from 32 minutes to 55 minutes.

Table.1: The quantity and time of achieving the quantity of micro climate parameters at the research location

Microclimate		Quantity of parameter acoording to location and position											
Variable	Parameter	Para village				Mantehagevillage				Behogangvillage			
		P1	time	P2	time	M1	time	M2	time	B1	time	B2	time
Air temperatureover the land	maximum(°C)	39.9	13:18	34.2	13:58	39.7	13:22	34.2	13:54	39.92	13:05	32.2	14:00
	minimum (°C)	27.4	02:55	25.2	02:52	27.3	02:48	25.0	02:48	27.3	02:44	24.8	02:42
	Maximum	0.2	10:56	0.08	11:22	0.18	11:22	0.12	10:38	0.19	11:20	0.03	11:24

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	gradient (°C/m)												
	Thermal equilibrium of Air – soil		19:32		19:42		19:24		19:26		19:44		19:22
Air temperature over the sea surface	maximum(°C)	40.1	12:58	39.8	13:16	39.9	12:56	39.70	13:22	39.8	12:55	39.2	13:16
	minimum (°C)	27.8	3:14	26.7	2:52	27.6	3:48	26.8	3:00	27.7	2:44	25.8	2:42
	Maximum gradient (°C/m)	0.22	10:02	0.1	10:40	0.2	11:02	0.12	10:03	0.19	10:28	0.03	11:24
	Thermal equilibrium of Air-Water		18:54		18:22		18:48		18:28		18:52		18:20
Humiity over the land surface	maximum(%)	88.4	02:00	90.2	01:58	88.5	02:10	89.4	02:00	88.8	02:10	93.8	01:50
	minimum (%)	82.8	11:40	84.8	11:54	83.0	11:35	84.5	11:40	83.2	11:42	85.5	11:48
	Maximum gradient (%/m)	0.008	13:20	0.008	13:06	0.008	13:15	0.008	13:40	0.008	13:24	0.008	13:55

Variations in the time to reach the maximum temperature are influenced by the reception and absorption of solar radiation energy, the conditions of land material, land cover, water on the surface and other ecological features. At the surfaces that are faster to heat (eg dry surface), the air temperature will increase faster than the wet surface that absorbs a lot of radiation energy but slowly becomes hot.

The minimum daily air temperature at a residential location is relatively higher than the minimum temperature in a forested location. The minimum air temperature in residential locations varies between 27.3°C to 27.4°C, while in forested locations range from 24.8°C to 25.2°C. The minimum temperature difference between residential locations and forested locations ranges from 2.2°C to 2.5°C. The time to reach the minimum air temperature between residential locations and forested areas did not differ significantly. The maximum - minimum air temperature difference at the six measurement sites shows that the residential area fluctuates more (12.4°C to 12.62°C) compared to the forested area (7.4°C to 9.2°C). Large temperature fluctuations in residential locations are caused by more full acceptance of solar energy, as well as reflection of radiation energy such as zinc roofs, absorption and reemition of solar energy by land surface, influence of thermal emissions by the sea, community activities such as cooking, and thermal energy emitted by the body. The high temperature difference between the location of the settlement and the forested beach, shows that deforestation for settlement or secondary crops can cause an increase in temperature in a wider area.

The maximum gradient of air temperature near the surface in residential locations varies from 0.18°C/m to 0.2°C/m, while in the forest area varies between 0.03°C/m to 0.18°C/m. Based on the results of temporal air temperature analysis and modeling, the smallest maximum gradient is found in Kundahasub-village.The maximum-minimum difference in daily air temperature in Kundala is also lower than the air temperature in other locations. In Kundaha there are two schools and six teacher houses. In the front, mangroves grow with a width of 40 to 55 meters with a fairly tight canopy.Land in the sub-village of Kundaha is drained by surface water, which originates from springs that appear at the foot of a forested hillside. This ecological feature causes the air temperature in Kundaha sub-village to be lower and more stable throughout the day. The water in the village of Kundaha is partly channeled to the main village of Behongang.Air-ground thermal equilibrium is relatively the same between locations, occurring around 17:30. This thermal equilibrium is characterized by the gradient value of air temperature at the surface of the land is zero. This means that there is no thermal energy flow between the air and the ground surface. Thermal equilibrium between air and soil in forested beach locations lasts longer than in settlements. At the settlement location, the air temperature starts to increase earlier and becomes higher than the soil temperature at around 05:00. On the location of forested beaches, an increase of air temperature occurs around 6:00. Increasing of air temperature at residential locations is also influenced by community activities such as cooking. This thermal

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equilibrium becomes important information in controlling comfort and in cultivating plants in the yard

Quantity of micro climate parameters: variable temperature of air above sea surface

Variable of air temperature above sea surface is measured in tidal areas with a distance of 60 m to 70 m, from the coastline. Temperatures above the water level in the six study sites had the same vertical profile. In the morning until around 10 o'clock, the air temperature near the sea surface mixes with the temperature in the upper layer. After 1 o'clock until around 3:20, the air temperature near the sea surface is higher than the air temperature. The temperature of the air above the sea surface reaches a maximum quantity around 12:56 to 13:22. The temperature of the sea water in front of the settlement location is slightly higher than the air temperature in front of the forested beach. The highest maximum air temperature difference was obtained from the results of air temperature measurements and modeling in Behongang village andKundahasub-village, namely 0.6°C. This difference can be thought to be caused by the supply of fresh water to the tidal area that occurs in coastal waters in front the Kundaha sub village. Difference in maximum-minimum air temperature in each location varies between 12.4°C to 13.4°C. Difference in maximum-minimum of air temperature above sea level is smaller than the air temperature above the land surface. This is influenced by the receiving ption and absorption of solar energy by sea water, the movement of water masses (vertical and horizontal) that emit thermal energy into the air. Sea water stores more heat energy and slowly emits it into the air after reaching the thermal emission limit temperature. Table 1 shows that the minimum air temperature above sea level is higher than above the land surface.

The interesting thing from the results of measurement and modeling of data, is the difference in the minimum daily air temperature between the location in front of the settlement and the location in front of a forested beach. The maximum difference in air temperature between two adjoining locations only varies between 0.2°C to 0.6°C.

At night, the air temperature at the front location of the forested beach becomes colder because of the supply of fresh water from the land and the influence of ecological conditions including mangrove forests. Although the differences were not significant, the maximum temperature reached at the location in front of the settlement was earlier than at the location in front of the forested beach.In forested beach locations, the air temperature is also affected by the supply of fresh water from the mainland. The maximum gradient of air temperature above sea level, in front of the settlement is slightly higher than in front of a wooded beach. This shows that during the day, vertical variations in air temperature near the sea surface at the location in front of the settlement are more significant than those in front of forested beaches. Air-water thermal equilibrium is reached earlier in coastal waters in front of forested beaches than in front of settlements.This is allegedly due to the influence of environmental conditions such as the supply of fresh water, and mangrove forests. Air-sea thermal equilibrium only occurs around 1 to 1.5 hours. After 8:30 a.m., the sea water temperature becomes higher than the air temperature above it. The gradient changes direction (second thermal equilibrium) around 05:20 due to the influence of sunlight.

Quantity of micro climate parameters: variable humidity above the land surface

Table-1 shows the maximum humidity in residential areas ranging from 88.5% to 88.8%. The maximum humidity on wooded beaches varies from 89.8% to 93.8%. The maximum humidity in residential locations differs slightly from the maximum humidity on forested beaches. The maximum humidity at six locations occurs around 2:00 and is not significantly different. This moisture data is the result of analysis and modeling of measurement data at a position of 50 cm above the land surface. In the vertical direction, air humidity is not significantly different. This can be seen from the maximum gradient of low humidity for all locations. The minimum humidity in the six study sites did not differ significantly and only varied between 82.8% and 85.5%. The minimum time for achieving humidity is almost the same for six locations, with variations from 11:35 to 11:54.

Quantity of micro climate parameters: variable humidity above the sea surface

Daily changes in air humidity above sea level at six measurement locations were not significantly different. The maximum air humidity in six locations varies between 89.8% to 90.4% and occurs at almost the same time around 00:50. The minimum humidity at six locations varies between 84.8% and 84% and there is no clear pattern between the location. The time of reaches of minimum humidity almost the same for six locations, it varies between 09:00 - 09:20. During that time, the sea water has not released much water vapor, while the concentration of water vapor in the air is reduced due to sun radiation.

Daily pattern of changes of air temperature

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The air temperature and air humidity have a sinusoidal pattern due to solar radiation and the process of absorbing radiation energy which is then emitted as thermal energy.Figure-4 shows the daily dynamics of above-ground air temperature at three measurement locations, namely at the Para village settlement location (location code P1), Behongang village settlement location (location code B1), and forested beach of Kundaha (location code B2). The graph shows that at residential locations, the air temperature throughout the day is higher than the air temperature on forested beaches. The air temperature on forested beaches is more stable compared to the air temperature in residential areas. This difference shows that ecological conditions such as the presence of forests and mangrove forests, as well as shallow surface water and groundwater causes the air temperature in Kundaha to be lower than the air temperature in two residential locations.

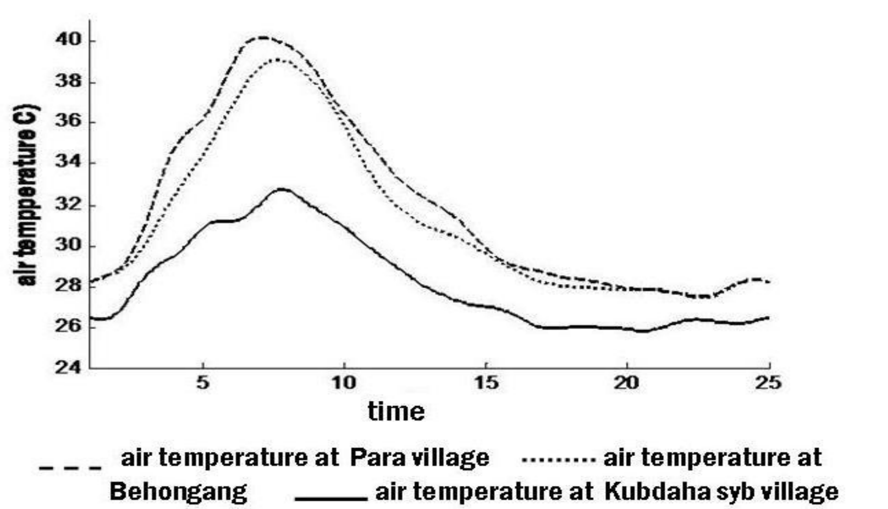

Figure-4, Variability of air temperature dynamic in small island

Micro-climate parameters data and the dynamics of daily changes of microclimate indicate that micro-climates on small islands vary greatly, mainly determined by ecosystem conditions, such as land cover, the presence of trees and mangrove trees, fresh water flow on the surface and underground water. Human activities such as cooking and other activities that produce heat also influence the increasingof air temperature at residential locations. Differences in ecological conditions that cause differences in the daily dynamics of microclimate, indicate the usefulness of microclimate data for characterizing and monitoring the condition of natural and environmental resources on small islands. The high spatial variation between residential areas and surrounding forests shows that deforestaion for settlement expansion will cause an increase in air temperature and subsequently will affect ecological conditions including animal life and environmental comfort. Micro-climate data in residential areas can be used as a reference for cultivating spices and vegetables in the yard, to divert forest reforms and the expansion of unproductive critical lands. The ecological conditions in important research locations must be respected especially for ensuring the availability of water in the dry season.

IV. CONCLUSION

The microclimate on three islands in the Tatoareng sub-district varies greatly, depending on ecological conditions such as the presence of forests and mangrove forests, land use for settlements. The parameters and daily dynamics of micro-climates can be used to characterize and monitor ecological changes in land and coastal waters on a small island.

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Emergence of Phyllochron of 3 Rice Varieties in Different time of Land Flooding in System of Rice Intensification (SRI)

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Abstract— *System of rice intensification (SRI) is a method of rice cultivation which has proven to increase the rice yield if comparing to the conventional method. The research aimed to study the influence of flooding of land to phyllochron emergence and tiller of rice plant. The research was conducted in farmer field in Koto Tangah, Padang from May-June 2018. Randomized block design in split-plot was used in this research. The main plot was the inundation time before planting in 7, 14, 21 and 28 days. Three replications were used in this research. The subplot was the three rice varieties, Pandan Wangi, PB 42 and Kuranji 012. The result showed that variety PB 042 and Kuranji 012 in 14 days of inundation were the best variety with the amounts of tillers were 40.*
Keywords— Flooding, phyllochron, SRI.

I. INTRODUCTION

Rice (*Oryza sativa* L.) is a dietary staple foods and one of the most important cereal crops, especially for people in Asia, but the consumption outside Asia has increased, recently (Orthoefer, 2005). It provides the bulk of daily calories for many companion animals and humans (Ryan, 2011).

Efforts to increase rice production have been carried out in various ways, but Indonesia still imports rice from the other country such as Thailand and Vietnam (Mariyono 2014). Even though the area under rice cultivation is large; the productivity is low due to various interaction factors. The imbalance usage of fertilizers is one of the main factors responsible for the low productivity and also the continuous use of inorganic fertilizers resulted in declining of soil fertility (Aaasif et al. 2018). For solving this problem, one way can be used is System of Rice Intensification (SRI). System of rice intensification (SRI) is a rice cultivation method that can provide higher yields with fewer inputs than conventional methods including irrigation water (Veeramani et al. 2012). Uphoff et al., (2002) stated that SRI can increase yields up to two times or more, because of land and water management, with wider spacing (25 cm x 25 cm), seedlings planted one point per planting point, seedling age seeding is shorter (7-15 days), and the soil is moist until hair cracks during the vegetative phase. This situation makes microclimate better around plants. Rozen et al. (2011) stated that the SRI method of rice cultivation can provide yields of dry grain harvested by 10 tons/ha, while rice production in West Sumatra has only reached 4.6 tons/ ha.

The reason why the SRI method can improve yields is because tillers are formed earlier and multiply. In this method, phyllocron is formed up to 12 times. Phyllochron is a phytomer circuit that is formed for 3-5 days after planting depending on temperature (Uphoff et al, 2002). Veeramani et al. (2012) added that phyllocron is influenced by temperature, seed age, and nursery method.

Amount of water requirement for growth and development of rice plant is still unknown yet. This condition causes the farmers give the excess water in rice field. The excess water that given to rice field causes the waste of water. The way to avoid the waste of this water is to arrange the water height in land. Uphoff (2002) stated that based on System of Rice Intensification (SRI) method, the minimum height such us 1-2 cm could save the water use and without the reducing of yield. Gani (2007) reported that the height of water 2-3 cm could increase the grain yield twice than 7-10 cm. Suhartatik et al. (2011) also reported that the 2 days of time interval influenced 98,85 of grill dry grain yield and production of dry grain yield per ha. Furthermore, Zani (2008) reported that the productivity of land in flooding treatment in 5 cm could save water up to 21%. The research aimed to study the influence of flooding to phyllochron emergence and tiller of rice plant.

II. MATERIAL AND METHODS

Place and Time

The research was conducted in farmer's rice field in Koto Tangah, Padang from May-June 2018.

Method

Randomized block design in split-plot was used in this research. The main plot was the inundation time before planting in 7, 14, 21 and 28 days. Three replications were

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used in this research. The subplot was the three rice varieties, Pandan Wangi, PB 42 and 012 Kuranji. Observation data were analyzed by variance and if F result was higher than F table then continued with DNMRT further test at 5%.

III. RESULT AND DISCUSSION

Development of Phyllochron

The result showed that variety Kuranji 012 and PB 42 produced the best tiller (40) (Figure 1 and 2). The different result occurred in variety Pandan Wangi where the total of tiller was 37 (Figure 3). Based on this result, the flooding of land affected the amount of tiller formed. The weeds can't stand in standing water because they don't have a morphological structure to support it. Inundation affected nitrogen availability in the soil. The longer of inundation, the absorption efficiency of element N decreases. Flooding also can change chemical properties, microbiology and nutrient availability in the ground (Rachmawati and Retnaningrum 2013).

The phyllochron was used to characterize the growth dynamic of cereal plants. On variety Kuranji 012, tiller was formed from the 2nd phyllochron. There was an exponential increasing in formation of tiller from 7th to 12th phyllochron (Table 1). For variety PB 042, the tiller was formed from 2nd phyllochron (Table 2). An exponential increasing occurred from 7th to 12th phlylochron in formatting of tiller. The tillering of variety Pandan Wangi was similar to both varieties.). An exponential increasing occurred from 7th to 12th phlylochron in formatting of tiller (Table 3). In SRI method, the seedlings were transplanted early so that 12 phyllochron can be completed and the formation of tiller is exponential. Barkelaar (2002) stated that the phyllochron is 5-7 days in rice and affected by temperature. Veeramani et al. (2012) added that the phyyllochron was influenced by temperature, age of seedlings transplanting and nursery method used.

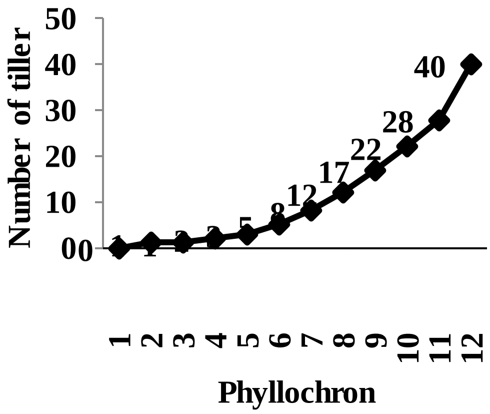

Fig.1. Number of tiller of variety 012 Kuranji formed in 14 days of inundation

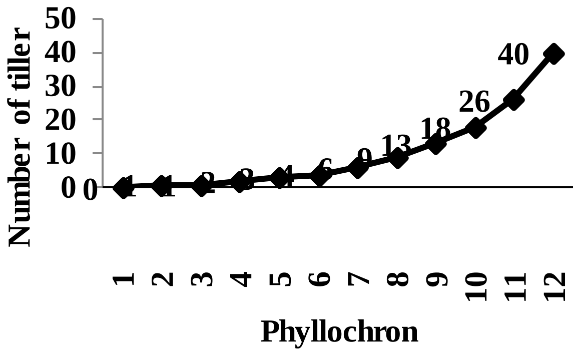

Fig.2. Number of tiller of variety PB 42 formed in 14 days of inundation

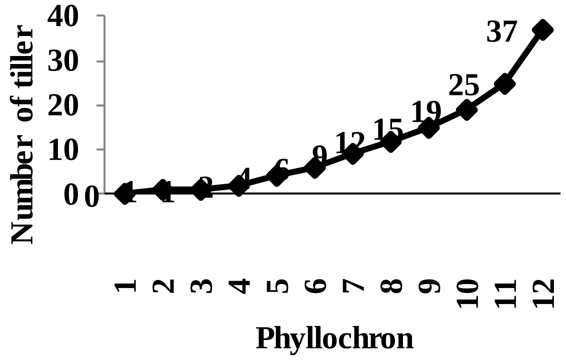

Fig.3. Number of tiller of variety Pandan Wangi formed in 7 days of flooding

SRI method provides a conducive environment for tiller growth during growth phase (Laulanie 1993). According to the phyllochron theory, the chance of forming more tillers will be more if seedlings are transplanted in early phase. These are the main component of SRI method (Laulanie 1993; Barkelaar 2001; Uphoff et al. 2002). On reported that for maximum tillering, the plant has to complete as many phyllochrons as possible during its vegetative phase. Each tiller produces another two phyllochrons later under favorable growing conditions (Singh et al. 2007). When a seedling is transplanted carefully at the initial growth stage, the trauma of root damage caused during uprooting is minimized following a rapid growth with short phyllochrons.

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Table.1: Formation of tiller of variety Kuranji 012 in 14 days of inundation

Phyllochron stage	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Main Stalk		1											1
First row of tillers				1	1	1	1	1	1				6
Second row of tiller						1	1	2	2	2	1	2	11
Third row of tiller							1	1	2	2	3	5	14
Fourth row of tiller										1	2	4	7
Fifth row of tiller												1	1
Total number per phyllochron	0	1	0	1	1	2	3	4	5	5	6	12	40
Total	0	1	1	2	3	5	8	12	17	22	28	40	

Table 2. Formation of tiller of variety PB 042 in 14 days of inundation

Phyllochron stage	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Main Stalk		1											1
First row of tillers				1	1	1	1	1	1				6
Second row of tiller							1	1	2	2	1	2	9
Third row of tiller								1	1	2	4	7	15
Fourth row of tiller										1	3	4	8
Fifth row of tiller												1	1
Total number per phyllochron	0	1	0	1	1	1	2	3	4	5	8	14	40
Total	0	1	1	2	3	4	6	9	13	18	26	40	

Table 3. Formation of tiller of variety Pandan Wangi in 7 days of inundation

Phyllochron stage	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Main Stalk		1											1
First row of tillers			0	1	1	1	1	1	1				6
Second row of tiller					1	1	1	1	2	1	1	2	10
Third row of tiller							1	1		2	2	7	13
Fourth row of tiller										1	2	2	5
Fifth row of tiller											1	1	2
Total number per phyllochron	0	1	0	1	2	2	3	3	3	4	6	12	37
Total	0	1	1	2	4	6	9	12	15	19	25	37	

Formation of total of tiller and total of productive tiller

The phyllochron influences the tiller of rice plant. The result showed that the different of number of tiller of 3 varieties occurred in the 21 of flooding (Table 4). Generally, length of flooding didn't affect the total of tiller. The number of tiller is influenced by genetic factor (Tien et al. 2017). Badshah et al. (2014) stated that the rice plant enabled to form productive tiller based on total of tiller, but not always due to the formation of tiller also influenced by environment. Wang et al. (2017) stated that the plant will form the productive tiller that reflected by the formed tiller.

Table 4. Total of tiller of 3 rice varieties in different land time of flooding

Flooding time (hari)	Varieties		
	Pandan Wangi	PB 042	Kuranji 012
7	37,67 A a	35,83 A a	38,83 A a
14	35,60 A a	35,90 A a	37,10 A a
21	30,10 B a	31,00 AB a	34,50 A a
28	36,50 A a	37,10 A a	35,10 A a
CV A = 20,58 %			
CV B = 8,81 %			

Notes : the numbers followed capital letters in the same rows and the numbers followed the lowercase in the same column are not different significantly

The cultivation of rice plant ins SRI method affected the total of tiller. In SRI method, the total of seedling that planted is only 1 so that it optimizes the growth of rice tiller. Mondol et al. (2017) explained that the density of plant affected the tiller growth. The contiguous clumps will undergo the competition in absorption of nutrients form soil. Berkelaar (2001) reported that for maximum tillering, the plant has to complete as many phyllochrons as possible during its vegetative phase. Each tiller produces another two phyllochrons later under favorable growing conditions (Singh et al. 2007). When a seedling is transplanted carefully at the initial growth stage, the trauma of root damage caused during uprooting is minimized following a rapid growth with short phyllochrons.

The total of tiller affected the total of productive tiller of rice plant. The result showed that the flooding time in 14 days was the best treatment for total of productive tiller (Table 5). The flooding time didn't affect the total of Kuranji 012 variety tiller. The different of productive tiller for each variety was influenced by genetic factor of each variety. Badshah et al. (2017) stated that the ability of rice plant to form productive tiller was influenced by genetic factor and each variety of rice plant had different genetic. The total of productive tiller represents the total of tiller that produced previously.

Table 5. Total of productive tiller of 3 rice varieties in different land time of flooding

Flooding time (days)	Varieties		
	Pandan Wangi	PB 042	Kuranji 012
7	37,67 A a	35,83 A a	38,83 A a
14	35,60 A a	35,90 A a	37,10 A a
21	30,10 B a	31,00 AB a	34,50 A a
28	36,50 A a	37,10 A a	35,10 A a
CV A = 20,58 %			
CV B = 8,81 %			

Notes : the numbers followed capital letters in the same rows and the numbers followed the lowercase in the same column are not different significantly

IV. CONCLUSION

The result showed that variety PB 042 and Kuranji 012 in 14 days of inundation were the best variety with the amounts of tillers were 40. The variety Kuranji 012 was the best variety for total of tiller and total of productive tiller.

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Seed Physiological Changes matoa (*Pometia pinnata*) during Storage

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Abstract**—***Seed matoa classified into families Sapindaceae, Proper storage process in maintaining seed viability matoa undiscovered. During the process of the seed storage undergo metabolic processes that may affect the viability of the seed after the storage process. The purpose of this study to determine the germination of seeds matoa before and after storage. The study was designed in the form of completely randomized design. Based on the test results showed that matoa seed viability decreased after storage. Matoa seed viability decline in line with the decrease in seed moisture content after it is saved.*

Keywords— Power sprouts, seeds, Storage, Matoa.

I. PRELIMINARY

Matoa (Pometia pinnata) is a typical plant Papua, belonging to the family Sapindaceae. Matoa trees can grow tall and have a hard enough wood. Fruit flavor is a mixture of rambutan, durian and longan. Matoa a tree which has a height of 40-50 meters. This plant will be higher if planted in the open. Matoa has a distinctive flavor based on the Ministry of Agriculture Decree No. 160 / Kpts / SR.120 / 3/2006, matoa Papua has been designated as superior fruit varieties that should be cultivated. Matoa can be propagated through seeds, cuttings and tissue culture. Matoa seeds are recalcitrant and do not have a period of dormancy. Matoa fresh seeds must be germinated. Matoa germination capacity will decrease after three days. During the open storage matoa seeds undergo natural drying, which is one characteristic of recalcitrant seeds, the seeds that require storage with high moisture and humidity so that the seed remains moist and the enzymes are still active. However, the proper technique to extend the shelf life matoa seed has not been found. Effira (2017) states that, matoa seed can only be stored in two days on medium ash, after three days the seeds will germinate during the storage. But at the media store sawdust and rice husk seed matoa death after being stored for six weeks.

Setbacks seed is a harmful process that occurs in seeds that can reduce the ability to store seed and can cause death in seeds (Byrd, 1983; Justice and Bass, 2002). Setbacks seeds can be caused by internal and external factors. The size, composition of seed coating and seed composition are factors affecting seed damage (Justice and Bass, 2002). The process of harvesting, post-harvest and storage of seeds can lead to deterioration of the seed (Mahjabin et al., 2015).

The purpose of this study to determine the effect of the storage process matoa seed germination.

II. RESEARCH METHODS

The study was conducted in May 2018 at the Laboratory of Seed Science and Technology, Faculty of Agriculture, University of Andalas. Matoa seed used was taken from the Bridge tabaka, Kenagarian Pianggu, District 9 koto Sungai Lasi, Solok District. The seed used was taken from matoa ripe fruit on one tree physiological parent. Criteria taken fruit is a fruit that is round or oval with a length of 5-6 cm, and yellowish green fruit. The seeds extracted and stored in medium ash.

Testing the viability of seeds that have been saved conducted on soil mixed sand media. Testing seed moisture content using the oven method. Testing germination and moisture content of the seeds is done before the seeds are stored until the last day of storage. The experimental design used is RAL factorial. Data were analyzed by analysis of variance.

III. RESULTS AND DISCUSSION

Seed Water Content

Water content matoa seed during storage has decreased, decreased seed moisture content during storage could affect the viability of seeds. Factors affecting seed viability after storage is a decrease in seed moisture content (Sukesh and Chandrashekar, 2013). Recalcitrant seeds setback caused by factors decrease seed moisture content (Tresniawati et al., 2014).

Water content matoa seed before it is saved by 37.11% and after the seed is stored for four days the water content of the seed becomes 29.95%. Several enzymes active in the reform process of food reserves (protein, fat and carbohydrate) are affected by the high water content of the seeds. High seed moisture content can stimulate the

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decomposition process of respiration through food reserves into simpler compounds (Sukarman and Rusmin, 2000).

Matoa seed germination decreases with decreasing water content of seeds. Matoa not saved seed has a high water content and have the seed germination of 100%, but at the end of germination of seed storage becomes 86.67% with a water content of 29.95% after storage. Roberts, 1973 stating that recalcitrant seeds are easily damaged (decreased viability) if the water level is lowered and less able to survive at high temperatures and low humidity. Conditions were very redah water levels or close to critical, damage symptoms would appear that diikiuti seed with a decrease in germination after storage (Justice and Bass, 2002).

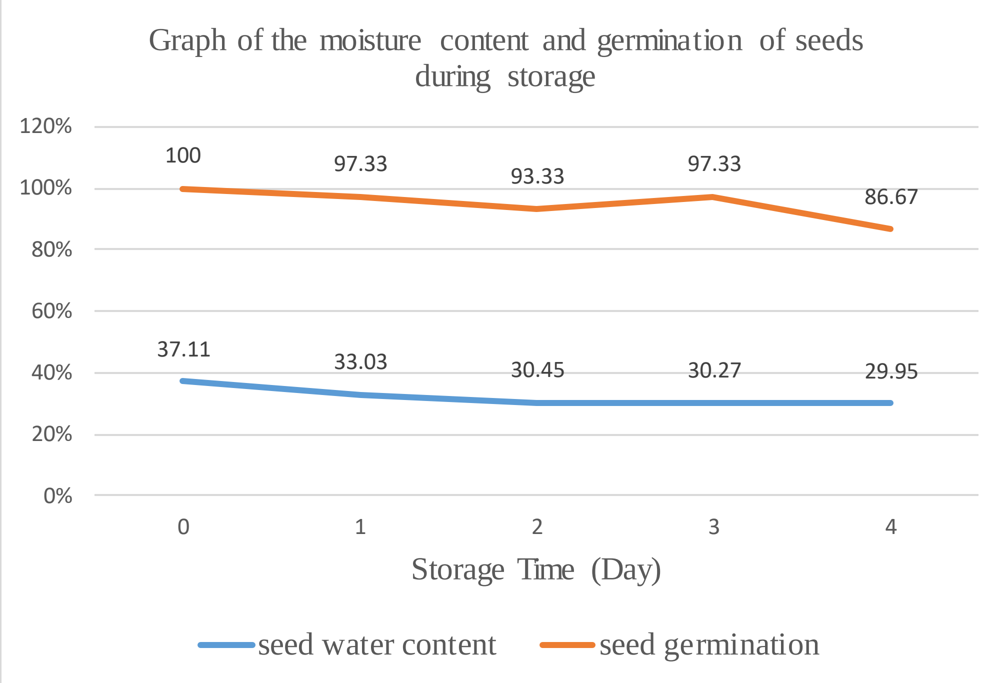

Fig.1: Graph Moisture and Seed germination during storage Matoa

Germination

Testing can determine germination seed quality after a storage process. Matoa seed germination before and after storage for one to four days can be seen in (Figure 1). Free germinated seed planted directly (without storage) is higher than the seeds that have been through the storage process. This indicates that the storage conditions of seed germination lasts without perfect as an indicator of seed vigor is still good. Seed vigor reflected by the two information about the viability of that is the growing strength and storability of seed. Both of these physiological value of placing the seeds in the possibility of its ability to grow into a normal crop production despite the biophysical field suboptimum or conditions beyond the seed after a long storage period (Maemunah and Adelina, 2009). Free germinate slowing with reduced germination and the length of storage time caused by food reserves in the seed of diminishing (Nurhasybi et al., 2007; Maemunah and Adelina, 2009; Solomon et al., 2010) including the water content of the material of the metabolic processes ,

Sadjad (1999) stated that the seed deterioration caused by moisture reduction physiologically indicated by the change in color of seeds, germination delays, declining growth and rising germinated sprouts abnormal growth. Matoa seed that germinated after three days of storage germination delayed for a day and a decline in the growth of germination. Matoa seed cotyledons not kept lifted to the surface soil after 9 days of planting. Matoa seed germination who have gone through the process of storing not significantly different from matoa seeds that are not stored, but delayed germination and germination power does not reach 100%.

IV. CONCLUSION

Matoa seed germination decreased after the storage process. Matoa not saved seed has a germination of 100%, and seeds that have been stored for four days has amounted to 86.67% germination. Matoa seed germination decline in line with the decrease in seed moisture content during storage.

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Assessment of Open Defecation and Prevalence of Soil Transmitted Helminthes among a Tertiary Institution Students in Nigeria

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Abstract— *Open defecation is a state of passing the indigestible food from the gastrointestinal tract to the open space. This mostly results in the spread of pathogenic microorganisms to susceptible person with majority of the symptoms being diarrhea especially when the infection is caused by intestinal parasite. The illiterates are most times implicated as group of people defecating openly together with lack of toilet facilities. This study was designed to examine open defecation habit among literate and its cause. The study was conducted among the students of a Nigerian University. The hostel premises was surveyed for feaces. A hundred and eight Fresh feaces samples found around the hostel premises were examined microscopically using formol ether concentration technique for presence of soil helminthes. The hostel premises surveyed showed opened defecation on going among the students. Twelve (12%) percent of the stool examined were positive for soil helminthes (Ascaris lumbricoides and hookworm). The soil helminthes infection was not gender associated (P>0.05) at 95% confidence interval (CI). Nine point one (9.1%) of male had mixed infection while 3.0% had mixed infection among the female. The use of anti-helminthes was statistically significant (P < 0.05), being more predominant among the female students. The contributing factors to open defecation among the students were; inadequate water supply, insufficient toilet facility, dirtiness of the toilets especially when cleaners are not around and fear of vaginal infections. University management need to ensure frequent flow of water in the hostels, a toilet may be attached to each room to create sense of belonging among the students which will ensure proper cleaning of the toilets. Likewise lectures on the implication of open defecation on health should be conducted periodically for the students.*

Keywords— Open defecation, Students, Soil helminthes.

I. INTRODUCTION

The world Health Organization estimated about 946 million people in the world defecate in the open such as street gutters, behind bush or open bodies of water (UNICEF, WHO, 2015). In Nigeria the prevalence of open defecation is estimated at 46 million people (FMWR, 2018). This attitude by people have a lot of adverse effect on the health of people in the community where open defecation is practiced. It enhances transmission of disease such as cholera, diarrhea, hepatitis A, typhoid and polio (WHO, 2018). Estimated 280,000 diarrhea deaths occurs annually form infection with pathogenic organism including intestinal worms, schistosomiasis and trachoma as a result of inadequate sanitation (WHO, 2018).

Open defecation mostly occur where there is a large population with few or no access to toilet facility. In order to curb the menace of open defecation, activists and government embarked on building toilet facilities in the communities. However, social norms and attitudes (Routray, 2015) together with inadequate or no water supply stopped people from using them. Ahmad(2014) opined that provision of community toilet should be less focused but shifted on collective behavioral change by people as 1% defecating in the open puts the health of everybody at risk.

The adverse impact of open defecation can be judged from the fact that one gram of faeces of a person can contain 10,000,000 viruses, 1,000,000 bacteria, 1,000 parasite cyst and 100 parasite eggs and pathogens. If left in the open, these are carried by flies, fluid (water), finger and field and infect another person through the faecal-oral route. Hookworm, that enters the body through unprotected feet, has a direct link with open defecation. The adverse effect is much in children as the infection cause malnourishing malnutrition, growth stunting, intellectual retardation, and cognitive and educational deficit (UNICEF, 2013; Routray, 2015).

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One of the effect of open defecation is excessive spending on drugs for infection treatments (Ahmad, 2014). There are also strong gender impacts of open defecation. Lack of safe and private toilets exposes women and girls to the dangers of physical attacks and encounters such as snake bites and it is an impediment to girls' education (by being victims of rape)(Jadhav*et al*., 2016).

Numerous surveys on prevalence of intestinal worms among different groups of people in Nigeria blamed the prevalence and intensity on low level of sanitation, domestic hygiene, poverty and illiteracy. Likewise, open defecation is also associated mainly to poverty and illiteracy. This geared this study to examine possible act of open defecation among literate and the possible factors for open defecation among this group of people. Also the study was designed to determine the presence of intestinal helminthes among the literate people. Tertiary institution was chosen for the study because a level of decency and hygiene was expected among the students because of the training they are undergoing in citadel of knowledge.

II. MATERIALS AND METHOD

2.1 Study Area

This study was conducted at Joseph Ayo Babalola University (JABU), a first entrepreneurial private Nigerian University located in Ikeji Arakeji. Ikeji-Arakeji is a town in Oriade Local Government Area of Osun state, Nigeria. It is located in western part of Nigeria, 37km (20mins drive) from Akure (capital of Ondo state). It lies on latitude 7.4°N of the equator and Longitude 4.9°E. All the students are hostel resident with a population size of 3,000.

2.2 Sample Selection

The student hostels premises were chosenfor stool sample collection and fresh stool samples defaecated in the open were collected and examined for soil transmitted helminthes (STH). One hundred and eight (108) samples were collected for the study.

2.3 Sample Collection

2.3.1 Questionnaires

Structured Questionnaire developed in English language was distributed to 108 consented students and completed. It was administered to obtain information such as gender, age, knowledge and perception of the participants about parasitic infections, use of anti-helminthes, water storage facilities, place and facilities for defaecation.

2.3.2 Collection of stool specimen

Samples of faeces were taken into a clean labeled sample bottle with plastic spoon from all the hostels premises. A spoon each was used to pick each sample to prevent cross contamination of the samples. The samples were taken to the Microbiology laboratory of the school were they were analyzed.

2.3.3Laboratory Procedure

The stool was examined using Formol Ether Concentration Technique. For each stool sample, 4ml of 10% formalin was dispensed into a test tube. Using an applicator stick, 1g of faeces was added to the 4ml of 10% formalin. The stool sample was emulsified in the formalin and 3ml of the same 10% formalin added to the preparation and shook so as to homogenize the solution. The emulsified faecal sample was sieved into centrifuge bottle using a surgical gauze and funnel.

Three milliliter (3ml) ethyl acetate was added to the suspension, it was then mixed and centrifuged immediately at 1500rpm for 1minutes. The layer of faecal debris was loosened from side to side of the test tube with the aid of an applicator stick by inverting the test tube so as discard the supernatant. After which the bottom of the tube was tapped to suspend the sediment, a drop of sediment was placed on a clean grease free glass slide. Then a drop of Lugol's iodine was addedto the sample on the slide. Cover slip was used to cover the sediment on the slide carefully avoiding air bubble. It was then examined microscopically using the x10 and x40 objective lens with the condenser iris closed sufficiently to give good contrast (WHO, 1991).

2.4 Statistical Analysis

The data were entered into Microsoft Excel 2013. Chi-square test was done to find the significant difference in the variables.

III. RESULTS

From the study, it was observed that the students practice open defecation. Stool samples were found in the open both in the male and female hostels. Some students defecated behind the hostel windows, hostel premise, while some faeces were thrown over the fence(Plate 1).

One hundred (100) stool samples from the faeces found around the hostel premises were examined for the presence of soil transmitted helminthes. Sixty-seven (77%) percent of the sample was from female hostel while 33% was from male hostel. Twelve percent (12%) of the total samples were infected with soil helminthes (*Ascaris* and hookworm). Fifty-eight point three percent (58.3%) of the infected faecal samples had *Ascaris lumbricoides* egg and 83.3% had hookworm egg. Forty-one point six (41.6%) of the infected samples had mixed infection with *Ascaris* and hookworm (Figure 1).

Figure 2 shows the distribution of *A. lumbricoides* and hookworm infection among the gender in the study population. The *Ascaris* infection was 12.1% and 4.5%

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among the male and female students respectively. Hookworm infection was 15.2% and 7.5% among male and female students respectively. Three (9.1%) had mixed infection among the male while 2(3.0%) had mixed infection among the female. However, the soil helminthes infection was not gender associated (P>0.05) at 95% confidence interval (CI).

Table 1 shows the use of anti-helminthes by the students. Sixty-two point five percent (62.5%) male used anti-helminthes while 79.5% of the female used anti-helminthes. A statistical difference ($P < 0.05$) was observed among the students based on the use of anti-helminthes.

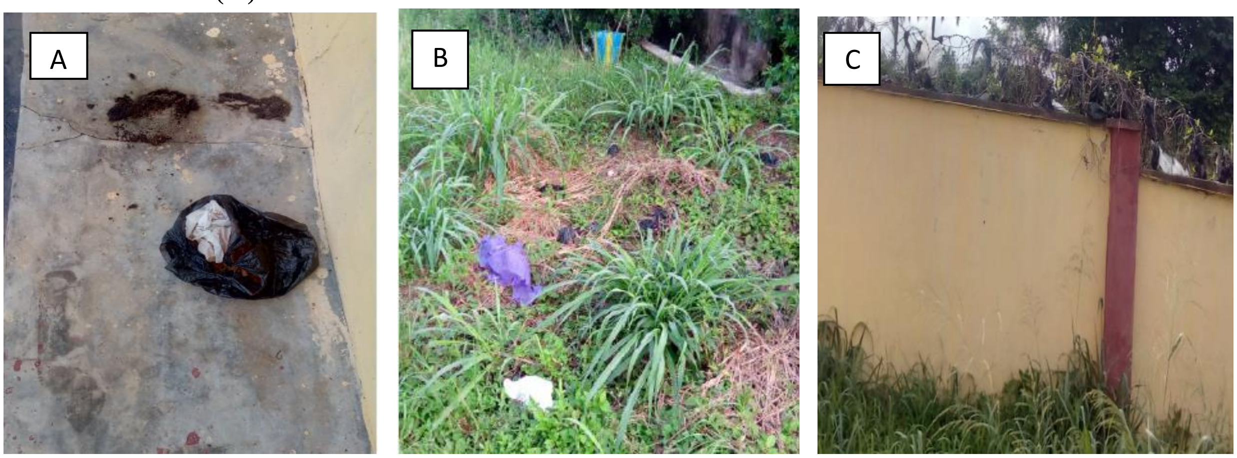

Plate 1: Faecal samples (A) behind hostel hostel window, (B) on bear ground, (C) on hostel fence

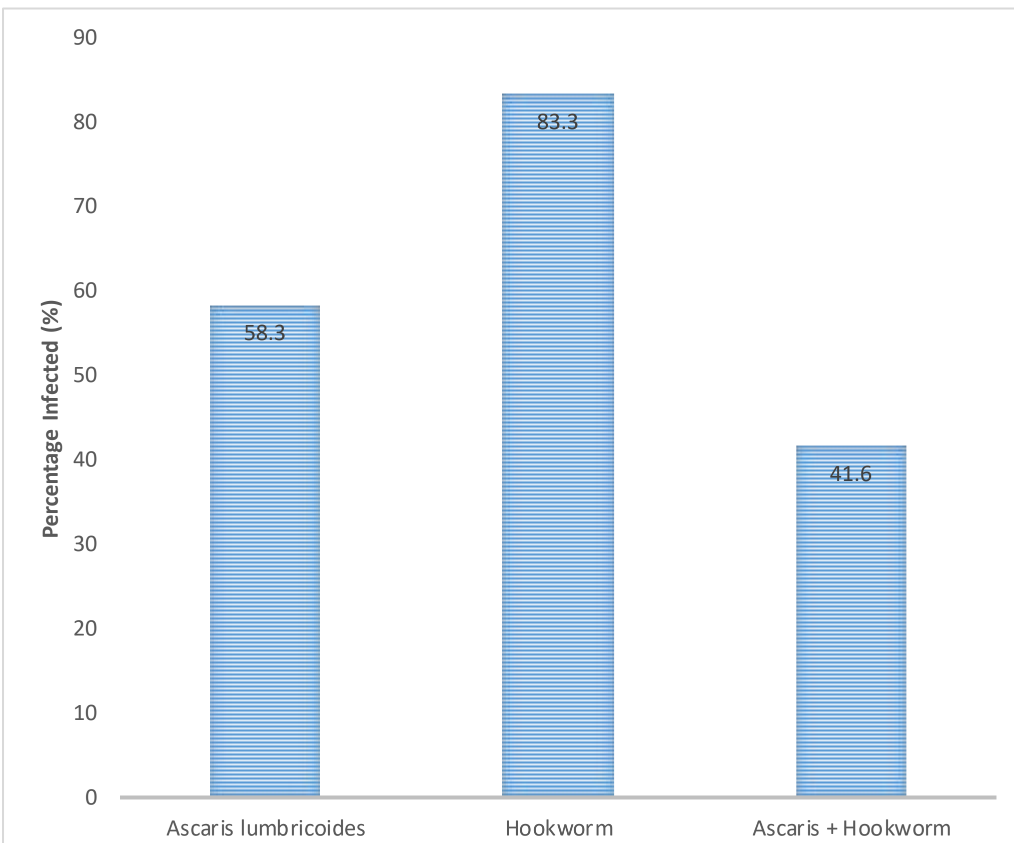

Fig.1: Soil transmitted helminthes found in stool samples.

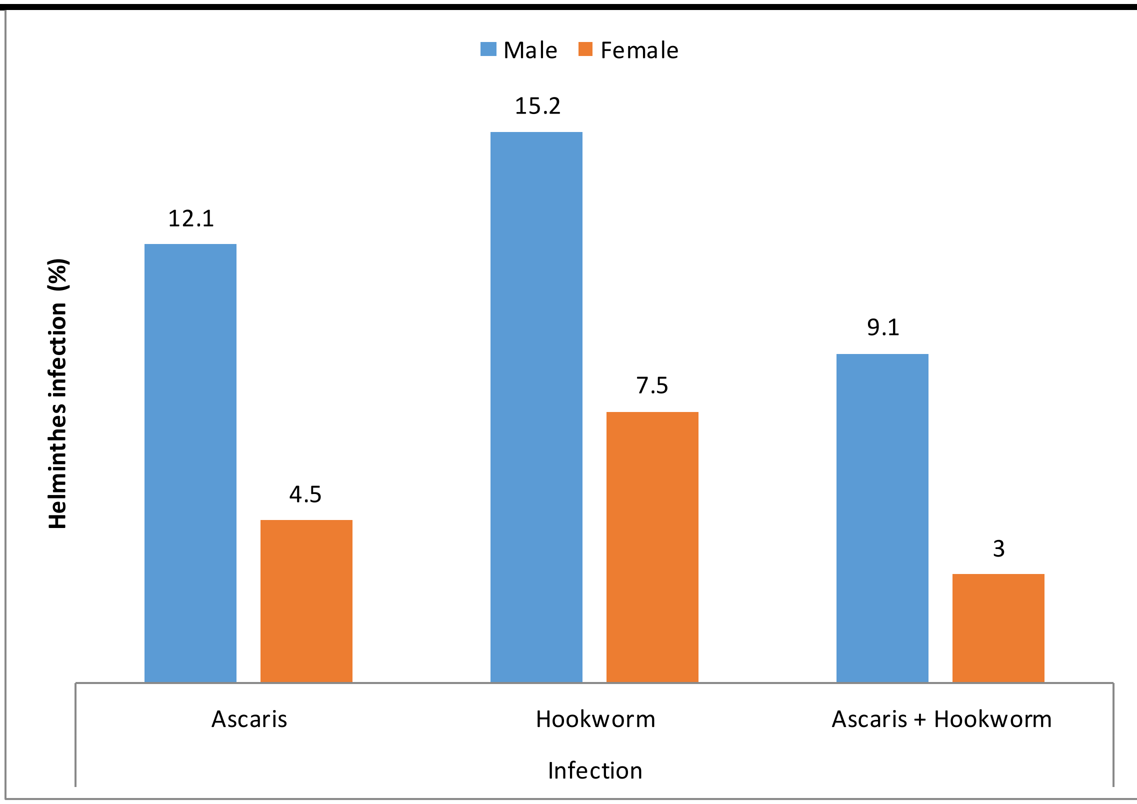

Fig.2: Gender distribution of soil transmitted helminth among students.

Table.1: Gender distribution of anti-helminthes usage by the students

	No. of Respondents	Used Anti-helminthes No. (%)	Do not Use Anti-helminthes No. (%)
Male	24	15(62.5)	9(37.5)
Female	83	66(79.5)	17(20.5)
Total	107	81(75.7)	26(24.3)

Among male students, 20.4% defecatedin toilet, 0% used potty, and 1.9% open defecatedin space. Among female students 40.7% used toilet, 30.6% used potty, and 6.5% used open space (Figure 3). There was a significant difference ($P<0.05$) between male and female based on facilities used by the students for defecation.

Most of the fresh stool samples used for the study were collected during the weekends. Each block of the hostel comprises of 24 rooms with 16 toilets. There are four students in a room. There are 96 students per block with 16 toilets. Therefore, the ratio of student to toilet provided by the school is 6:1.

From the questionnaire interview, information obtained was that water supplied to the hostel stayed mostly for 5 hours in a day (Figure 4). Twelve point five percent (12.5%) and 44.4% of male and females respectively are in habit of storing water in personal storage facilities (Table 2). A statistical significant difference ($P<0.05$) is obtained in water storage habit among the two genders. The toilets are washed by the cleaners and they only worked during the week days. From the study population it was observed that the male students have higher helminthes infection than the female students.

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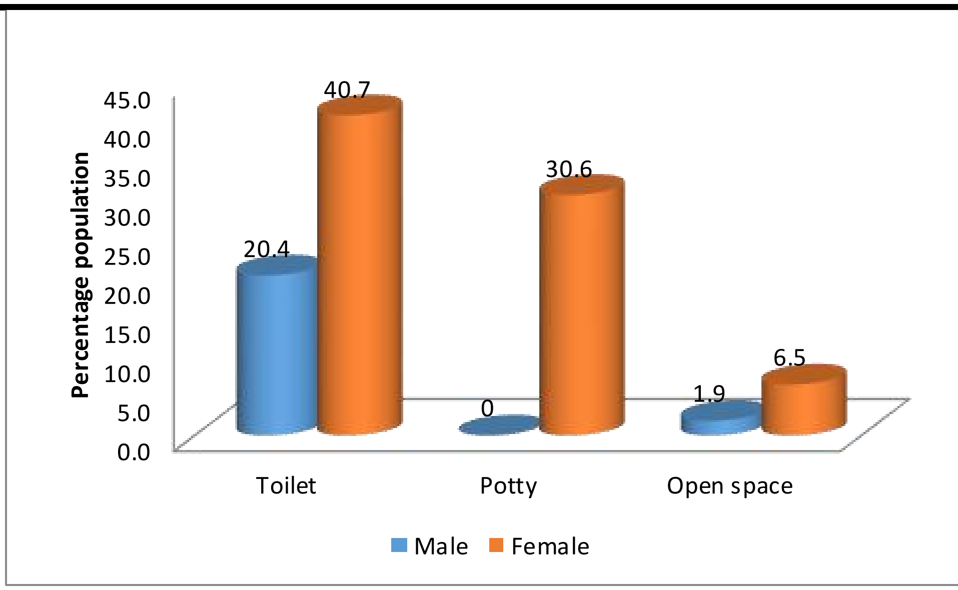

Fig.3: Facilities used for defecation by the students

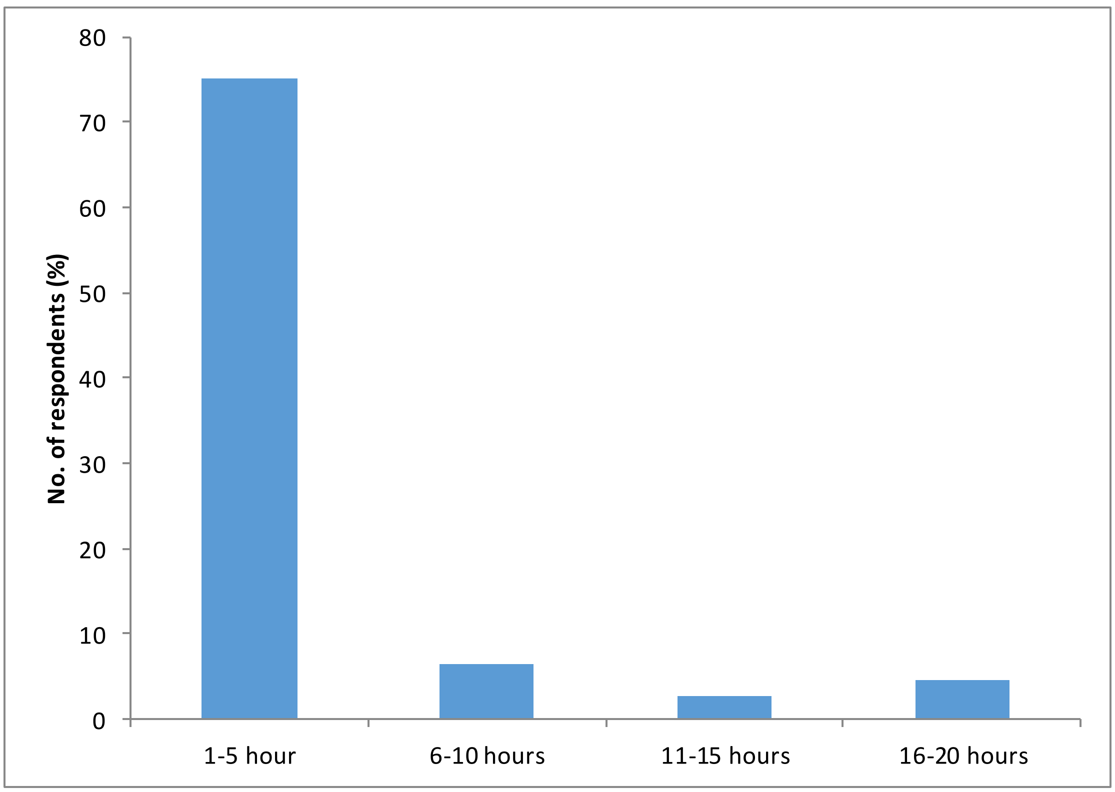

Fig.4: Hours of water supply in the hostel

Table.2: Water storage habit among the students in the hostel

Gender	Total no. of respondent	Stores water No. (%)	Do not store water No.(%)
Male	24	3(12.5)	21(87.5)
Female	81	36(44.4)	45(55.6)
Total	105	39(37.1)	66(62.9)

IV. DISSCUSION

Open defecation has been a major problem in developing country. Some of the reasons were due to unavailability of toilet facilities in houses especially in the rural areas and lack of public toilets in most human communities. The result from this study help to elucidate that open defecation is not limited to unlearned population and may not probably due to lack of toilet facility as also observed by Routray *et al* (2015). A level of decency is expected among the students of higher institution because of their training to become literate and respected people in the community. In contrast, the study population in this study reacted negatively to the expectation.

Stool sample was found littering the hostel environment where the students reside. Some of the factors of open defecation found from this study were insufficient toilet facility provided for the students, inadequate water supply to the hostel and unavailability of cleaners during the weekend to clean the toilets because majority of stool samples got for the study was during the weekends. This implies that common toilets may face the problem of cleaning due to lack of who takes responsibility of cleaning the toilets. It had been noticed that most people are in habit of not flushing the toilet even when there is water in the cistern. So most time the dirtiness of toilets which pushed some people to defecate in the open air is as a result of human behavior towards hygienic usage of the toilets. The finding corroborate the opinion of Ahmad (2014) that the focus on making a community open defecation free should be more on human behavior and not majorly on building community toilet facilities.

It was observed from the study that higher number of female students have facilities for storing water more than the male students. Nevertheless, open defecation was higher among the females than the males. The major reason given by the students that practice open defecation was avoidance of vaginal infection which may be contracted from the use of dirty toilets. The splash of water which might have been used by infected person to the vaginal may result in infection with some microorganisms such as yeast and Bacteria. A study conducted by Ojo and Anibijuwon (2010) among the female students of University of Ado Ekiti in Nigeria linked urinary tract infection to state of toilet facility.

The soil-transmitted helminthes found from the stool samples were *Ascaris lumbricoides* and hookworm. The prevalence of soil helminthes found in this study was lower than the prevalence obtained by Oyeniran *et al.* (2014) and Olaniran *et al.* (2015) among school children both in Osun state. The lower prevalence observed in this study may be due the possibility of getting the sample from few infected persons since the sample were gotten indirectly. The male students have higher helminthes infection than the female. This may be due to low usage of anti-helminths among the male students and also theirhabit of removing foot wear when playing football. Since the hostel premises are littered with faeces because of open defecation, there is a great tendency of helminth larvae present in the soil. This explains the reason for high hookworm infection among the male students in this study.

In conclusion, the level of education does not correlate to behavioural pattern among people. Likewise, to subvertthe habit of open defecation among students of higher learning, adequate provision of toilet facilities with regular water supply is needed. Possibly the hostel room should be designed in such a manner that each room will have a toilet attached to it. Self-contained room system may be adopted by the universities to help in preventing open defecation among the students. Also campaign against open defecation should not be limited to the rural communities alone but should be extended to schools. The students need to be lectured on the adverse effects of open defecation such as transmission of pathogenic organisms which can affect their well-being.

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Separation and Identification of Many Natural Products from *Emblicaofficinalis* Fruits and Study of their Antibacterial Activity

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***Abstract*— *The active constituents were separated from Emblicaofficinalis fruit, using column chromatography (CC) with solvent system of (pet.ether:ethyl acetate; 5:1) from petroleum ether extract (A_1) and solvent system (chloroform:Methanol; 10:1) from Ethanol extract (A_2). Saponification process was carried out on (A_1F_2) to separate many fatty acids and identification of five fatty acids (Heptanoic, Octanoic, Lauric, Palmitic and also cis& trans Oleic acids) using GLC-analysis. Moreover, acid hydrolysis was also carried out on (A_2F_2), to separate many free poles of phenolic compounds, such as (Hydroquinone and Gallic acid) were identified using HPLC-analysis. The active separated compounds under study showed different effects against the micro-organisms (m.o), using disc diffusion method turbidity.*

Keywords*— *GLC analysis, Emblicaofficinalis, fatty acid, phenolic compounds.

I. INTRODUCTION

Emblicaofficinalis (amla) belongs to the familyEuphorbiaceae. It is one of the most often used herb in Ayurveda. It has a reputation as a powerful rejuvenating herb. Amla is a medium-sized deciduous tree with gray bark and reddish wood. It is native to tropical southeastern Asia, particularly in central and southern India, Pakistan, Bangladesh and Sri Lanka. It is commonly cultivated in gardens throughout India and grown commercially as a medicinal fruit. Amla fruit is reputed to have the highest content of vitamin C. the major chemical constituents of amla are phyllemblin, ascorbic acid (vitamin C), gallic acid, tannins, pectin (Priya et al., 2012).Amla is hepatoprotective, anti tumor, antioxidant, antiulcerogenic and antimicrobial against a wide range of bacteria (Sairam et al., 2002; Rajkumar et al., 2014).Amla has been found rich in unsaturated acids. Most predominant polyunsaturated fatty acids like (Lauric, Myristic, Palmitic, Stearic, Oleic, Linolenic and Linoleic and its rich in phenolic compounds like Ascorbic acid, Gallic acid, Chlorogenicacid, Ellagic acid, Myricetin, Quercetin and Kaempferol (Arora et al., 2011; Bansal et al., 2014).The antimicrobial properties of methanolic seed extract of amla was evaluated against various microbial *E. coli*, *Staph. aureus*, *K. pneumoniae* and *P. aeruginosa*. The sensitivity test for the bacterial species on the methanolicseed extract of amla showed exhibited good activity as similar results (Priya et al., 2012).

II. MATERIALS AND METHODS

Amla fruits were collected from local markets of Mosul city then classified and verified by Dr. TalalTaha(a director of the medicinal plants project in Mosul Dam project) according tothe sources of classification.

Preparation of plant extracts:A batch of 50gm of the ground fruits of amla was Soxhlet extracted for 6-8 hrs. with 1L of two solvents (petroleum-ether and ethanol). All these extracts were concentrated to 25 ml on a vacuum rotary evaporator at 50°C. the crude of each extract was used for further studies.

Fractionation of petroleum-ether and ethanoliccrude extract: 300 mg of each crude extract which was previously prepared was mixed with a small amount of Silica gel 25 gm and then transferred to the top of a prepared Silica gel (60-120 mesh) column. The column was eluted with (pet-ether-ethyl acetate; 5:1) V/V intervals. Dissolved 1 gm of each extract of petroleum ether $A_1$and ethanolic A_2 on the basis of amla fruits. Separation of the extract wasperformed using a Silica gel filled column type Silica gel 60 A for flash chromalography filled with 30 gm of gels with petroleum ether-ethylacetateas a solvent (5:1 V/V) and code for P.E for crude petroleum ether extract, two fractions were obtained A_1F_2, A_1F_3. The ethanol extract has been filled with solvent chloroform: Methanol

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(10:1 V/V) Ch:M, several fractions were obtained A_1F_2 depending on the similarity of the spots in their positions and shapes on the TLC plate. And for the same solution system used in the column. The parts were evaporated by rotary evaporator RVE under pressure.

Saponification of the extracts: Saponification process was carried out using petroleum ether extract which belongs to (A_1) from (petroleum ether: ethyl acetate) (5:1) to gel A_1F_2 and A_1F_3 as a resulted from column chromatography. Moreover, the fraction of A_1F_2 was also saponified to librate free fatty acids, also acid hydrolysis was done. Also, the crude ethanolic extract was fractionated to (chloroform-methanol) (10:1).The fraction $A_2F_2$was subjected to saponification to while the A_2 fraction were acid hydrolysed.

Alkaline hydrolysis to obtain fatty acid compounds: Pet-ether extracts and the fractions of petroleumether:ethylacetate resulted from column chromatography.A mixture of 10 gm of each pet-ether extract and also the fractions (petroleumether:Ethylacetate) from petroleum ether extracts (A_1F_2) and 100 ml of 7-5 M of solution of KOH in MeOH:water (3-2) was refluxed in a round bottom flask for 20 min at 100°C. The suspension crude extract was allowed to cool down at room temperature, and 100 ml of distilled water was added. The crude was extracted with diethyl ether (2×100 ml) to remove unhydrolysed1lipid. The hydrolyte was acidified with 20% (V/V) conc. H_2SO_4 up to PH=2. the librated fatty acids were extracted with diethyl ether (2×100 ml) (Aruther, 1972).The combined extracts were washed with water and dried over anhydrous sodium sulfate, filtered and concentrated in vacuum to give 1.2 gm of crude fatty acid compounds.

Preparation of Methyl Esters: 0.1 ml of acetyl chloride was added to 25 ml dry methanol with stirring,. Also, the sample of 0.5 ml of dry fatty acids was added to the above mixture, then boiled under reflux in a water bath for 20 min and dry closed system, then cooled for analysis by GLC method (Al-Kaisy, 1991).

Acid hydrolysis to separate free pole phenolic compounds: The fractions of (Chloroform:methanol) (10:1) resulted from column chromatography. A mixture of 5 ml of fraction (Chloroform: methanol) from ethanol extracts A_2F_2 and 25 ml of (1N) HCl was refluxed in around bottom flask for 1 hr. at 100°C. after cooling, the solution was transferred to the separating funnel then (2×5 ml) of ethyl acetate was added with stirring and after isolation of organic layer from aqueous layer, the organic layer was dried by adding 10 gm of magnesium sulfate for 10 min. The ethyl acetate was concentrated under vacuum rotary evaporates and then kept the free pole of phenolic compounds in glass bottles for further analysis (Harborne, 1998).

GLC-Analysis: The fatty acid methyl esters can be obtained either directly by transmethylation of the parent lipids by refluxing for 90 min-with (MeOH-benzene H_2SO_4) (20:10:1) or from the free acids by the acetyl Chloride-Methanol. The esters were analysed by using GLC on a packurd 419 equipped with adanl flame ionization detectors at 270°C temp. A(2-12 m×2m) international diameter column. Packed with 3% silar10°C on Gas Chrom Q (100-120m) was initially, then raised to 5°C for one min to 20. The identification of fatty acidswere determined by references to a standard of known composition (Bauer et al., 1966).

HPLC-Analysis: The free pole of phenolic compounds was identified by using HPLC apparatus with shimadzo-2010 AHT after purification by filters with a diameter of 0-1 micrometer, and using 320 nm wavelength and 1 ml/min flow rate and (85/ Acetonitrile:15. H_2O) as a mobile phase by using the column of C18 (4×240mm) at30°C temperature. The instrument was provided from a Cherey company Naged and all measurements were carried out in the laboratory of University of Mosul.

Antibacterial activities of prepared extracts of amla: The antibacterial effect of these extracts were tested on all studied bacteria according to the method of modified Kirby-Bauer (Adam, 2006) in which the inoculums were prepared in nutrient broth and incubation at 37°C for (18-24) hrs. The density of the tested suspensions was adjusted to 0.5 McFarland Standard Muller-Hinton agar plated was inoculated by dipping a sterile cotton swabs in the inoculums the excess inoculums were removed by pressing and rotating the swabs firmly against the side of the tubes above the level of the liquids and the swabs were streaked all over the liquids and the swabs were streaked all over the surface of the solution.

Finally, the inoculums were left to dry for few minutes later 50 ml of each of the prepared extracts were dried and re-dissolved in DMSO and placed in walls 6 mm in diameter which were placed on the inoculated plates, the antibiotic discs were also placed. The plates were incubated at 37°C for (18-24) hrs. the diameter of each zone of inhibition (including the diameter of wells and discs) were measured, recorded and compared with the standard antibiotics (Gentamicin (CN) 10 meg, Amikacin (AK) 10 meg, ciprofloxacin (10 meg). Also we have used various concentration (200-50) mg/cm^2 of plant extracts under study (Asif, M., 2011).

III. RESULTS AND DISCUSSION

During the phytochemical screening and previous studies (Priya et al., 2012; Sairam et al., 2002; Rajkumar et al., 2014) of the amla composition which were mentioned with many fatty acid compounds and many phenolic compounds which were investigated in the fruits of amla. From the study of above we have noticed and identified many fatty acid compounds, by using GLC-analysis. Table 1. and Figure 1. and Figure2. showed the presence of five fatty acid compounds within the fraction A_1F_2they are Heptanoic In this study, major unsaturated fatty acids were found such asOleic acid in this species, at high percentage (Priya et al., 2012). Oleic acid was also found as a major fatty acid which play an important role in the body as it is combined with omega-3 to many health benefits (Okpako and Ajibesin, 2015). Also two phenolic compounds were identified Table 2. and Figure 3. and Figure 4. in the fruit of amla. The fraction A_2F_2 which were found the column as acid hydrolysis took place to release free phenolic compounds to get HPLC analysis which is explaining as follows. The fraction A_2F_2 was contained Gallic acid with R_t(2.048 min) and Hydroquinone R_t(2.537 min).The results were similar to previous studies(Bansal et al., 2014; Agarwal et al., 2012). Table 3. and Table 4. and Photos 1-3. showing the antibacterial activity of amla (fatty acids & phenolic extract) against some pathogens bacteria (*Staphylococcus aureus, Escherichia coli* and *Salmonella typhimurium*).

The results showed that fatty acid extracts (A_1F_2) and phenolic compound (A_2F_2) at (200 mg/c^3) per disc possessed high antibacterial activity against *Staph. aureus*

(0.0079%), Octanoic (0.0138%), Lauric (0.0161%), Palmitic(0.045%) and (cis& trans)Oleic acid (0.172%).

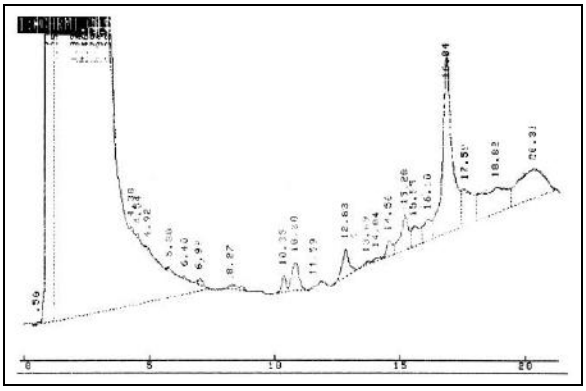
and *Escherichia coli* whereas it was moderately active against *Salmonella typhimurium* compared with antibiotic compounds (Gentamicin (CN) 10 meg, Amikacin (AK) 10 meg, and Ciprofloxacin (Cip) 10 meg). From previous studies (Nitiema et al., 2012) we focused on some phenolic compounds action against bacteria involved in cute gastroenteritis diarrhea.

The study (Priya et al., 2012) results by using seeds of amlathat it contain high antibacterial and antioxidant activities and can be further studiedfor the isolation of its bioactive compound. So, the amlaand Cayratiapedata exhibited a potential of in-vitro antimicrobial activity against *Helicobacter Pylori* which suggest that it may be useful for the treatment of *H. Pylori* infection (Rajkumar et al., 2014).

Thus, several studies have reported the antimicrobial activities of plant extracts from various parts like leaves, seeds and flowers (Karon et al., 2005; Falleh et al., 2008). These results often pointed out that crude extract possesses low antibacterial activities against enteric bacteria (Karon et al., 2005; Zongo et al., 2011).

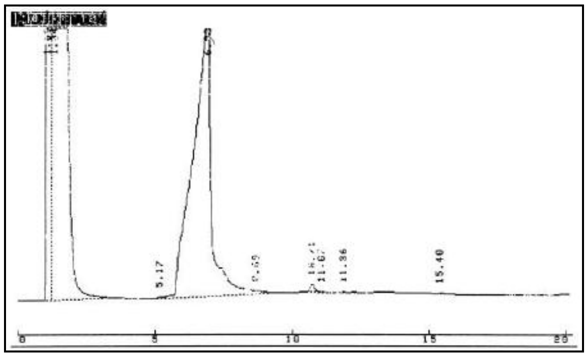
Table.1: GLC analysis of amla extracts of fatty acid compounds.

Extracts of amla	Fatty acid compounds									
	Heptanoic		Octanoic		Lauric		Palmitic		cis& trans Oleic acid	
	R_t(min)	Conc.	R_t(min)	Conc.	R_t(min)	Conc.	R_t(min)	Conc.	R_t(min)	Conc.
Fraction A_1F_2	6.999	0.0079	8.273	0.0138	12.835	0.0161	15.558	0.0451	18.825	0.172



Fraction A_1F_2

Fig.1: GLC chromatograms of fatty acid compounds presented in amla.



Heptanoic

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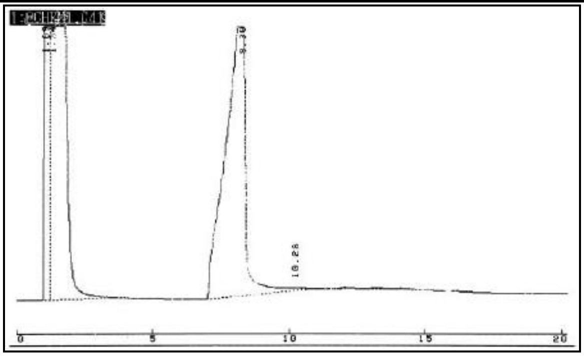
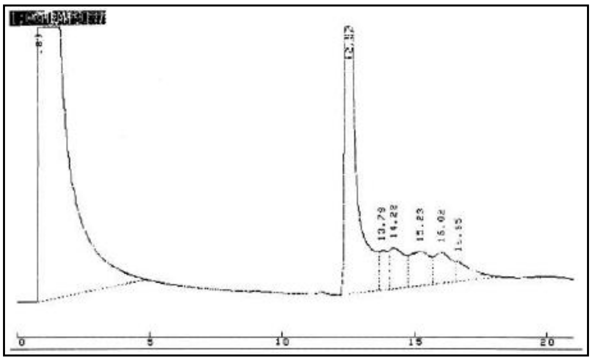
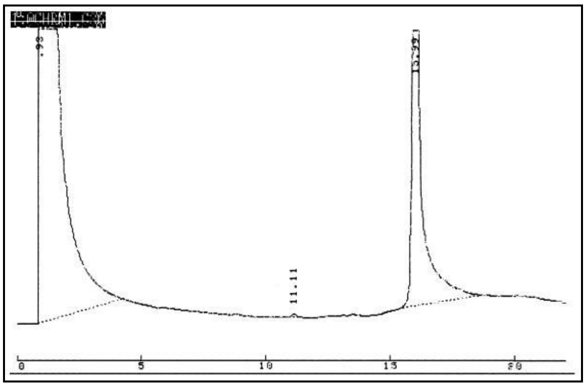


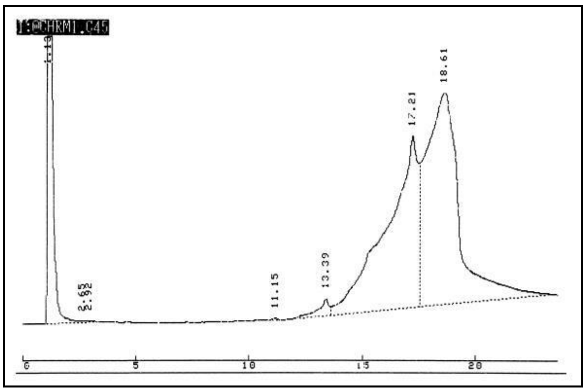
Octanoic



Lauric



Palmitic

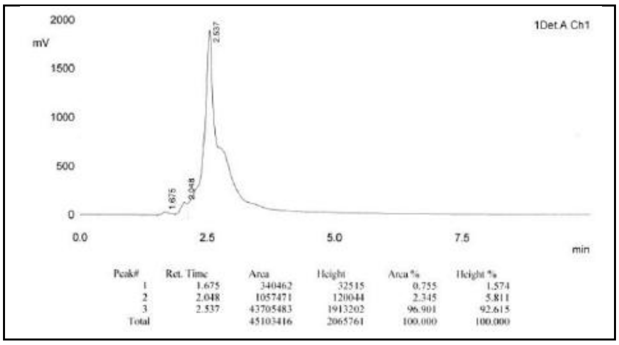


Oleic

Fig.2: GLC chromatograms of standard fatty acid compounds.

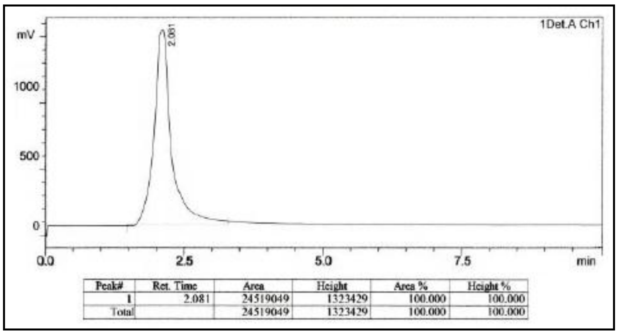
Table.2: HPLC analysis of amla extracts of phenolic compounds.

Standard / Sample	Phenolic compound			
	Gallic acid		Hydroquinone	
	2.081		2.530	
	R_t(min)	Area %	R_t(min)	Area %
Fraction A_2F_2	2.048	2.345	2.537	96.901

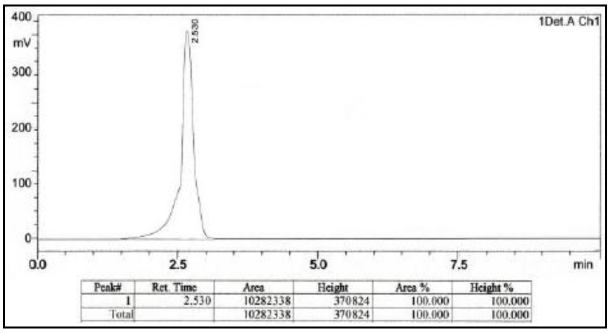


Fraction A_2F_2

Fig.3: HPLC analysis of phenolic compounds present in amla extract.



Gallic acid



Hydroquinone

Fig.4: HPLC analysis of standard phenolic compounds.

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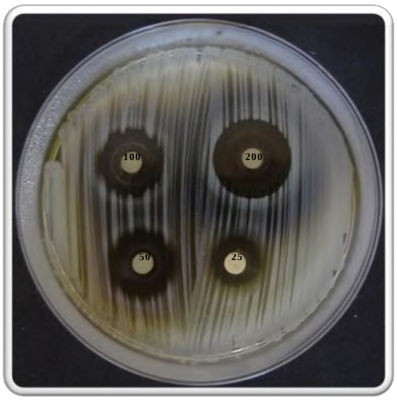
Table.3: Antibacterial activity of fatty acids and phenolic compounds of amla in some pathogenic bacteria (mm).

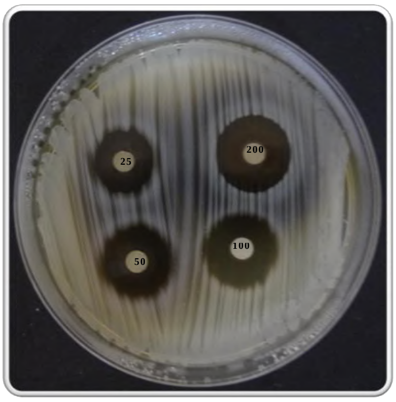
Microbial species	Fatty acids extracts Phenolic compound extracts	Concentration of extracts (mg/c^3)			
		200	100	50	25
Staphylococcus aureus	A_1F_2	25	20	19	15
	A_2F_2	25	20	16	15
Salmonella typhimurium	A_1F_2	24	20	16	10
	A_2F_2	22	20	19	14
Escherichia coli	A_1F_2	27	20	15	11
	A_2F_2	26	15	11	9

Table.4: Antibacterial activity inhibition zone (mm) using the standard antibiotics.

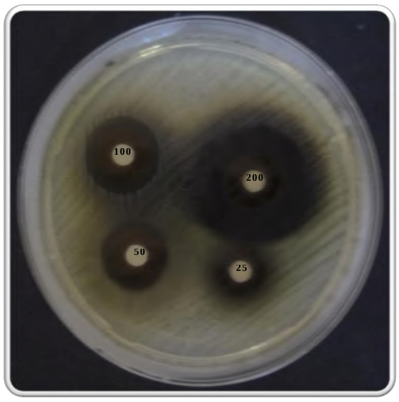
Bacteria / Antibiotics	*Staphylococcus aureus*	*Salmonella typhimurium*	*Escherichia coli*
Gentamicin (CN) 10 meg	21	19	25
Amikacin (Ak) 10 meg	15	15	16
Ciprofloxacin (cip) 10 meg	24	18	26



1. Effect of A_1F_2 on *Staph. aureus*



2. Effect of A_2F_2 on *Salmonella typhimurium*



3. Effect of A_1F_2 on *E. coli*

Photos 1-3. Antibacterial activity of some fatty acids and phenolic compounds in amlaextracts on bacteria under study.

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A Study of Invasive Alien Plant Species of Kuttadan Kole Wetlands of Thrissur District, Kerala

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Abstract*— *An exploratory survey conducted on invasive alien plant species in Kuttadankole wetlands of Thrissur district, Kerala reveals that 46% of the floral components fall under the invasive category. An invasive plant species-rich habitat exhibits a tendency towards steep degradation.

***Keywords*— Kuttadan, Kole wetlands, Thrissur.**

I. INTRODUCTION

Fundamental nature of ecosystemis destroyed by various factors. Biological Invasion is such a natural phenomena and simply refers to range expansion of species into new areas. Such species are named as introduced species, non-indigenous, non-native, invasive, exotic, immigrant, naturalized and alien species. Introduced species are those that have been intentionally or unintentionally transported by human activities in to an area where they did not occur before and where they now reproduce successfully. Invasive alien species are a global issue that requires collaboration among government, economic sectors and non-governmental and international organizations. In this threshold, studies on invasive species in localized habitats have got high relevance.

The Kole wetlands are one of the most threatened wetlands in Kerala. It covers an area of 13,632hectors, are spread over Thrissur and Malappuram Districts, extending from the northern bank of Chalakudyriver in the South to the Southern bank of Bharathapuzha river in the North. These coastal tracts lying 0.5 to 1mbelow MSL, located between $10^0$20" and 10^0 40" N latitude and 75^0 58" to 76011" E longitude. The fields are geographically distributed in Munkundapuram, Chavakkad and Thrissur taluks of Thrissur district and Ponnani taluk of Malappuram district. The study location is a wetland habitat of kole, where the farming activities were not practicing more than past two decades, in which a detailed study of invasive plant species was carried out with the following objectives.

- To carry out the invasive species impact assessment of plant species within the study area.
- To understand the vegetation structure of invasive alien plant species (IAS) in the study area.

II. METHODOLOGY

The present study focus on invasive alien plant species of Kuttadankole wetland of Thrissur district. The invasive species of the area were worked out for its exact identityusing the floras of Gamble & Fischer (1923), Manickam & Irudayaraj (1992) and Sasidharan & Sivarajan (1996) and are compared with thespecimens deposited in KFRI Herbarium, Peechi, Thrissur, Kerala. The herbarium specimens prepared were deposited in the herbarium of Sree Krishna College, Guruvayur as voucher specimens.

Invasive plants of the area were identified using the key provided by Sudhakar Reddy *et al*., (2000). Plant specimens encountered within the plots laid were collected, preserved and prepared herbaria by following the method given by Martin (1995). The invasive species assessment protocol by Morse *et al* (2004) was used for assessing, categorizing and listing non-native invasive plant species according to their impact on native species and natural biodiversity in a particular geographical region or habitat. The protocol is used to assign each species an invasive species impact rank (I Rank) of high, medium, low or insignificant to categorize its negative impact on natural biodiversity within the habitat. Twenty questions in four categories are incorporated in this protocol, *viz.* 1) ecological impact 2) current distribution and abundance 3) trend in distribution and abundance and 4) management difficulty. Each question has five answer options: A, B, C, D or U, where A denotes high, B – moderate and C – low significance. D is for insignificant and U for unknown. The answer should be left null if the question has not been considered substantially. The high rank points the role of species which pose severe threat to native species and the ecological communities. Lower the rank denotes lower impact on the ecological communities. Rank and sub rank calculations are done based on the point value assigned to each answer.

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In order to study the IAS plants of the area, plot studies were conducted as per the method described by Shailaja and Sudha (1997). Appropriate plot size was determined using species – area graph. In the plots 5 x 5 m quadrats were demarcated and vegetation was analyzed by list-count method. Number of individual species and space utilized by individual species per plot were recorded in order to evaluate their relative frequency, density and abundance.

IVI: Percentage values of relative frequency, relative dominance and relative abundance when added together give the importance value index (IVI) based on which an association of plant species is derived. The plot size determination for conducting the study of vegetation was done initially using Species-Area graph and the size of plot for Kuttadankole was designated as 5 x 5 m.

III. RESULTS AND DISCUSSION

The IAS plant species pose severe threat to the native local plantcommunities and negatively affect the biodiversity of the area. The present study reveals that 46% of the floral components fall under the invasive category. Aninvasive plant species-rich habitat exhibits a tendency towards steepdegradation.It is worth to note the IVI values of vegetation represent speciesdominance in the given habitat. In the study area, the dominant species as perthe IVI values were *Eichhornia crassipes* (IVI = 80.89), *Salvinia molesta* (IVI =60.72) and *Sesbania javanica* (IVI = 32.49). The association of three species is obtained as *Eichhornia – Salvinia – Sesbania*, where all the three are falling under the IAS category. Sudhakar Reddy *et al*., (2000) has also mentioned the obnoxious nature of these species. The Impact Assessment Protocol was applied to rank theinvasiveness of individual species and the highest ranks were scored by thesame three species, which clearly point to the risk they pose on the ecosystem.All the high and medium ranked species play an important role in thedisplacement of native species by occupying majority of available space as well as maximum nutrient utilization. All these tend the degradation of theecosystem. The study further points the need of managing IAS plants within the habitatand to take effort to save this unique ecosystem and conserving its natural habitat and biodiversity.

IMPACT ASSESSMENT: Out of the 24 species encountered in the plot studies, 11 are identified as invasive and detailed studies of these species were conducted along with the documentation of the local problems posed by them. Detailed score marks are provided for individual IAS species and the ranks were awarded to individual species considering its invasive characteristics (Table 1).

Table.1: Score obtained for invasive plant species in the study area.

	Species*										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	Score obtained for sub rank levels										
Sub rank *i* intervals	61	6	23	78	40	28	78	78	0	0	51
Sub rank *ii* intervals	23	6	12	33	11	11	26	16	2	6	11
Sub rank *iii* intervals	57	30	32	51	24	24	60	50	23	24	25
Sub rank *iv* intervals	17	10	17	33	16	16	28	39	0	0	12
	Points obtained for rank calculation										
Eco. impact	33	0	0	50	0	0	50	50	0	0	17
Current distribution & abundance	17	0	8	25	0	8	17	8	0	0	8
Trend in distribution & abundance	15	5	5	17	5	5	15	17	5	5	5
Management difficulty	3	0	3	7	3	3	7	10	0	0	0
I Rank intervals	**68**	**5**	**16**	**99**	**8**	**16**	**89**	**85**	**5**	**5**	**30**
I-Rank	Medium	**	**	High	**	**	High	High	**	**	Low

** insignificant

** 1.Alternanthera philoxeroides 2.Azollapinnata 3.Cyperuscephalotus 4.Eichhorniacrassipes 5.Pistiastratiotes 6.Sacciolepisinterrupta 7.Salviniamolesta 8.Sesbaniajavanica 9.Sphaeranthusindicus 10.Spirodelapolyrhiza 11.Utriculariaaurea*

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Production of *Dipteryx odorata* (Aubl.) Willd seedlings with high Quality Standard, making Possible Environmental Valorization

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Abstract— *The species Dipteryxodorata (Aubl.) Willd. – Fabaceae) is distributed in the Amazon and produces noble wood used for different means; moreover, its seeds are used in the perfume and cosmetics industry, and as medication in folk medicine. Luminosity and substrate affect growth and quality before planting when seedlings are produced in plant nursery. Thus, wood particles of Ochromapyramidale (Cav. ex Lamb.) Urban in substrate supplemented with macro- and micronutrients at 0%, 30%, 50% and 70% shading were used to replace chicken manure in the production with high-quality D. odorata seedlings. The experiment was installed in the plant nursery of Tropical Forestry Experimental Station of INPA, in Manaus – AM. It was based on substrates composed of clay soil, sand and chicken manure at ratio 3:1:1/2of O. pyramidale particles to replace manure at ratios 3:1:1/2; 3:1:1 and 3:1:2. The completely randomized design was adopted, to enable factorial (4x4) analysis through ANOVA; means were compared through Tukey test at 5% at 306 days. Height, neck diameter, number of leaves, leaf area and, root, stem, leaf and total dry matter were measured; the survival was evaluated and, quality standard, assessed through the height/neck diameter ratio and Dickson Quality Index.The substrate with half part of O. pyramidale particles at 70% shading led to higher growth of D. odorata seedlings, to higher quality standards and better survival than chicken manure, allowing environmental valorization through the use of wood and residues of O. pyramidale from plantations in the Amazon.*

Keywords— Plant nursery, Biometry, Shading and Allocation of assimilates.

I. INTRODUCTION

The forest tree species *Dipteryxodorata* (Aubl.)Willd. – Fabaceae, known as 'cumaru', belongs to the climax ecological group and is distributed in the entire Amazonian region; it is a large-sized plant native to mainland dry forests [1], and can reach 40m high and 150cm DBH [2]. The species is not classified as endangered; it is possible finding three individuals per hectare in natural forests [3].

D. odorata wood is used in civil and naval construction, in lampposts, furniture, laminated wood joinery and railway sleepers due to its life span and because it does not crack due to exposure to sunlight [2] and [4]; overall, logging takes place in natural populations. It is one of the most used woods in the Brazilian Amazon to secondary forest enrichment [5], as well as in Agroforestry Systems [6], besides having high potential to recover degraded areas by itinerant farming [7], and by extensive livestock [8],still fruitsearlyat 4 yearsof age[2].

The nuts of *D.odorata* fruits has coumarin, which is a substance used in the perfume and tobacco industries [9], and is used (in small drops) as perfume in moisturizers and shampoos by the cosmetics industry. It is also applied in the manufacture of liqueurs, whisky and vermouth [10]. Folk medicine uses it as diaphoretic or sweaty to treat respiratory and heart issues, to fight intestinal worms and the oil of its nuts is applied to heal mouth ulcer, otitis and scalp issues [2]. It becomes toxic to leaf-cutting ants due to increased coumarin concentration [11], and inhibits the oxidative metabolism of rabbits' neutrophils [12]. Yet, the American Food and Drug Administration (FDA) agency classified this plant as toxic and prohibited its use in food [13]; however, there is poor evidences of its toxicity to human beings in therapeutic doses (1900 higher than the doses acquired through food and cosmetic sources) [14].

In 2014, ParáState was responsible for 87.4% of the national production: 103 tons of *D. odorata* nuts [15]. Given the high potential of the species wood and seeds in planting, or in recovering degraded areas, the production of high-quality standard seedlings is an important factor for forestry development in the region.

Luminosity conditions, and substrate, affect growth in the production of forest species seedlings and cause morphological and physiological changes in interactions with the environment [16]. *D. odorata*seedlings adapt either to sunlight or to partial shading; therefore, they are an option for reforestation and agroforestry systems [9]. On the other hand, the substrate is one of the important inputs directly influencing plant performance in the field [17]; each species prefers a certain combination of substrates [18]. A good substrate must make plants more resistant, mainly at initial planting phases [19].

The use of particles of balsa wood (*Ochromapyramidale*(Cav. ex Lamb.) Urban– Malvaceae (PB) to compose the substrates in the present study was based on the physical-mechanical features and use-diversity of the species, as well as on its fast growth and on the fact that it is native to the Amazon. Seedlings of this species reached approximately 6m high in the first year of plantings focused on recovering areas degraded by itinerant agriculture [20]. Seed production started eight months after planting and it did not present integumentary numbness [21]. Wood can be used in paper and cellulose manufacturing, in boat construction and as ceiling linings [22], in the production of boxes for perishable products, besides being a good thermal isolation [23]. Cellulose nanofibers of the species were obtained [24]. This species has been cultivated by the paper industry in commercial planting in Brazil, in São Paulo State [25]. The planted area in Mato Grosso State covers 7,900 hectares and is in constant expansion [26].

O. pyramidale particles supplemented with macro- and micronutrients were used in the present experiment to allow better use of timber-industry waste and to provide more sustainability to pure and mixed planting, since the branches and stems deriving from thinning and pruning can be used as part of the substrate in seedling production; they can also replace the chicken manure added to substrates used in plant nursery. This manure often has different origins, composition and cure stages, fact that causes heterogeneity and unsafety to the survival and quality of seedlings produced in large scale in the Amazonian region.

The aim of the present study was to find technological alternatives to the production of D.odorata seedlings given the potential use of this species wood and seeds in the timber and cosmetics industries, as well as its use in folk medicine in the region. The quality of the seedlings identified through a new substrate with O. pyramidale particles, can provide more homogeneity and more sustainable in seedling production of these species appropriate to recover degraded areas, for use in the timber industry and for the production of forestry seeds in pure and mixed planting.

II. MATERIALS AND METHODS

The experiment was installed in the forest nursery of the Tropical Forestry Experimental Station of the National Research Institute of the Amazon, Manaus – AM, which is located in BR–174 Road, Km 43, at geographic coordinates 2º35'00'' S and 60º20'00'' W (GPS/SAD 69 DATUM).

D.odorata fruits were collected under the canopy of matrix trees in EEST, broken in order to remove the seeds, washed in running water, horizontally sown at 1cm deep in germination boxes filled with washed sand and at the same day.

After germination, seedlings presenting developed first leaf and perfect roots were selected; their root system was thinned 7cm from the root cap in order to standardize root size and to make transplanting easier. Seedlings were transplanted to plastic bags (28x16 cm) with drainage holes on the sides. The bags were filled with different substrate types, which were composed of 3 parts of clay soil (horizon b), 1 part of sand and half part of chicken manure (CM) – dry and pulverized (3:1: ½ PB; 3:1:1 PB and 3:1:2 PB). Chicken manure in the other substrates was replaced by *O. pyramidale* (PB) particles at ratios 3:1: ½ PB; 3:1:1 PB and 3:1:2 PB.

The particles of *O. pyramidale* stems and branches, from plantationsto recover degraded areas, were obtained through grinding in wood grinder (Nogueira DPM 4 with 15mm sieve). The stems and branches were sun-dried, immersed in nutritional solution in 1m³ plastic boxes and daily revolved for 3 months. The nutritional solution was composed of macronutrients (N2: 4%, P2O5: 14% and K2O: 8%) and micronutrients (Ca: 20.6%, S: 3.2%, B: 0.160%, Cu: 0.280%, Mn: 0.320% and Zn: 0.200%) to dilute 3Kg of mineral fertilizer/1000L of water. Subsequently, the particles were once again left to dry in the shade for 30 days in covered shed, without side walls.

D.odorata seedlings were transplanted, but their root caps were kept at substrate level, 1cm below the edge of the plastic bag. After the transplantation, seedlings remained in cover sheds for 30 days; they were subjected to sprinkle irrigation for 5 minutes, twice a day. Next, they were exposed to 30%, 50% and 70% shading treatments in plant nursery covered with black polyolefin Sombrite® screens on the top and sides. The control-treatment garden was subjected to 0% shading and it did not have Sombrite® screen.

Each experimental plot was composed of 35 seedlings,they were distributed in 5 rows with 7 single border seedlings each. In total, 5 seedlings (repetitions) were randomly removed in each evaluation and the remaining ones were rearranged in order to keep the same distance between plants in the useful area and the single border.

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Treatments were called T1 – (0% shading at 3:1: ½ CM), T2 – (0% shading at 3:1: ½ PB), T3 – (0% shading at 3:1:1 PB), T4 – (0% shading at 3:1:2 PB), T5 – (30% shading at 3:1: ½ CM), T6 – (30% shading at 3:1: ½ PB); T7 – (30% shading at 3:1:1 PB), T8 – (30% shading at 3:1:2 PB), T9 (50% shading at 3:1: ½ CM), T10 – (50% shading at 3:1: ½ PB), T11 – (50% shading at 3:1:1 PB), T12 – (50% shading at 3:1:2 PB), T13 (70% shading at 3:1: ½ CM), T14 – (70% shading at 3:1: ½ PB), T15 – (70% shading at 3:1:1 PB), T16 – (70% shading at 3:1:2 PB).

The statistical design used to data analysis was entirely randomized at 306 days. The data were analyzed in a factorial scheme (4 x 4), through analysis of variance (ANOVA) and, the means, compared by the Tukey test at 5% probability.

The effects of the treatments on seedling growth were assessed through total height (TH), neck diameter (ND), number of leaves (NL), leaf area (LA), root dry matter weight (RDW), stem dry matter weight (SDW), leaf dry matter weight (LDW) and total dry matter weight (TDW) measurements. The quality of the seedlings was determined through the Dickson's Quality Index (DQI) (DQI = TDW / ((H/ND) + (GPDM/RDW)). GPDM (dry matter of the above ground part)= stem dry matter weight –(SDW) + leaf dry matter weight (LDW)[28]; TH/ND ratio [29] and, through survival at the end of the experiment.

The chemical analyses applied to the substrates were conducted at the beginning, and at the end of experiment [30].

III. RESULTS

3.1 The effects of shading on the growth of *D. odorata* seedlings

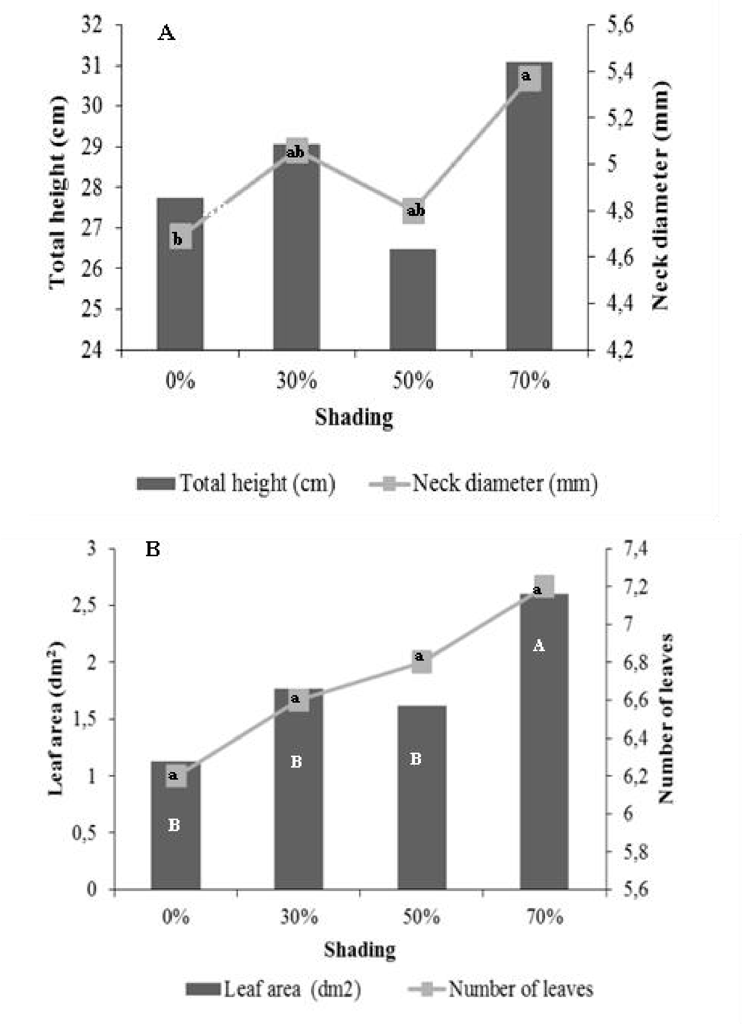

Fig.1: A) Total height and Neck diameter. B) Leaf area and Numeerof leaves of seedling Dipteryxodorata (Aubl) Willd. at 306 days in the nursery in different shading. Means followed by the same capital letter comparing height and leaf area, or followed by the same lower case, comparing stem diameter and number of leaves, did not differ significantly from each other by the Tukey test at 5 % probability

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Seedling height at 306 days in nursery did not present variation proportional to the tested shading levels. Height was higher in the treatment at 70% shading than in the one at 50% shading, but treatments at 0% and 30% shading did not record significant differences in comparison to all shadings (Fig. 1A). However, neck diameter at 70% shading was only bigger than that recorded for the treatment at 0% shading; differences were not significant in treatments with intermediate shading (30% and 50%) (Fig. 1A).

Leaf area had more regular response to the tested shadings; it was significantly larger at 0%, 30% and 50%, whereas the number of leaves did not record differences among all shading conditions (Fig. 1B), but it interacted with the different types of tested substrates (Table 1).

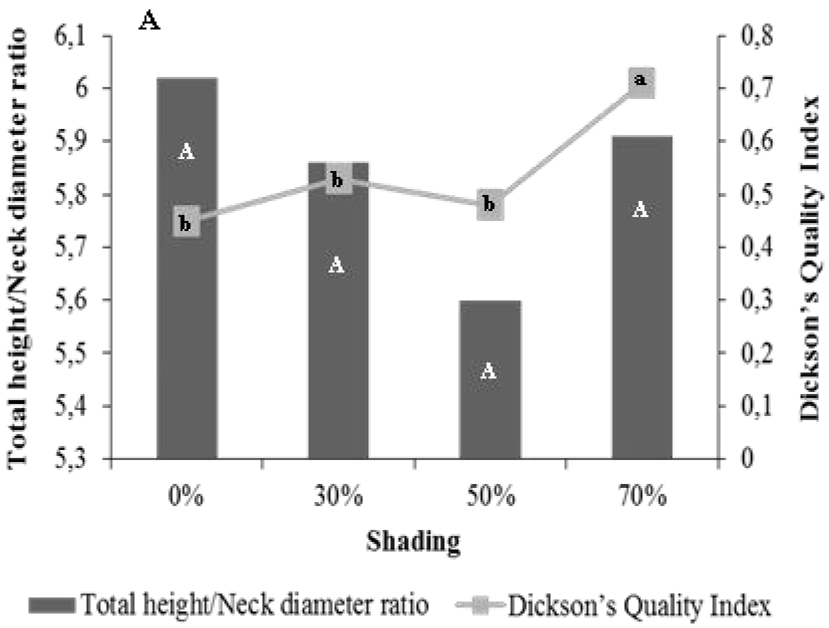
Table 1: Interactionbetweenshadingandsubstratum in thenumberofleavesofDipteryxodorata (Aubl.) Willd. seedlingsat 306 days in nursery.

Days in nursery	Shading (%)	Substrate			
		3:1: ½ CM	3:1: ½ PB	3:1:1 PB	3:1:2 PB
306	0	5,40 a B	8,80 a A	6,20 a AB	4,40 b B
	30	6,20 a AB	9,20 a A	6,00 a AB	5,00 b B
	50	4,20 a B	6,80 a AB	7,60 a A	8,60 a A
	70	4,00 a B	8,20 a A	7,80 a A	8,80 a A

Meansvaluesfollowedbydifferentlowercaseletters in columnsandbyupper case in rows, differfromeachotherbyTukeytestat 5% probability. CM: ChickenmanureandPB :Ochromapyramidale.

The interaction has shown that there was larger number of leaves at 0% shading in the substrate with half part of *O. pyramidale* (3:1:1/2 PB), and different at 3:1:1 PB. The highest values at the highest shadings (50% and 70%) were observed in substrates with more *O. pyramidale* particles (3:1:1 PB and 3:1:2 PB), although all substrates with *O. pyramidale* particles at 70% shading recorded larger number of leaves than the substrate with chicken manure(Table 1).

Values of the height/neck diameter ratio did not record differences between shadings (Fig. 2A), due to balanced height and diameter growth at significantly shading differences (Fig. 1A). There was no neck diameter difference in the treatment recording the shortest height (50%) in comparison to the treatment at 70% shading. There was also no height difference in the treatment recording the smallest diameter (0%) in comparison to the treatment at 70% shading (Fig. 1A).



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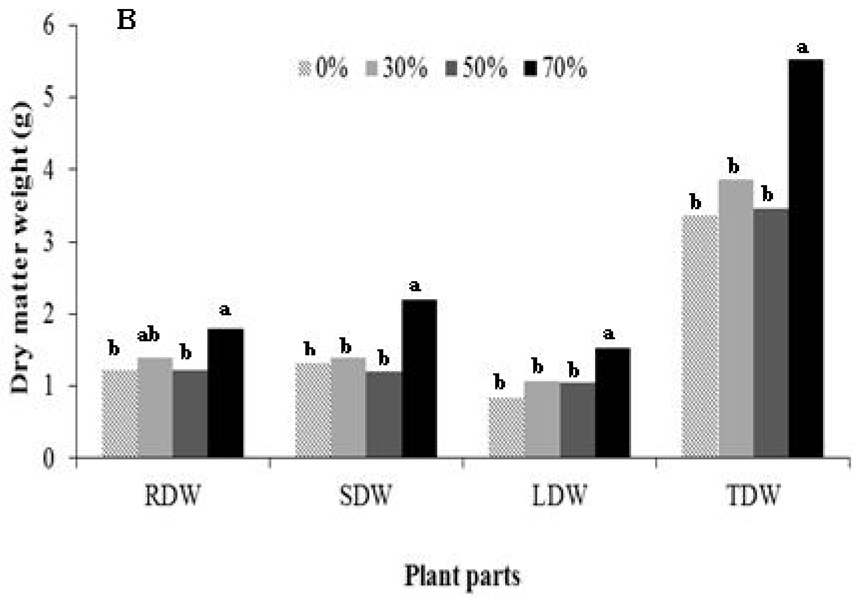
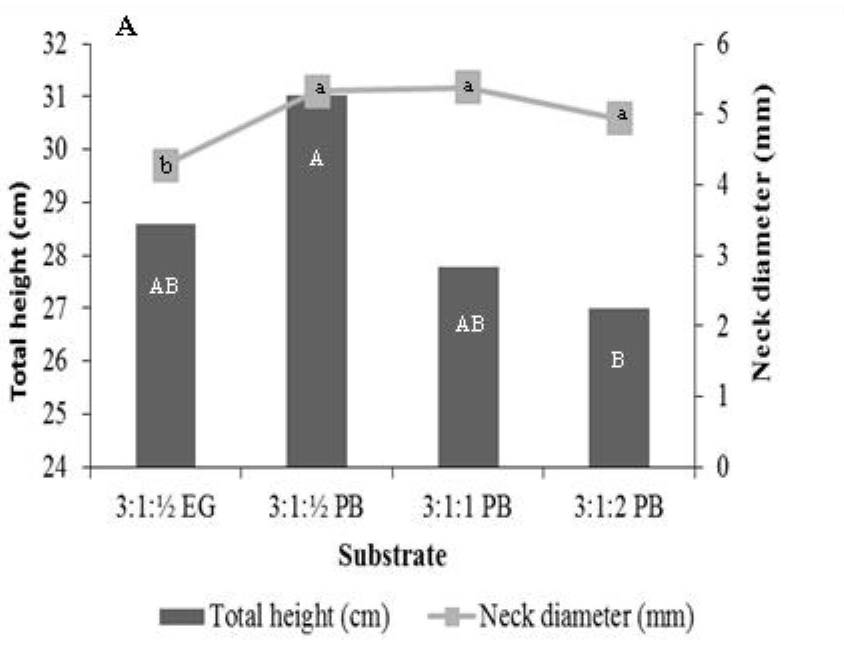


Fig.2: A) Height/Neck diameter ratio (H/ND) and Dickson's Quality Index (DQI). B) Weight dry matter of root (DRW), Stem (DSW), Leaf (DLW) and Total (TDW) of Dipteryxodorata (Aubl.) Willd. seedling at 306 days in nurseryin different shading. Means followed by the same capital letter compare H/ND ratio, orfollowed by the same lowercase letter comparing DQI and shading in the dry matter weight,did not differ significantly from each other by the Tukey test at 5% probability.

The highest DQI (0.71) was recorded for the treatment at 70% shading (Fig. 2A), which has resulted from the highest values recorded for dry root, stem, leaf and total dry matter (Fig. 2B), as well as from the non-significant differences between shadings in the H/ND ratio (Fig. 2A). This ratio is one of the components in the formula applied to calculate the index used to evaluate the quality of forest seedlings.

3.2 Effects of substrates on the growth of *D.odorata* seedlings

The highest height in substrate 3:1: ½ PB diminished as the number of *O. pyramidale*particles and chicken manure increased, it was only different from 3:1:2 PB. However, the neck diameter in all substrates with *O. pyramidale*particles was larger than the treatments with chicken manure (Fig. 3A).



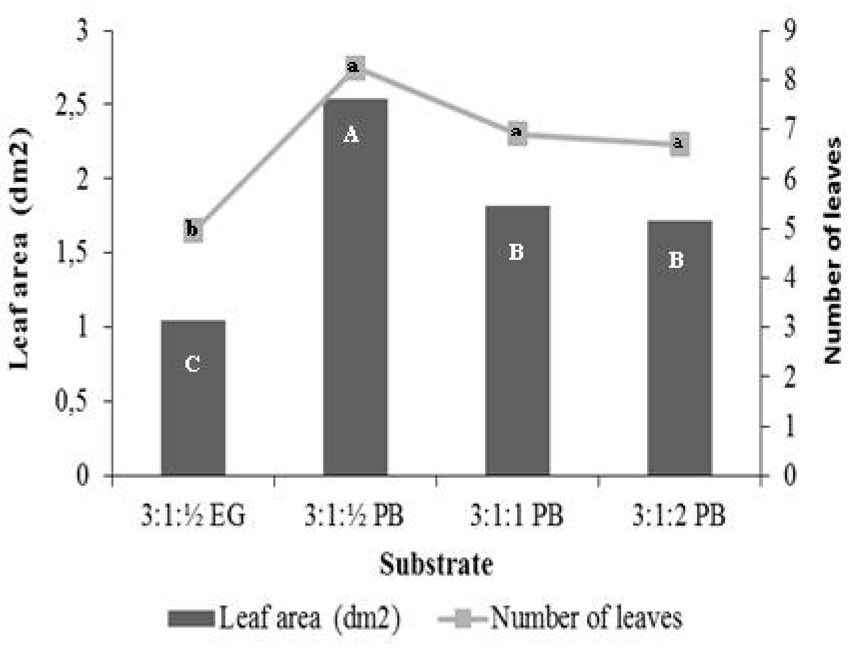
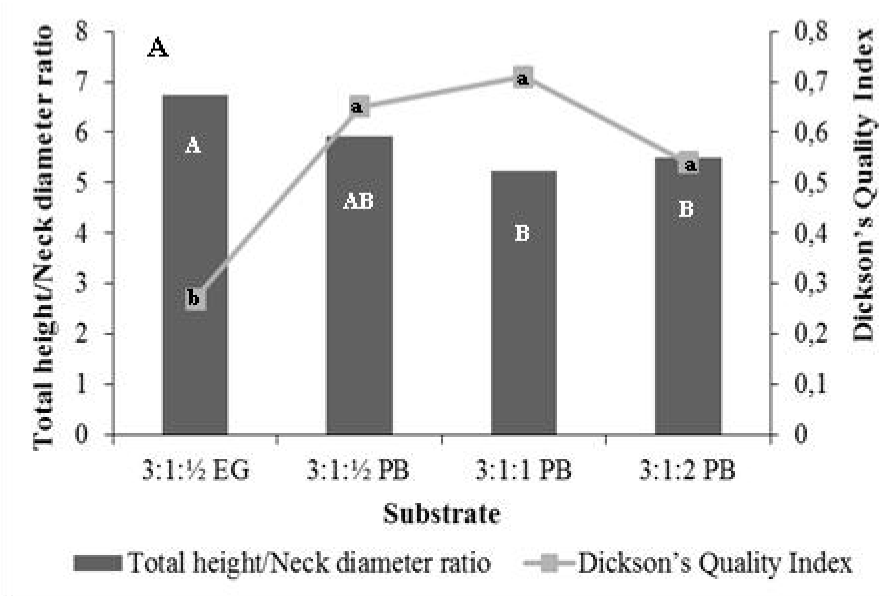


Fig.3: A) Total height and Neck diameter. B) Leaf area and Number of leaves of seedling Dipteryxodorata (Aubl) Willd. at 306 days in the nursery in different shading. Means followed by the same capital letter comparing Total height and Leaf area, or followed by the same lower case, comparing Stem diameter and Number of leaves, did not differ significantly from each other by the Tukey test at 5 % probability.

Leaf area in the substrate 3:1: ½ PB with 2.54 dm^2 was bigger than that in the substrates with *O. pyramidale*particles: mean value 1.77 dm^2. This value wasalso higher than that recorded for substrates with chicken manure: mean value 1.05 dm^2. However, the number of leaves in all substrates with *O. pyramidale*particles recorded mean number 7.28, besides being larger than that recorded for the substrate with chicken manure (Fig. 3B). Each leaf recorded 0.31 dm^2 in substrate 3:1: ½ PB, on average; in substrates 3:1: 1 PB and 3:1: 2 PB, both recorded 0.26 dm^2, and 0.21 dm^2 in the substrate with chicken manure.

The H/ND ratio recorded the highest value in the substrate with chicken manure, but the value was not different from that of the substrate with less *O. pyramidale* particles (3:1: ½ PB). However, values were lower and significantly different than that of the substrate with chicken manure as the amount of *O. pyramidale* increased (Fig. 4A).



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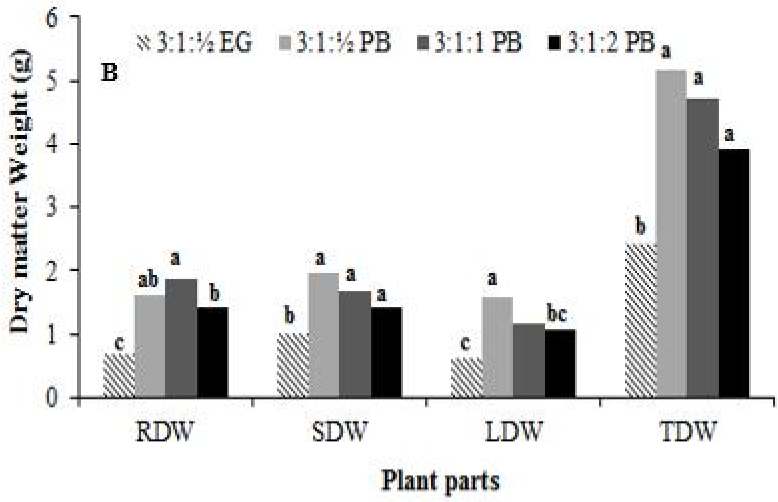

Fig.4: A) Total height/Neck diameter ratio(H/ND) and Dickson Quality Index (IQD). B) Weight of dry matter of root (MSR), Stem (MSC), Leaves (MSF) and Total (MST) of Dipteryxodorata (Aubl.) Willd. seedlings, at 306 days in the nursery. Means followed by the same capital letter comparing H/ND ratio, or followed by the same lower case compare IQD and substrates in dry matters did not differ significantly from each other by the Tukey test at 5 % probability.

The Dickinson's Quality Index of *D. odorata*seedlings grown in substrates with *O. pyramidale*particles recoded mean value 0.63 and it was even higher that with chicken manure: mean value 0.27 (Fig.4A). The substrate 3:1: ½ PB stood out among substrates with *O. pyramidale* particles recording the highest DQI values, since there was more growth balance between shoot and root parts. The highest height value was followed by the largest diameter, and the leaf area was followed by the number of leaves (Figs. 3A and 3B). The highest root and leaf dry matter values were observed in 3:1:1 PB, and the dry stem and total matter were higher in substrates with *O. pyramidale*particles (Figs. 4A and 4B).

The lowest DQI value in the substrate with chicken manure mainly resulted from the smallest neck diameter (Fig. 3A), which influenced the height/diameter ratio recording the highest value (Fig. 4A), as well as the lowest values recorded for the roots, stem, leaves and total dry matter (Fig. 4B).

3.3 Effects of shadings and substrates on the survival of*D.odorata*seedlings

The lowest survival rate of cumaru seedlings at all shadings reached 76.8%; it was recorded in substrates with chicken manure and in those with two parts of *O. pyramidale*. On the other hand, the highest mean survival rates were observed in substrates with half, and one part of *O. pyramidale*particles: 90.5% and 93.5%, respectively. However, the 70% shading produced the best quality of *D.odorata* seedlings in the substrate with half part of *O. pyramidale:* 82% survival.

3.4 Chemical characteristics of substrates with chicken manure and *O. pyramidale*particles at 70% shadings at the beginning, and at the end, of the experiment.

The Table 2 shows that, overall, the organic matter (OM) in the substrate with chicken manure recorded higher values at the beginning, and at the end of the experiment based on treatments with *O. pyramidale*, except for that with two parts of *O. pyramidale*. This treatment recorded higher value at the end of the experiment (12.25 g/kg) than that recorded for the substrate with chicken manure (9.02 g/kg).

*Table.2: Chemical characteristics of substrates under 70% shading. In the beginning and end of the experiment at 306 days *.*

Component	70%/3:1: ½ EG		70%/3:1: ½ PB		70%/3:1:2 PB	
	Beginning	End	Beginning	End	Beginning	End
OM (g/kg)	15.72	9.02	8.10	7.41	7.65	12.25
P (mg/dm^3)	1016	752	205	22	34	45
K (mg/dm^3)	270	40	60	10	40	17
Ca ($cmol_c/dm^3$)	2.32	2.37	0.58	0.54	0.56	0.74
Mg ($cmol_c/dm^3$)	1.68	1.66	0.11	0.10	0.13	0.13
CEC ($cmol_c/dm^3$)	5.12	4.36	0.93	0.96	1.03	1.06

Legend: OM – Organic Matter. CEC - Cations Exchange Capacity.
* Soil and Plant Analysis Laboratory /EMBRAPA Western Amazon.

Values observed for the treatment with one part of *O. pyramidale* particles (3:1:1 PB) were not shown in Table 1, because they did not show differences in the assessed variables in comparison to the other treatments with *O. pyramidale*particles. Phosphorus (P) and organic matter (OM) values in substrate with chicken manure, and half part of *O. pyramidale*particles, diminished in the final evaluation, but they increased from 7.65 to 12.25 g/kg, and from 34 to 45 mg/dm^3, respectively, in the substrate with two parts of particles. Potassium (K) diminished in all treatments. Calcium (Ca) and Magnesium (Mg) values, and the ability to effectively exchange cations (CTCt) had little, or no, variation between the beginning and the end of the experiment.

IV. DISCUSSION

4.1 Effects of shading

The height variation in *D. odorata* seedlings was not proportional to the levels of tested shading at 306 days in nursery, and this outcome evidences the species adaptation to more shaded environments. The evaluations conducted at 81 days showed that the 50% shading only generated higher heights than the 0% shading. Based on the evaluation at 201 days, the 70% shading recorded higher heights than the 30% one and, at the 306 days, height at 70% shading was only higher than at 50% shading [31]. Thus, height growth at the highest shading rate (70%) got more intense with time, whereas seedlings under lower shading returned to the same height values.

The effects of shading on the height of *D. odorata* seedlings were also observed in seedlings of other climatic forest species. However, *Copaiferalangsdorffii* (copaiba) seedlings had growing linear response in variable 'height' due to increased shading [16], which is a characteristic result for climax species.

Height is the most often used parameter to assess plant growth responses to intense lighting, since plants grow faster under shading - an adaptation mechanism and valuable strategy to scape shading [16]. Height growth must be related to neck diameter when it comes to express growth balance and to determine quality standards, but it must be followed by other morphological and physiological parameters [29].

Neck diameter growth in *D. odorata* seedling at 306 days grown in nursery was proportional to shading increase, but there were differences in values recorded for treatment without shading (0%) and the one using the highest shading rate (70%). Therefore, the highest height (31.10cm) and the largest diameter (5.37cm) were recorded for *D. odorata*seedlings at 70% shading, which also allowed better growing balance and quality standards. Better growth balance can determine higher quality standards before planting [29]. Moreover, forest species seedlings presenting height ranging from 20 to 35cm, and diameter between 5 and 10mm, have good quality [32].

The height/neck diameter ratio (H/ND) in *D. odorata* seedlings have changed and tended to get steady due to height and neck diameter growth, mainly at 70% shading. This shading rate only generated larger diameter than the 0% shading; however, height was lower at 50% shading and the diameter did not show significant difference between shadings. Values recorded for the H/ND ratio ranged from 5.60 to 6.02. The variation recorded for *Pinustaeda*ranged from 5.4 to 8.1 and this outcome expresses growth balance; therefore, it can be used to determine the quality standards before planting, although it must be followed by other morphological and physiological parameters [29].

Among other morphological parameters, the leaf area was higher at 70% shading in comparison to other shading rates. However, as the number of leaves did not show differences between shadings, it is possible saying that the higher the shading the bigger the leaves and, consequently, the higher the dry mass weight, which evidences that leaf expansion resulted from cell multiplication. The strong effects of higher shading were also observed in the integration between shadings and substrates, mainly when the number of leaves did not change at higher shading in all substrates with *O. pyramidale* particles, although the number was larger than that recorded for plants grown in substrates with chicken manure. The number of leaves in *Cassia grandis*seedlings in the interaction between shading at 50% and substrates with soil+bovine manure (2:1) and with soil+sand+bovine manure (1:2:1) was larger than that in the substrate with soil+sand (1:1) [33].

The leaf expansion under low lighting is a frequent response, and it indicates that plants compensate, or inflict better use, under such conditions [34], and somehow, they invest more photo-assimilates in area expansion in order to maximize light capture by thin leaves, since they have larger area and lower density [35]. Leaf area in cumaru seedlings at 70% shading grew more proportionally than the dry leaf mass weight: mean specific leaf area 1.70 cm^2/g.

The number of leaves was lower in *Hymenaeacourbaril* and *Enterolobiumcontortisiliquum*seedlings under full sunlight than that of seedlings grown on the shade [36]. The number of leaves is an important indicator of this strategy, as well as biomass allocation in the leaves [37]. Shading also caused morphological and physiological changes in *H. courbaril*seedlings in order to increase light absorption and to maximize carbon gains [36].

The highest root, stem and leaf dry mass values recorded for *D. odorata* seedlings prevailed at 70% shading, and

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the same outcome was observed in height and neck diameter. These numbers corroborate the statements by [38], about the existing relation among root biomass, neck diameter and root growth, and the interdependence to shoot growth. Similar results were observed in *Copaiferalangsdorffii*seedlings, which recorded more root dry mass at higher shadings [16]. The root dry mass in *Swieteniamacrophylla* seedlings at 50% was higher than that recorded for plants at 0% shading [39].

By taking into account the minimal value for [40], it is possible saying that the higher the value, the better the quality of the seedlings [41]. The highest value recorded for seedlings of climax species *D. odorata*(0.71) concerned 70% shading, this outcome indicates that the production of higher quality *D. odorata* seedlings depends on high shading levels. *Simaroubaamara* seedlings – which is a species belonging to an initial intermediate ecological succession group –recorded DQI 0.69 at 50% shading [43]. This outcome evidences that DQI reflects, and follows, the characterization of the ecological group the species is classified in.

Accordingly, *D. odorata*seedlings can be recommended for nursery cultivation at any of the tested shadings, but these seedlings recorded higher dry biomass and growth balance between shoot and root at 70% shading.

4.2 Effects of the substrates

The highest height recorded for *D. odorata*seedlings was observed in the substrate 3:1:½ PB; it was only higher than that recorded for the substrate 3:1:2 PB. This outcome evidenced that only half part of *O. pyramidale*particles is the sufficient physical and nutritional condition to keep this variable growing in nursery; moreover, this value can be compared to the substrate with chicken manure. But, height growth must be related to neck diameter in order to express growth balance and to determine the quality standards; besides, it must be followed by other morphological and physiological parameters [29].

Neck diameter in substrates with *O. pyramidale* particles was larger than that recorded for substrates with chicken manure. This outcome also evidences that these substrates allow more balanced growth in *D. odorata*seedlings. By taking into account that forest species seedlings must measure from 5 to 10mm [32], it is possible saying that *D. odorata* seedlings were within this interval: 5.2mm in :1:½ PB, and 5.38mm in 3:1:1 PB. *T. impetiginosa* seedlings recorded neck diameter 6mm in the substrate with organic compounds and climax species, and their heights were higher in the substrate with underground sand and organic composites than seedlings treated with manure (22.5%) [45].

The highest leaf area growth was observed in the substrate 3:1: ½ PB, which was followed by the number of leaves, whereas the other substrates with *O. pyramidale*particles recorded leaf number growth relatively higher than the growth recorded for leaf area. This outcome evidences that each leaf had smaller leaf area. Substrate 3:1:½ PB led to more leaf expansion, i.e., bigger leaves with higher dry mass, which shows that expansion resulted from cell reproduction and helped generating higher shoot dry mass at the allocation of assimilates.

Leaf area and number of leaves in *Mimosa caesalpiniaefolia* seedlings were higher in substrates with coconut powder, it reached 77.2cm² leaf area and 16.8 leaves in the substrate with soil+coconut powder [46]. *Calophyllumbrasiliense*seedlings recorded the largest leaf areas in the substrate with 101 $Kg.m^{-3}$ of bovine manure, which was 18.9% higher in the substrate without manure; 24.8% in the in substrates with 175 $Kg.m^{3}$ manure and 47.1% in the substrate with 229 $Kg.m^{-3}$[45].The addition of bovine manure to the substrate used for *Caesalpiniaférrea*also allowed larger leaf area [47].

The relative diameter higher than the height growth in the substrates with *O. pyramidale* particles made the H/ND ratio in substrates 3:1:1 PB and 3:1:2 PB adopted for *D. odorata*lower than that recorded for substrate 3:1: ½ EG; however, substrate 3:1:½ PB did not show results different from those of the other substrates, and it resulted in proportional diameter and height growth.

Although height growth was followed by diameter growth in substrate 3:1:½ PB, leaf area and number of leaves also showed proportional growth, as well as the highest relative values recorded for root, stem, leaf and total dry masses. This outcome expresses higher growth balance between shoot and root and evidences higher-quality forest seedlings. These results corroborate indication by [29], about height growth, which must be related to neck diameter, and followed by other morphological and physiological parameters in order to express growth balance and to determine the quality standards of forest species seedlings. Thus, these outcomes showed that the H/ND ratio must not be taking into consideration alone, as well as record the lowest value in order to classify, or determine, the quality standards of forest seedlings.

The H/ND ratio ranged from 6.13 to 8.73 in *Araucaria. angustifólia* in the mixture with Plantmax, sieved organic compound and vermiculite (mean particle size) added with slow-release fertilizer doses (Basacote®) in the base substrate. The highest value in the highest Basacote® value ranged from 5.34 to 6.39 in *Ocoteaodorífera* [48]. The value in the substrate 3:1:½ PB was 5.92 in *D. odorata*seedlings.

The Dickinson's Quality Index in *D. odorata* seedlings, and in the substrates with *O. pyramidale*particles, had mean value 0.63, it was higher than that of the substrate with chicken manure (0.27) at 70% shading, at 306 days, in nursery. This outcome indicates higher quality seedlings when one takes into account that the minimal value suggested by [40] is 0.20 and that, the higher this value, the better the quality of the seedlings [41]. The highest growth balance in the seedlings of forest species reflects the accumulation of reserves, and assures higher resistance and better fixation in the soil by reducing plant tipping, death or deformation that can compromise the forestry value of the seedlings [49].

Phosphorus and potassium had positive effect on [50], in *Eucalyptus grandis* seedlings grown in the substrate with 80% organic composite and 20% fertilized coal mill with, or without, nitrogen. DQI was higher in *Caesalpiniaferrea* seedlings (0.50) under full sunlight and grown in substrates with bovine manure in comparison to the sloppy substrate (soil from granite and gneisses with partially decomposed minerals – sandy or silty, with low clay content) [47].

Substrate 3:1:½ PB was composed of less *O. pyramidale*particles in the present experiment. It could be cheaper and promising to *D. odorata*seedlings presenting higher standard quality to replace chicken manure, besides providing environmental gains by enabling more wood use and wood waste from sawmills, thinning and pruning in pure, or mixed, planting fpocused on recovering degraded areas. It happens because since this species has high forestry potential for such means, based on [7] and [8].

*D. odorata*seedlings also recorded higher survival rates in the treatments with the highest shading (70%) and lowest shading (0%), as well as in substrates with chicken manure and with two parts of *O. pyramidale* particles (3:1:2 PB). However, they recorded longer survival in the substrate with half (3:1:½ PB), and with one, part of (3:1:1 PB) *O. pyramidale*particles. This outcome evidences that the most balanced growth leads to higher quality standards and longer survival. The survival of *Copaiferalangsdorffii*seedlings – climax species – also recorded shorter survival under full sunlight; however, it was higher at 50% shading, but there were no significant differences between the tested substrates [16].

With regard to the composition of the substrates, the increase or maintenance of pH, organic matter (OM), phosphorus (P), Calcium (Ca). Magnesium (Mg), sum of bases (SB), ability to effectively exchange cations (CTC – 1) and the ability to exchange cation at pH 7.0 (CTC – T), in the substrate with two parts of *O. pyramidale* (3:1:2 PB), and at the highest shading (70%), was observed between evaluations at the beginning, and the end, of the experiment. It likely resulted from the highest composition of particles (two parts), and from their highest decomposition, through the 306 days in the nursery, which generated more organic matter in the environment with higher shading. Consequently, the content and composition of these components in *O. pyramidale* particles, so far not decomposed, were released as decomposition took place. On the other hand, and by taking into account the absorption of nutrient by *D. odorata* seedlings, the leaching throughout the experimental period also led to the accumulation of these components in the substrate. However, the interaction between shading and the chemical composition of the substrate did not allow higher growth of *D. odorata* seedlings showing higher quality standards in comparison to the substrate with half part of *O. pyramidale*particles (3:1:½ PB).

However, the treatment with half part of *O. pyramidale* particles (3:1:½ PB) at 70% shading generated the seedlings with the highest quality standards. The contents of pH, organic matter and Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sum of bases (SB), Ability to Effectively Exchange Cation (CTC – t) and Ability to Exchange cation at pH 7.0 (CTC – T) decreased between the beginning, and the end, of the experiment due to the possible higher ability to absorb nutrients. Besides, thus treatment allowed leaching, and produced higher growth throughout the assessed period, as well as high quality standards. Yet, at the end of the experiment, pH, organic matter, Phosphorus (P), Calcium (Ca) and Magnesium (Mg) contents in this treatment were higher than the ones observed in the soil solution 40-60cm down into the ground, and the in the mainland dry forests subjected to selective wood extraction in Central Amazon [51].

V. CONCLUSIONS

*D. odorata*seedlings grew with better balance between shoot and roots, higher quality standards for forest species in the nurseryand highsurvival, on the substrate with 3 parts of clay soil (Horizon b), 1 part of sand and half part of *Ochromapyramidale* particles (3:1:1/2 PB) supplemented with macro- and micronutrients at 70% shading. Under these conditions,this substrate replaced the chicken manure (3:1:1/2 CG) to produce *D. odorata* seedlings, besides allowing environmental valorization through the use of wood and residues of *O. pyramidale* from plantations to recovery degraded areas or production in the Amazon.

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Assessing the Drivers of Vegetal Cover Dynamics in the F.C.T, Nigeria using Remote Sensing/ GIS Techniques

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***Abstract*— *Vegetation in Abuja has been discovered to be on the decrease and there is a dire need for proper monitoring using remote sensing and GIS technology since it has proven to be effective when examining spatio-temporal dynamics of vegetation cover. This research was aimed at assessing the extent and intensity of development in the FCT using Geospatial Techniques as it affects vegetal cover. This was done by utilizing remotely sensed data such as Tamsat rainfall data, Landsat TM, ETM and L8 data, to examine the changes in vegetation and monitor vegetation health in the FCT using Normalized Difference Vegetation Index (NDVI) which has long been used and widely accepted as an effective means of estimating changes in vegetation cover. The study showed that vegetation cover has depleted tremendously at alarming rate of about 34.8% within the period of three (3) decades (1987-2016) in the study area. It also showed NDVI and rainfall were found to be highly correlated (r=0.72) indicating that temporal variation of NDVI is linked to precipitation.*

Keywords*— *AVHRR, NDVI, GIS, Spatio-Temporal, Remote Sensing.

I. INTRODUCTION

1.1 Background of Study

Vegetal cover is an important variable in many earth system processes [1]. It is the assemblages of plant species and the cover they provide [4]. Vegetation also represents an important natural resource for humans and other species. Monitoring and evaluation of the types and extent of vegetation is important for resource management and issues regarding land cover change [5]. Vegetal cover today is altered primarily by direct human use and any conception of global change must include the pervasive influence of human action on land surface conditions and processes. As the human population increases and more people relocate to urban areas, anthropogenic factors are having a profound effect on the urban environment, thus redefining vegetation which has introduced new challenges and research opportunities. This has resulted in an increase in social burden in the urban cities [3].

The Federal Capital Territory (FCT) is diverse and varied with respect to biophysical composition. FCT is characterized with savannah vegetation with 53% of grass land, 12.8% of woodland and 12.9% of shrub lands. FCT has witnessed tremendous developmental activities since inception. Most of these developmental activities include massive infrastructural developments like roads, dams, residential and commercial layouts, schools and hospitals as well as other physical developments. These activities tend to affect the vegetal cover and natural resources of the area especially in depleting the natural vegetal cover. These activities are mostly carried out without due consideration to conservation measures and adherence to the original master plan especially in the rural areas of the FCT and are impacting negatively on vegetal cover and natural resources. This work examined the changes in the vegetation (forest, shrubs, grassland and farmlands) of the FCT for the period of three decades (1987-2016), assessing the extent, intensity and drivers of vegetal cover dynamics using geospatial techniques and the specific project objectives include: -

- To assess the extent and dynamics of changes of vegetal cover in the FCT.
- To identify the drivers of vegetal cover change in the FCT.
- Examine the temporal pattern of vegetation condition in the six area councils of the FCT.

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- To examine the relationship between NDVI and Rainfall in the study area.

II. MATERIAL & METHODS

2.1 Study Area

The study was conducted in Abuja, the Federal Capital Territory (FCT) of Nigeria. The city is in the North central region of Nigeria, between latitude and 9°03′ and 9°07′N and longitude 7°26′ and 7°39′E as shown in Fig 1.

The Federal Capital Territory has a land area of 8,000 square kilometres, has two distinct seasons, the rainy season that begins around March and runs through October and the dry season, which begins from October and ends in March. The Federal Capital Territory falls within the Savannah zone vegetation of the West African sub-region and divided into three Savannah types namely; Grassy, Savannah woodland and Shrub Savannah.

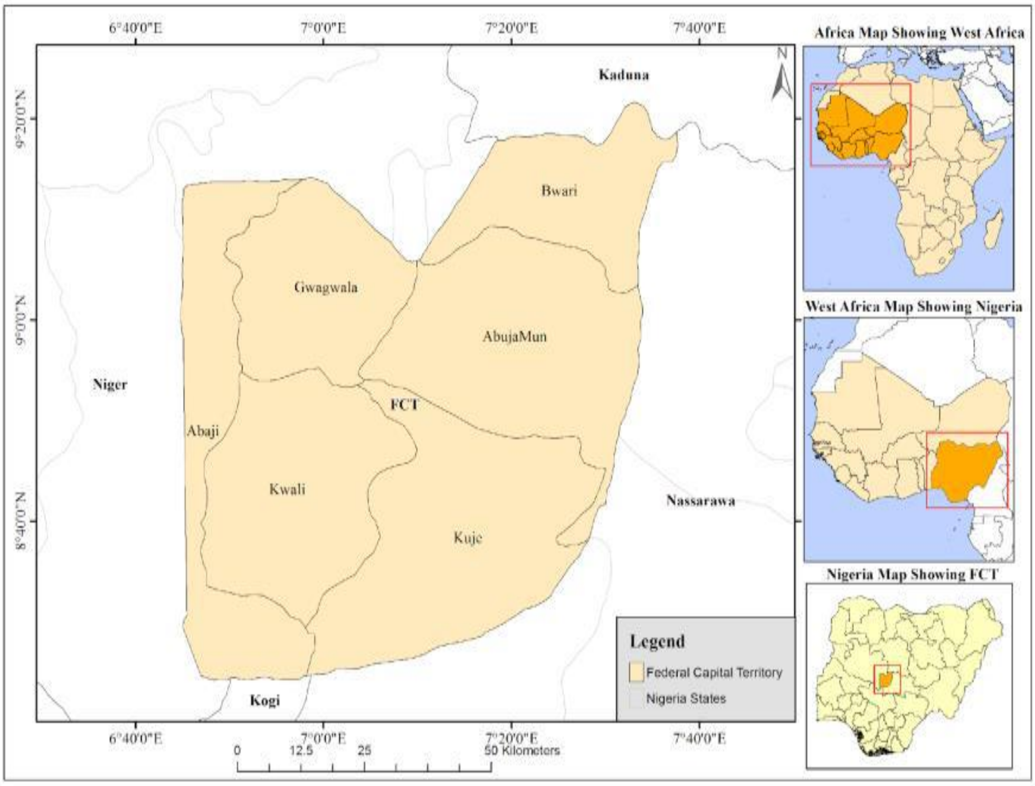

Fig. 1: Map of the study area. (Source: author's work, 2016)

2.2 Data & Methods

The primary data used for this research were acquired from field work and discussions with the local inhabitants in the study area while the secondary data were obtained from National Space Research and Development Agency (NASRDA), global land cover facility (GLCF), TAMSAT.org, and FCDA. These data included; Landsat TM, ETM and L8, and Tamsat Rainfall data at a spatial resolution of 22m, 30m, 2.5m, 1km and 4km respectively.

The methods employed in this research are broadly classified into Pre-Processing of the Satellite Imagery, Field Work and data conversion, Image classification and analysis, and Post classification. Maps were prepared from the images overlaid with settlements and road network for field guide. The methodology flowchart employed for the purpose of this research is shown in Fig. 2 below.

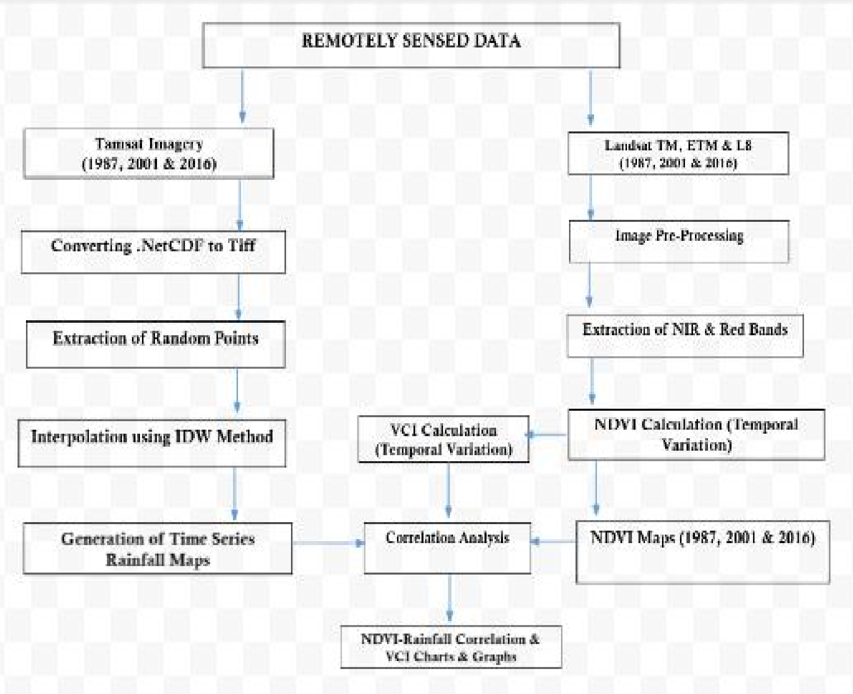

Fig. 2: Flowchart diagram illustrating methodology used for the research

NDVI, schemed in fig. 3 below is universally defined as:

NDVI=NIR-Red / NIR+RED

(Where NIR is the Near Infra-red band and Red is the red band in the electromagnetic spectrum) [2] and Rainfall Data Extraction is the most commonly used method for assessing vegetal cover and was adopted for this study. Theoretically, NDVI threshold value ranges between -1 to +1.

The study area Vegetation Condition Index was then computed using the following expression:

VCI=100*NDVI-NDVImin / (NDVImax-NDVImin)

Where NDVI, NDVImax and NDVImin are the smoothed maximum NDVI, multi-year maximum NDVI and multi-year minimum NDVI, respectively, for each grid cell.

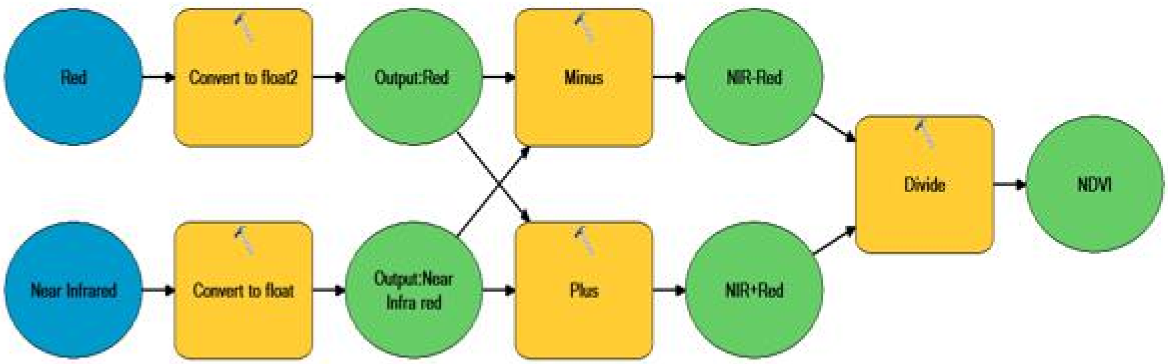

Fig. 3: Showing the Schematics of NDVI

Average rainfall data from Tamsat of the study area for over thirty-two a year period from 1981-2016 for each year was computed by using following expression:

Average RAINx=JANRAIN+ FEBRAIN+ MARRAIN+… DECRAIN12

Where, RAINx is rainfall for x year and JANRAIN, FEBRAIN………… DECRAIN stands for RAIN of particular months in that year. The locations of the rainfall stations were plotted and then interpolated using the Inverse Distance Weighting (IDW) technique in ARCGIS 10. And finally, correlation and regression

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analyses were carried out to observe the relationship between rainfall and NDVI.

III. RESULTS AND DISCUSSIONS

3.1 Change Detection Analysis of Normalised Differential Vegetation Index (NDVI)

Normalised Differential Vegetation Index (NDVI) shows the healthiness index of the vegetal cover measured between -1 to +1. Values between -1 to 0 indicate no vegetation; 0.1-0.3 shows poor vegetation health while 0.3 to 1.0 show very good health status of vegetation.

The results in Table 1 below showed that in year 1986, Areas with no vegetal cover is about 1,481.73 km2 (20.53%) while the areas with poor vegetation health conditions covers 4,014.14km2 (52.62%) and the good health vegetation has a spatial extent of 1,720.34 km2 which is about 23.84% of the total landmass. The areas with good health condition are the Kuje, AMAC and Bwari area councils. Areas with good vegetation health condition as of year 2001, had reduced to 1,402.29 km2 (19.43%) with the Bwari and AMAC vegetation losing its vegetation healthiness most (Figures 4,5,6). Vegetation reduced by about 50% which is 2208.06 km2 affecting all the Area councils with more concentrations at the Abuja municipal. By 2016, areas with good vegetation health decreased drastically to about 853.08km2 (11.82%) while the poor Health condition covers about 2559.24km2 (35.46%) and areas with no vegetation continued to increase to about 3803.89km2 (52.71%) which is due to settlement growth and other human activities most especially in AMAC where the highest vegetation loss is drastic in the study area.

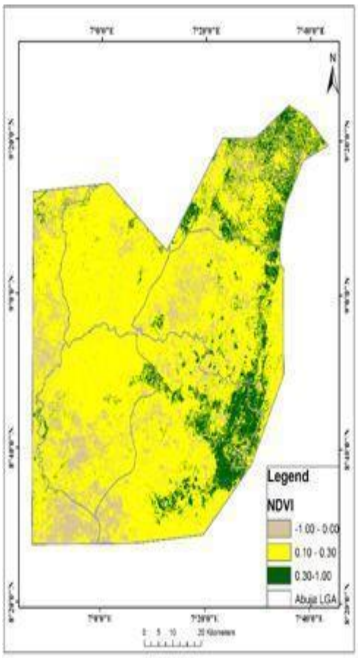

Fig.4: NDVI (1986)

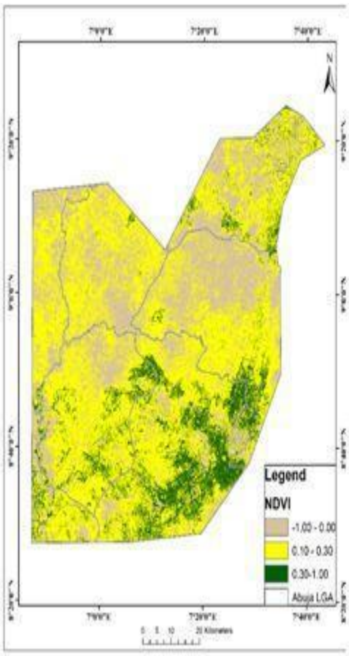

Fig 5:NDVI(2001)

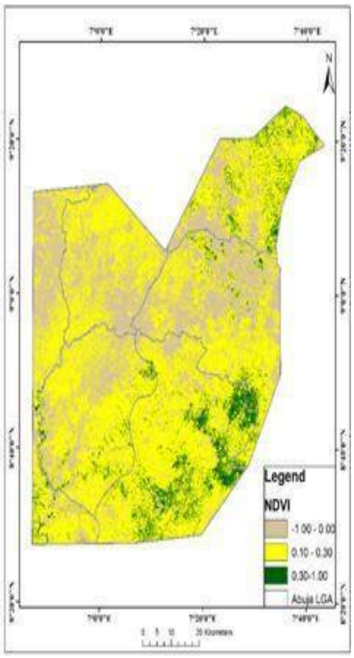

Fig 6:NDVI (2016)

Table.1: Showing Areas of NDVI in Kilometer Square and Percentage

NDVI Categories	Year 1986 Area km ^{2}	%	Year 2001 Area km ^{2}	%	Year 2016 Area km^2	%
Non Vegetation	1,481.73	20.53	2,208.06	30.59	3,803.89	52.71
Poor Vegetation Health	4,014.14	52.62	3,605.88	49.96	2,559.24	35.46
Good Vegetation Health	1,720.34	23.84	1,402.29	19.43	853.08	11.82

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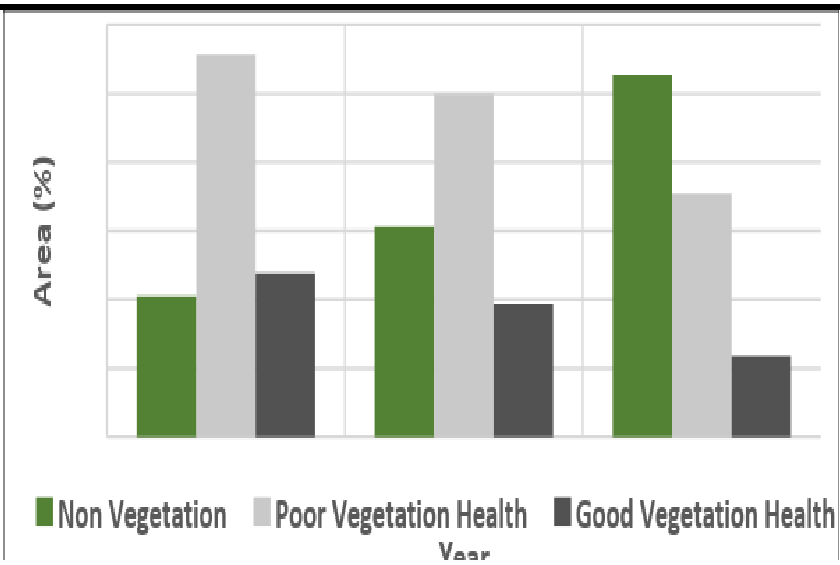

Fig. 7: Bar chart showing Areas of NDVI in % and Kilometre Square

3.2 Examining the drivers of vegetal cover change and the temporal pattern of vegetation condition.

The drivers of vegetal cover change is basically urbanization from the increase in settlements as noted from the mean NDVI results in fig. 8 and table 2 below. The mean NDVI across the LGA showed that Abuja area council has the lowest vegetation health in the area council which is attributed to increase in settlement while Kwali Area council has the highest vegetation health. From the result, two area councils which is Kuje and Kwali Area councils have good vegetation health while the remaining four area councils have Poor vegetation health condition.

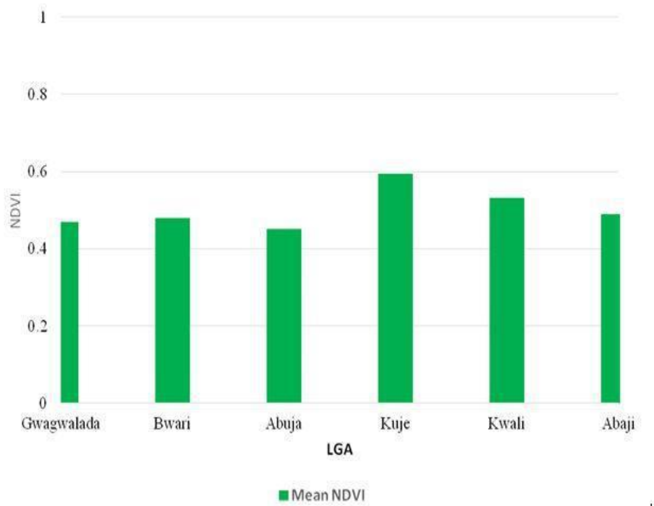

Fig. 8: Mean NDVI for the Six Area Councils

Table 2: Showing the Mean NDVI value across the area councils

Area Council	NDVI value
Gwagwalada	0.47
Bwari	0.48
Abuja	0.45
Kuje	0.5
Kwali	0.53
Abaji	0.49

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The result in Fig. 9 below shows the temporal pattern of vegetation condition index at the FCT. Figure 11 showed that year 1995 had very high drought severity while Years 1987, 1990, 1993 and 1999 had no occurrence of vegetative drought. Other years during the period of observation are experience low severity of drought during the period of study.

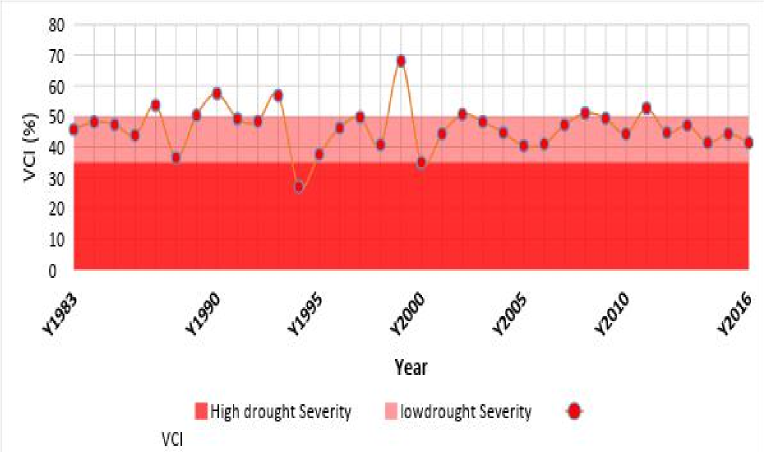

Fig. 9: Temporal Variation of Vegetation Condition Index (year 1981-2016)

3.3 Examining the relationship between NDVI and Rainfall

Considering the average seasonal rainfall and NDVI patterns for FCT Abuja for the period 1981-2016, as depicted in fig. 10 and fig. 11 below, there exist a strong correlation between NDVI and rainfall. The rainfall is characterized by low amount in December, January and February which is the Harmattan period having rainfall less than 100mm which corresponds to low NDVI values of about 0.3. The rainfall continued to increase till May having about 150mm while NDVI continued to increase till June (0.55) showing improved health condition in the study area. NDVI-Rainfall correlation was found to be highly influenced by mean rainfall it is therefore concluded that temporal Variation of NDVI is linked to precipitation.

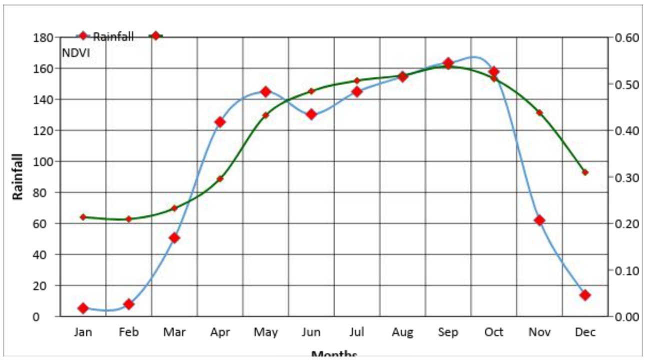

Fig.10: Monthly Variation of NDVI and Rainfall in Abuja FCT

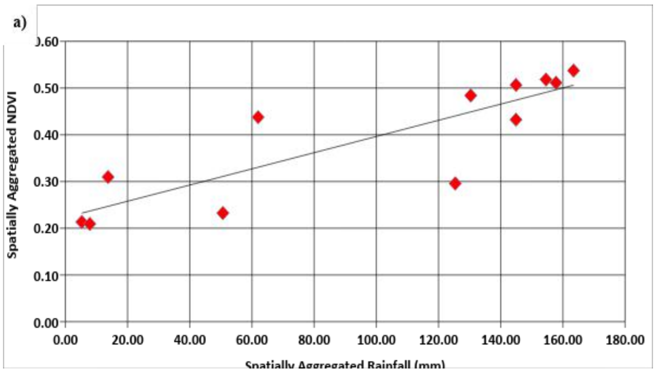

Fig. 11: Relationship between Spatial Aggregated NDVI and Rainfall

3.4 Discussions

This study employed the use geospatial techniques in assessing the vegetal cover in the FCT for sustainable development. The objectives of the research included to identify the drivers of vegetal cover change in the FCT, to assess the extent and dynamics of changes of vegetal cover in the FCT, to examine the relationship between NDVI and Rainfall and to examine the temporal pattern of vegetation condition in the six area councils of the FCT for necessary intervention and sensitization on vegetal cover preservation for sustainable development.

The results of the Normalised Differential Vegetation Index (NDVI) indicate changes in terms of the quality of the vegetal cover in the FCT for the epoch of the study. The results showed an increase in the non-vegetation features (such as water, rocks and bareland) from 20.5 % in 1987 to 30.6% in 2001 and 52.7% in 2016. The poor health vegetation reduced dramatically in 1987, 2001 and 2016 as 52.6%, 49. 96% and 35.46% respectively. The NDVI values for the poor heath vegetation ranges between 0.1 to 3. The good health vegetation ranges between 0.4 to 1. It reduces from 23.8% in 1987 to 19.4% in 2001 and to 11.8% in 2016.

The NDVI of the six area councils were computed and the result shows a spatial variation in terms of healthiness index of the vegetation. Based on the healthiness quality index, Kwali area councils recorded high NDVI value of 0.53 followed by Kuje area councils with 0.5. Abaji, Bwari and Gwagwalada area councils has 0.49, 0.48 and 0.47 respectively. Amac has the least value of NDVI with 0.45. Based on the statistics above, Amac is the most affected area councils in the FCT in terms the healthiness index. This can be attributed to the human induced activities such as expansion of settlement and intensification of agriculture aimed at meeting the food security of the teaming population. The results of the NDVI of the six area councils conformed with the results of hotspot analysis which showed Amac and Gwagalada as the most affected area councils in terms of human induced activities in the FCT. Correlation analysis were carried out to determine the relationship between rainfall and NDVI. The results indicate positive relationship (r=0.729). This implied that rainfall exert significant impact in terms of the healthiness and quality of vegetal cover in the study area.

IV. SUMMARY & CONCLUSION

4.1 Summary of Major Findings

In summary, the study used geospatial techniques to assess the changes in the natural land cover in the FCT for sustainable development. The research also identified the major driver of land cover change, it also identifies the hotspot areas for necessary interventions.

Based on the research undertaken, the following were major findings:

- The results of the NDVI analysis carried out in the study area showed that Amac and Gwagwalada area recorded the least values of 0.45 and 0.47 respectively.
- Vegetal cover has depleted tremendously at an alarming rate of about 34.8% within the period of three (3) decades (1987-2016) in the study area.
- The major contributors or drivers of vegetal change were urbanization or increase in settlements bare surface and rock outcrops as indicated in the change detection analysis carried out using land change modeler.
- The result of the correlation analysis portrays a positive relationship between rainfall and vegetation. This implied that rainfall is an active driver of vegetal cover change in the study area.

4.2 Conclusion

Geospatial technology has proven to be the most effective tools of measuring impact of human activities in the ecosystem as it provides models and modules for analyzing, inventorying and quantifying the rate of vegetal change in the FCT. From the relationship between rainfall and NDVI, it was concluded from the study that temporal variation of NDVI are closely linked with precipitation and there is a strong linear relationship between NDVI and precipitation for Abuja, FCT. A strong relationship exists between annual rainfall and season-integrated NDVI for all of FCDA in Abuja (r^2=0.7). This research concluded with a call for action to develop mitigation strategies that include comprehensive vegetation monitoring and early warning systems using geospatial technology, appropriate impact assessment methods. The role and importance of vegetation in cities need much more attention. Vegetation is an inexpensive way to have a significant impact in the lives of urban residents, as vegetation not only modifies the climate and creates areas of cool; it absorbs pollution and particles as well as adding to the beauty of cities. Policies could be considered for planting vegetation, for instance via new guidelines for urban landscape design and construction.

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Evaluation of Various Local Rice Genotypes in the Mandailing Natal Province of North Sumatra

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***Abstract*—*The purpose of this study was to evaluation of several local rice genotypes in the Mandailing Natal Province of North Sumatra. This studay was and has been conducted from April 2017 to October 2017. Data observed in the form of quantitative data and qualitative data of local rice plants. The results showed that rice cultivars were found in various regions in Mandailing Natal District with a high variety of characteristics. Sampling was done by purposive sampling from 23 sub-districts in Mandailing Natal District. Data observed in the form of quantitative data and qualitative data of local rice plants. The results showed that rice cultivars were found in various regions in Mandailing Natal District with a high variety of characteristics. The sigudang genotype was the best genotype with a total grain weight of 82.6 grams. Genotype Sisorang have a good agronomic appearance.*

Keywords*— *Local rice plants, Germplasm, Characterization, exploration.

I. INTRODUCTION

Rice (Oryza sativa L.) is one of the most important food crops. Rice is a staple food source for almost all Indonesian people. therefore rice becomes a commodity that can have a serious impact on the social, economic and political fields.

Through the initiation of plants, genetic resources are a source of hereditary traits that are useful for assembling a new superior variety with certain traits[4] and [12]. The genetic resources of rice are very important for Indonesia because they are a source of hereditary characteristics for superior rice assembly which is a very strategic commodity in Indonesia [6] and [7]. Local rice is one source of genetic diversity that has unique characteristics such as resistance to disease and aroma and kepulenan which is very favored by the people of Indonesia in general. Even based on the results of Brar and Krush's study, where if the local rice is classified as wild rice, it is likely that it has potential properties that are useful for breeding such as the nature of resistance, especially for biotic and abiotic stresses.

To maintain the genetic resources of local rice, it is necessary to carry out an inventory of local rice in a location. One area that still has a large variety of local rice cultivars is Mandailing Natal District. The rice cultivars have been cultivated by local farmers for generations.

With the availability of superior varieties with desirable traits is the goal of improving rice varieties. This will not materialize without the genetic diversity of rice germplasm. In some cases, cultivated rice germplasm diversity for important traits such as pest resistance, drought tolerance and salinity is very limited. Given the importance of rice to human life, the existence of local rice genetic resources (SDG) needs to be preserved. In the condition of paddy fields, the use of superior varieties of lowland rice cannot solve the problems faced [5], [7], [9] and[12].

However, local rice varieties for an area do not necessarily show the same superiority in other regions, because in Indonesia it is very religious, including the highlands. This is caused by the influence of the interaction between the genotype and the growing environment.

The program of starting rice plants in producing new high-yielding varieties with high yield productivity and stability requires gene sources from plant characteristics that support this goal. The sources of genes from these traits need to be identified and found in germplasm through germplasm characterization activities that already exist and must be conserved so that they are always available both now and in the future and are beneficial for plant breeding. The genes that appear to be now not useful, in the future may be needed in the formation of new superior varieties.

This present study was aimed at evaluation of several local rice genotypes in the Mandailing Natal Province of North Sumatra.

II. MATERIALS AND METHODS

This research was carried out at the screen house of South Tapanuli Muhammadiyah University of North Sumatra Province. In April 2017 to October 2017 South Tapanuli Regency.

This study used a survey method with purposive sampling. Data collection and determination of location used as a place for sampling through a preliminary survey. Exploration method by collecting each rice cultivar planted by local residents. Plants that will be used as samples are preferred for crops that have been harvested or in the form of grain that are still stored in farm houses. There are 8 sub-districts that will be used as place for sampling plants. Each plant genotype that is used as a sample is repeated 5 times so that there are 40 units of the experiment. Then the qualitative and quantitative characters of each genotype were observed.

III. RESULT AND DISCUSSION

1. Height of rice plants

The highest plant height found in the Siganteng genotype had the highest value of 177 cm while the lowest plant height was found in the 87 cm Genotype Sis (Table 1). The shorter the rice plant, the more number of tillers produced so that it will produce maximum production. The higher the plants, the easier the plants will experience shedding and cause the distribution of metabolic processes throughout the plant to break. The flag leaf above will mostly shade the rice seedlings below it, so the higher the plant will be the greater the shade because rice plants need full light intensity in increasing their production. The diversity of rice plants is thought to be due to the more dominant differences in cultivar genetically. This is in accordance with the opinion of [9], [10] and [12] that plant height is a genetic factor of the plant itself and plant variation is its environmental factor.

2. Flowering age of rice plants

Based on observations of the age of flowering of rice plants in each genotype observed, the age at which the flower appeared the fastest appeared in the Genotype genotype. The age of the flower appeared, it took 95 days after planting. While the average appearance of the longest flowering age is Siganteng 150 days after planting (Table 1).

Factors that affect the speed or failure of interest are external factors which consist of temperature, solar radiation, humidity during the generative phase and internal factors such as genetics. The faster the flower's age appears, it will affect the age of the harvest [11] .

3. Harvest age

The fastest fastest harvesting age is found in the Sisot genotype which is 125 HST and the longest is found in the Siganteng genotype 180 HST (Table 1). This is in line with the age of interest appearing in each genotype. Where, the age of the fastest flower appears also found in the Sisoreang genotype while the age at which flowers appear at the latest is found in the Siganteng genotype. In rice plants the age of plants is an observation variable that is done to determine the right harvest time. The sooner the age of the rice plants, the farmers will feel happy by planting in a short time and high productivity. The age of the rice plants has to do with the age of harvest, 50% flowering age, panicle length, and grain amount. Harvest age means the faster the plant enters the generative phase earlier.

4. Number of productive tillers

The highest number of productive tillers is the Siganteng genotype with an average of 13 while the lowest average number of productive tillers is found in the Sigudang 4 genotype (Table 2). According to [13]. productive tillers can be grouped into three types, namely less tillers (less than 12 stems per clump), medium tillers (13-20 stems per clump) and many tillers (more than 20 stems per clump).

5. Rice Per Rice Panai

Quantitative observations on the number of grains with permalent contents were 118 genotypes and a few were coal genotypes 41 (Table 4). The number of filled grain per panicle will determine the productivity of the plant if the panicles formed produce a lot of rice that is pithy, then the productivity of rice plants is high[10]. The amount of grain is determined by the number of productive tillers and the age of flowering earlier, where pollination will succeed and produce a lot of rice. Cooking or the process of filling rice with starch in plants derived from photosynthetic sources and from assimilation sources before flowering which is stored in stem and leaf tissues is then converted into sugar and transported to the fruit.

6. Hollow Grain Percentage Per Panai

Quantitative observations on the number of percentage of empty grain per panicle are coal genotypes 72.4 and fewer, namely Zahra genotype 59.06 (Table 4). The higher quality of rice plants is influenced by the number of filled grain and at least empty grain. Many farmers want at least grain vacuum contained in the crop because it can reduce the weight of the paddy harvest. The components that affect the empty grain are dry weight, total grain content and 1000 grain weight [2], [5]and [10].

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The small amount of empty grain will affect the size of plant productivity. If in a panicle there is a grain which is mostly empty so that it will affect the productivity of plants which are getting lower and the weight per hectare is getting smaller. Factors that cause a lot of grain, namely splash, lack of light intensity and dry leaves, this causes starch in rice grains to shrink and disturbed.

7. Amount of Unbalanced Total Grain

The most quantitative observations of the total number of seed grains found were the sad genotype 134.2 and the least found in the bujingwangi genotype 55.6 (Table 2). The difference from the total number of grain per panicle is thought to be caused by the genetic influence of different cultivars. But apart from genetic influences, environmental factors also affect the total grain count per panicle. [4], [7] and [9] states that the properties of each genetic and environmental growth of varieties will affect the grain density of each panicle. Voidness can also be caused by non-genetic factors, such as pests and diseases.

8. Grain Weight Total Per Clump (g)

Quantitative observations on total grain weight per clump were found in the sigudang genotype of 86.2 gr and the least found in the zahra genotype was 41.4 gr (Table 3). There is a difference in total grain weight of clumps influenced by genetic factors. This is consistent with the statement of [1], [3] and [8] that the difference in total production can be caused by differences in the genetic composition of each rice cultivar, so that the response to the environment is also different. Besides genetics, environmental factors also influence plant production.

Table.1: Average Quantitative Character of Local Rice Plants Based on Plant Height, Flowering Age, Harvest

Genotype	Plant Height (cm)	Fowering Age (hst)	Harvest Age(hst)	Harvest Age Total Tiller Number
Mirah	99	105	142	10
Batubara	101	105	140	13
Tebing	95	98	128	11
Sigudang	103	120	152	14
Sisorang	87	95	125	9
Siganteng	177	150	180	20
Zahra	126	110	140	16
Bujing Wangi	135	120	150	18

Table.2: Genotype Number of Productive and Puppies Amount of Total Grain Per Panai

Genotype	Number of Productive	Pupppies Amount of Total per Panai
Mirah	10	134,2
Batubara	8	88,8
Tebing	12	92,2
Sigudang	4	99,6
Sisorang	6	106,2
Siganteng	13	96,6
Zahra	11	112,6
Bujing Wangi	9	55,6

Table.3: Grain Weight Total per Clump (g)

Genotipe	Grain Weight Total per Clump (g)
Mirah	45
Batubara	44,2
Tebing	45,2
Sigudang	86,2
Sisorang	43,6
Siganteng	44,6
Zahra	41,4
Bujing Wangi	44,4

IV. CONCLUSION

Sigudang genotype was the best genotype with a total grain weight of 82.6 grams. Genotype Sisorang have a good agronomic appearance.

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Analysis of Factors Affecting Farmer Satisfaction in Artificial Insemination Services in Jepara Regency Central Java Indonesia

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***Abstract*—*Artificial Insemination (AI) is a technology developed with the aim of increasing production by increasing population in livestock and livestock genetic quality. AI services are currently carried out by relevant official officers who handle the field of animal husbandry. Satisfaction in the service of AI is the farmer evaluation after comparing the performance or the results he feels with his expectations. The purpose of this study is to analyze the factors which influence farmer satisfaction in AI services in Jepara Regency. The study was conducted in three districts in Jepara Regency (Donorojo District, Bangsri District and Pakis Aji District). The data collection is done through distributing questionnaires to 150 respondents who use the services of Artificial Insemination, determining the sample using purposive sampling. Path Analysis (Path Analysis) was used to determine the effect of availability of AI iequipment, field conditions and service quality on farmer satisfaction. The results of Path Analysis show that there is a direct relationship between the equipment availability to service quality and the indirect relationship of the equipment availability to the satisfaction of farmers. equipment availability has a positive effect on service quality. The equipment availability also has a positive effect on satisfaction. Field conditions have a positive effect on service quality and service quality has a positive effect on farmer satisfaction.*

Keywords*— *Artificial Insemination (AI), Path analysis, farmer satisfaction.

I. INTRODUCTION

Population growth, improved per capita income, and changes in consumer tastes have an impact on increasing meat requirements. Domestic meat production has not been able to fulfill the needs so until this time, to fulfill meat needs are fulfilled from imports. Various efforts have been made by the government to fulfill the needs of beef. According to the Ministry of Agriculture of the Republic of Indonesia (2015) the general policy of animal husbandry and animal health development in order to achieve self-sufficiency in meat is to increase livestock production and productivity where one operational step is optimization of artificial insemination (AI) and lust synchronization. AI technology is one of the reproductive technologies that is capable and has succeeded in improving the genetic quality of livestock, so it can produce good quality tillers by utilizing superior males (Ismaya, 2014).

Jepara Regency is an AI service area in the self-help stage with the realization of AI services with average of 12,000 doses per year with Service rates per Conception (S / C) 2.0 in 2016 and 1.9 in 2017. (Jepara Regency Food and Agriculture Resilience Service , 2017). The technology of insemination is now well known to farmers in Jepara where it can be seen from the increasing number of acceptors every year. Problems in AI services in Jepara Regency include the availability of AI infrastructure facilities namely frozen semen and AI equipment, staff skills, still high S/C numbers, farmers' ability to detect lust, the presence of cattle reptoduction disorders, the ratio of staff to acceptors and regional conditions / field of work. These problems will affect the quality of services that have an impact on the satisfaction or dissatisfaction of farmers.

Service quality is the expected excellence level and control over the level of excellence to fulfill customer desires (Tjiptono 2008). Whereas according to (Wijaya 2011) Quality of service is a measure of how well the level of service provided is able to fulfill customer expectations. Service quality according to Parasuraman in Kotler (2000) is customer valuation (a form of attitude) and is the result of comparisons made by customers regarding actual expectations and perceptions of the services they receive.

Satisfaction is important used to evaluate service performance and improve competitiveness (Ferreira and Fernandes, 2015). After consuming a product or service consumers will feel satisfaction or dissatisfaction with the

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product or service that has been consumed (Sumarwan, 2011). Engel *et al.*, (1990) stated that customer satisfaction is a full-time evaluation where the alternatives chosen are at least equal to or exceed customer expectations, while dissatisfaction arises if the results do not meet expectations.

Satisfaction is important to be used to measure the performance of a service, therefore it is important to analyze the factors that influence farmers satisfaction in AI services so that steps can be taken to improve the AI service.

II. METHODOLOGI

The research method used is the survey research method. This study uses two types of data, namely primary data and secondary data. Primary data is a source of research data obtained directly from original sources. Primary data was specifically collected from questionnaires in the field to answer research questions. Secondary data is data obtained by recording data that has been documented by related parties including agencies / institutions, other parties, literature and other library sources. Primary data collection techniques with interviews and questionnaire dissemination secondary data collection with literature studies and documentation studies.This study uses two types of data, namely primary data and secondary data. Primary data is a source of research data obtained directly from original sources. Primary data was specifically collected from questionnaires in the field to answer research questions. Secondary data is data obtained by recording data that has been documented by related parties including agencies / institutions, other parties, literature and other library sources. Primary data collection techniques with interviews and questionnaire dissemination secondary data collection with literature studies and documentation studies.

Sampling in this study using a purposive sampling sample with consideration of having female cattle and using Artificial Insemination services. Sampling is determined as much as 150 so that the number of samples is in accordance with the recommended and quite representative for the study. According to Hair *et al*., (1995), the sample size needed for multivariate data is between 100-200 samples, or when using the estimated maximum likelihood the sample size is 5-10 times the indicator variable.

Tabel.1: Research Variables, Definitions and Indicators.

NO	VARIABLE	Definition	Indicator
1	Equipment Availability	Availability of equipment that must be owned by inseminator in order to perform AI services properly	1. Availability straw 2. The use of field clothes 3. The use booth shoes 4. The use Gloove 5. The use thermos
2	Field conditions	Staff working area conditions.	1. The closest distance to the officer 2. Total of acceptors 3. The condition of road facilities 4. Field conditions in the work area
3.	Service Quality	AI customer views on the form of service provided by officers	1. Tangibility (increase in livestock productivity, increase in farmer income, birth and pregnancy rates, appearance of officers 2. Reliability (able to fulfill the desires of farmers, not making mistakes in service) 3. Rresponsiveness (fast, precise, clear and certain in providing service) 4. Assurance (skills, knowledge, politeness, ability to provide services that are free of danger and risk). 5. Emphaty (ease in establishing communication, individual attention, and avoiding the use of terms that are not understood by livestock).
4	Farmer satisfaction	The level of feeling of the farmer after comparing the performance or results he feels with his expectations	1. Feeling satisfied / happy 2. Interest in reusing AI 3. The desire to recommend to other farmers 4. Complaints / complaints by farmers

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The questionnaire is measured by a Likert scale 1 (one) up to 5 (five). Sugiyono (2012) explains that the Likert scale is used to measure the attitudes or opinions of someone or a number of groups on a social phenomenon where the answers to each instrument item have radations from very positive to very negative Variables in this study include Equipment Availability, field conditions, service quality as exogenous variables and farmer satisfaction as endogenous variables. Operational definitions are explained in Table 1.

Data analysis techniques to analyze the factors that influence farmer satisfaction are used path analysis as in Figure 1.

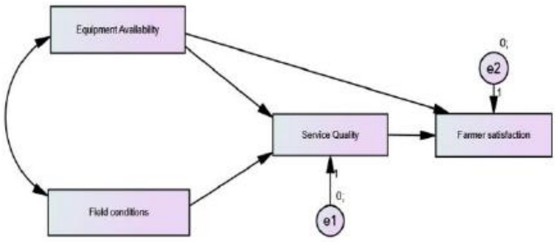

Fig. 1. Path Analysis Model.

Mathematical equations for the models developed in the study:

$$Y1 = \rho(y1x1)X1+\rho(y1x2)X2+e1$$

$$Y2 = \rho(y1x1)X1+ \beta(y2y1)Y1+e2$$

Where :

X1 : Equipment Availability
X2 : Field conditions
Y1 : Service Quality
Y2 : Farmer satisfaction

Hypothesis :

H1 : It is suspected that there is an influence on the Equipment Availability on service quality
H2 : It is suspected that there is an influence on field conditions on quality service
H3 : It is suspected that there is an influence on the Equipment Availability for satisfaction
H4 : It is suspected that there is an influence of service quality on satisfaction

Before the path analysis is carried out, classic assumption tests must be done first. The classic assumption test is done so that the regression model in the study is significant and representative. Classical assumption tests in this study include:

1). Autocorrelation test. Autocorrelation test to find out whether there is a perfect correlation between the members of the observation. Detection using Durbin Watson Test (Gujarati 1991: 201). If the Durbin Watson value between du (Durbin Watson is maximal) and 4-dl (Durbin Watson is minimal) then autocorrelation does not occur.

2). Multicollinearity Test. Multicollinearity is a situation where there is a perfect relationship between several / all independent variables in the regression model. Detection is done by using tolerance value and VIF (Variance Inflation Factor). If the tolerance value is > 0.10 and VIF <10, multicollinearity does not occur.

3). Heterocedasticity test. Heterocedasticity means that there are variants that are not the same in the confounding error. The detection is done by the Glejser method (Arief 1992: 134), namely by regressing the absolute value of residuals. If the t-count is between ± t-tables, there is no heterocedasticity in the study.

4). Normality test. The normality test is used to determine whether the population of the data is normally distributed or not. This test is usually used to measure ordinal, interval, or ratio data. If the analysis uses parametric methods, the normality requirements must be fulfilled, ie the data comes from a normal distribution.

III. DISCUSSION AND RESULT

3.1. General Overview of AI Services in Jepara District

Jepara Regency Government through the Food and Agriculture Resilience Service has made efforts to improve and improve the quality of local cattle and livestock production, especially beef cattle, by implementing an artificial insemination program. The total number of inseminators in Jepara Regency as a whole is 25 people spread across 15 subdistricts, while Karimunjawa sub-district does not yet have an inseminator officer so that farmers rely on natural mating with low productivity because they are influenced by feed quality and maintenance patterns.

The realization of AI services in Jepara Regency continues to increase from year to year. Data on realization of AI services in 2015 were 9,400 doses and increased to 12,926 doses in 2016 and reached 18,656 doses in 2017. The improvement in AI services in Jepara Regency was partly due to the increasing knowledge of farmers about AI, successful socialization by AI officers, and additions AI officers by related agencies thus expanding the reach of the service area. Evaluation of the success of AI can be done by calculating the value of Service per Conception (S/C). S/C is the number of insemination services needed by a female until pregnancy occurs. The S/C value of Jepara Regency was 1.9 in 2017. Normal S/C values were between 1.6-2 (Toelihere, 1981).

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The second most preferred type of cow seedlings is the type of PO. PO cattle are local Indonesian cattle, so farmers are used to this type of cow, besides that PO cattle are preferred because they are relatively tame and can be used as labor to plow fields. Adult PO cattle weight reaches 800 kg for bulls, for females the weight can reach 500 kg.

3.1. Path Analysis Results

The path diagram that is processed by Amos data shows the following results:

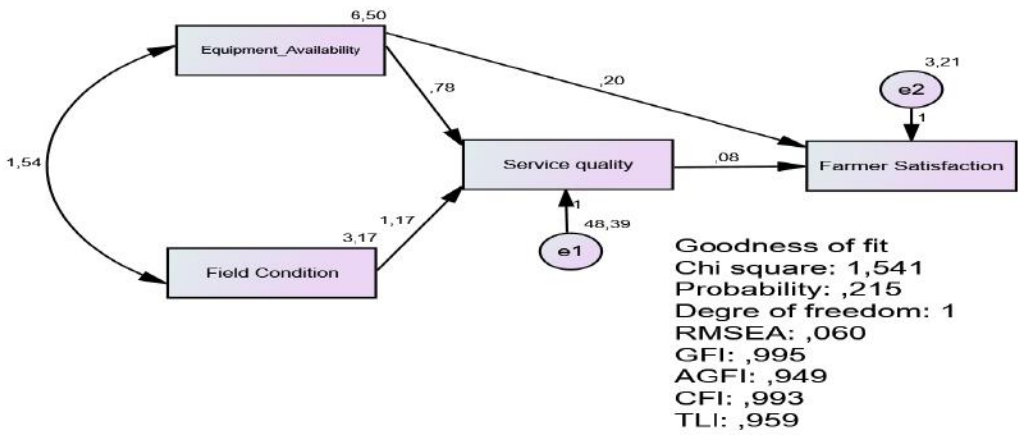

Fig 2. Research Result of Path Diagram

Path analysis must go through the stages of *Goodness-of-fit* criteria assessment (Ghozali, 2017). This step is to assess the overall model fit as a whole, both structural and measurement models together. The results of *the Goodness of Fit* test are presented in Table 2.

Table.2: Testing Results Criteria Goodness of Fit Research data

Criteria	Limitation	Score	Information
RMSEA	0,05 < RMSEA < 0,08	0,060	*Fit*
GFI	> 0,90	0,995	*Fit*
AGFI	≥ 0,90	0,949	*Fit*
CMIN/df	≤ 2	1,541	*Fit*
TLI	> 0,90	0,959	*Fit*
CFI	> 0,95	0,993	*Fit*

Source : Primary data analysis, 2017

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Hypothesis testing is done by analyzing the significance of regression weight. The results of the Standardized Regression Estimate (loading factor) calculation can be seen in Table 3.

Table.3: Results of Standardized Regression Estimate (loading factor).
Regression Weights: (Group number 1 - Default model)

			Estimate Unstandardized	Estimate standardized	S.E.	C.R.	P
Service quality	<---	Equipment Availability	,779	,258	,238	3,280	,001
Service quality	<---	Field conditions	1,166	,269	,340	3,428	***
Farmer Satisfaction	<---	Service quality	,078	,301	,020	3,859	***
Farmer Satisfaction	<---	Equipment Availability	,198	,251	,061	3,222	,001

Based on the results of processing with the AMOS program obtained regression weight values as in Table 3 from the results of data processing can be seen that all variables have a significant effect.

The basis for decision making test of significance for regresion weight are : if p value < alpha 0.05 so the hypothesis become zero (0) and H0 is rejected, means that there are influences between two variables statiscally. if p value > alpha 0.05 the hypothesis become zero (0) and H0 is accepted, means that there is no influence between the two variables statiscally.

Thus the hypothesis test can mean something like this:

a. Hypothesis test 1

H0: There is no influence between the variable equipment availability and service quality

H1: There is an influence between the variable equipment availability and service quality

The test results prove that the variable coefficient of equipment availability for service quality is positive at 0.258. The effect of the equipment availability of statistically significant means is because it is known that the variable equipment availability has a p-value of 0,000 smaller than 0.05, then H0 is rejected which means there is a significant relationship of variable equipment availability with service quality variables.

b. Hypothesis test 2

H0: There is no influence between field condition variables and service quality

H1: There is an influence between field condition variables and service quality

The effect of field condition variables is statistically significant because the field condition variable has a p-value of *** smaller than 0.05. And has a positive variable coefficient value of 0.269, therefore H0 is rejected which means that there is a significant effect of the field condition variable on service quality variables.

c. Hypothesis test 3

H0: There is no influence between the variable equipment availability and satisfaction.

H1: There is an influence between the variable equipment availability and satisfaction.

The test results prove that the variable coefficient of equipment availability is positive at 0.251. The influence of availability of means is statistically significant because it is known that the availability variable has a p-value of 0,000 less than 0.05, then H0 is rejected which means there is a significant relationship of the variable equipment availability with satisfaction variables.

a. Hypothesis test 4

H0: There is no influence between service quality variables and satisfaction.

H1: There is an influence between service quality variables and satisfaction.

The test results prove that the variable coefficient of service quality to satisfaction is positive at 0.301. The influence of service quality is statistically significant because it is known that service quality variables have a p-value of *** smaller than 0.05, then H0 is rejected which means there is a significant relationship of service quality variables with satisfaction variables.

3.1.1. Effect of Equipment Availability and Field Conditions on Service Quality

The results of path analysis with exogenous variables are the equipment availability, and field conditions while the service quality endogenous variable (Figure 2) shows the results of the equation as follows:

Service quality = 51,954 + 0,779 Equipment Availability + 1,166 Field conditions

The above equation constant value is 51,954. Positive constant values indicate positive effects of exogenous variables (equipment availability, and field conditions).

The constant value is 51,954, which means that if the independent variable which consists of the availability of means equipment availability, and the conditions of the field , increases by 1 scale, farmers' satisfaction will increase by 51,954 units. Based on these equations can be interpreted as follows:

In the above equation the coefficient value of the equipment availability is 0.779 and the coefficient of the field condition variable is 1.116, the positive path coefficient value indicates the variable equipment availability and field conditions has a positive influence on service quality. This means that if AI facilities such as straw are always available, AI equipment is increasingly fulfilled, and field conditions such as good road facilities, a small number of acceptors, and the distance of officers is getting closer, it will improve AI service quality.

Sutardjo (2003) states that the availability of AI infrastructure has an effect on the quality of service, because the availability of sufficient facilities will facilitate service operations but the condition of the field / work area does not affect the quality of AI services. AI officers in Malang Regency according to Sutardjo have high professionalism and consider providing AI services to the community is a duty and obligation that must be carried out.

3.1.2. Effect of Equipment Availability and Service Quality on Farmer Satisfaction

The results of path analysis with exogenous variables on the equipment availability, and service quality while the endogenous variables of farmer satisfaction (Figure 2) show the results of the following equation

Farmer Satisfaction = 14,384 + 0,198 Equipment Availability + 0,078 service quality

The value of the constant of the equation above is 14.38. Constant value of 14.384 means that if the independent variable consisting of the equipment availability, and service quality, has increased by 1 scale then, farmer satisfaction will increase by 14,384 units. Positive constant values indicate the positive influence of exogenous variables (equipment availability and service quality) on endogenous variables of farmers satisfaction.

The variable coefficient of equipment availability is 0.198 and the variable coefficient value of service quality is 0.078, the positive path coefficient value indicates the variable equipment availability and service quality has a positive effect on farmer satisfaction. This means if AI equipment such as straw is always available, AI equipment is more complete, S/C is getting smaller, skilled staff, officers are fast, precise and clear in providing services, and great attention from officers to farmers, it will increase farmer satisfaction in AI services. The value of S/C is very important to measure the success of insemination (Hardjopranjoto, 1995), so it is necessary to try to reduce the S/C number because farmers are not satisfied with the current pregnancy rate. To improve the pregnancy rate, it is necessary to increase the competence of AI officers through technical training, improving the reproductive conditions of livestock to support the success of the AI, improving the ability of farmers to detect lust through socialization and training, and maintaining straw quality to be in good condition.

This is in line with the research conducted by Rahayu, YM (2017) that the equipment availability and service quality have an effect on customer satisfaction through customer value. Service quality and price have an effect on farmer satisfaction (Yazdanpanah et al., 2013). According to Hapsari et al., (2016) that satisfaction does not only depend on service quality but also depends on the cost and time sacrificed by the customer to get services.

IV. CONCLUSION

1. There is a direct relationship between the equipment availability and the quality of services and there is an indirect relationship between the equipment availability to satisfaction of farmers.
2. There is a direct relationship between field conditions and service quality and there is an indirect relationship from field conditions to farmer satisfaction.
3. Equipment availability has a positive effect on service quality. the equipment availability also has a positive effect on satisfaction.
4. Field conditions have a positive effect on service quality and service quality has a positive effect on farmer satisfaction.

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Determination of Heavy Metals in Soots from Petroleum Vehicles Exhaust Tailpipes

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***Abstract*— *In recent times, the skyrocketing vehicular population has been accompanied by a decreasing level of vehicle maintenance, aging of vehicle, and increasing inclusion of metal-based additives in fuel. Heavy metals have deleterious health implications ascribed to their propensity to displace the functional groups of enzyme thereby modifying physiological and biochemical processes within the body. With the aid of a plastic spatula, accumulated soot particles were scrapped and collected from the inner surface of the tailpipe of vehicles located at Maraban Jos and Pantaker of Kaduna State. Samples were analyzed for the presence of Cd, Hg, Cu, Pb and Fe via atomic absorption spectrophotometer (AAS). The results showed that Fe emission was the most significant with 1153.560±0.361 mg/kg and 796.816±0.522 mg/kg being the mean concentration for gasoline engine vehicle (GEV) and diesel engine vehicle (DEV) respectively. Pb followed in the order of higher concentration having an average concentration of 14.097±0.644 mg/kg for (GEV) and 11.278±0.028 mg/kg for (DEV). Mercury average concentration was found to be 5.899±0.070 mg/kg for GEV while 2.044±0.054 mg/kg was obtained for DEV. 3.083±0.034 mg/kg for GEV and 1.453±0.051mg/kg for DEV was attributed to Cu. Cd had the least concentrations for both engines, with 0.044±0.036 mg/kg and 0.0403±0.037 mg/kg for GEV and DEV respectively. Hence, the result shows GEV to have higher heavy metals pollution as compared to DEV. There exists also a similar trend associated with the emitted metal concentrations of the two fuels (gasoline and diesel) engine which follow the order of Fe > Pb > Hg > Cu > Cd. All the results exceeded the maximum permissible limit for air control given at 0.5 mg/Nm^3 of an averaging period of 30 minutes to 8 hours according to (European commission 1991) with the exception of Cd from all the samples and lead from two sample of the diesel engine which recorded no detection. It is therefore inferred that soots from the exhaust tail pipes of petroleum vehicles are a major source of toxic heavy metals which are capable of altering physiological health states.*

Keywords*— *Heavy Metals, Petroleum Soot, Physiology, Vehicle Exhaust, Diesel and Gasoline.

I. INTRODUCTION

Transportation is an imperative component for comfortable human existence. The liberty to travel petite and stretched distances creates the prospect for individual progress and professional activities, increases the alternative for leisure and holidays, and allows better contact and understanding with people. The economic expansion of whole regions depends on the effortless contact to citizens and goods ensured by modern transport machinery. Due to its suppleness, road transport is a major transport means, and cars are substance of aspiration and pride in various societies. Sorry to say, these positive aspects are very much related with the hazards to the surroundings and human health caused by transport, chiefly road transport (Dora & Philips 2000).

This has resulted in the rising transport volume, associated risk of harm to air quality and health, and an increased threat to the guiding principles of many countries, as affirmed by the European Union (EU) in its 6th Environment Action Programme; to realize pollution levels that do not give rise to damaging effects on human health and the environment (European Commission, 2001)

Transportations by means of gasoline and diesel engine vehicles, have received growing consideration as a cause of air contamination at both local and international scales since 1970. Greater than 95% of mechanical transport relies on petroleum and accounts for nearly 50% of world use of petroleum (Woodcock *et al*, 2007). There is a substantial increase in the number of vehicle (Quari & Hassan, 2017). At the moment there are more than 700 million vehicles on roads, and this numeral figure is projected to double in 30 years to come (Iaych *et al*, 2009). This significant contribution led to (Guilherme *et al*, 2017; Lu Qi *et al*, 2016) findings of vehicular exhaust emission as a primary source apportionment of particulate matter which he performed using positive matrix factorization (PMF).

Heavy metals, such as Ni, Cd, Pb, Zn, Cu, Hg, Cr and others refer to metals with densities greater than 5 g/cm3 (Li *et al*, 2014) Inappropriate disposal of engine oil, brake fluid, and petroleum exhaust transmission oil and leaded gasoline in the surrounding region of fuel contributes to the heavy metals load (Dauda & Odoh, 2012; Khorshid & Thiele-Bruhn 2016; Luo *et al*, 2012).

Heavy metals can be able to affect human health when exposed by means of ingestion, inhalation and dermal contact (Ling *et al*, 2008; McLaughlin *et al*, 2000). For instance, excessive exposure to Pb can damage the skeletal, nervous, endocrine, circulatory, immune and enzymatic systems (Zhang *et al,* 2012). Mean while, exposure to Cd can cause pulmonary adenocarcinomas, hypertension, kidney dysfunction, lung cancer, prostatic proliferative lesions and bone fractures, (Chen *et al*, 2015)

Different reasons leads to the addition of various compounds to liquid fuels (such as methyl tert-butyl ether (MTBE), tetraethyl lead (TEL) so as to get higher the octane number of the fuel and also to oxygenate the fuel in winter months to lessen urban smog (US EPA 2008). Several of these sources have been directly linked to adverse health effects. Instances shows that the major aerosol cause of human toxicity in Barcelona was credited to traffic activities which has to do with vehicle emissions, road dust and secondary nitrate), with fuel burning and industrial emissions also contributing to increased cancer risk (Reche *et al*., 2012; Turoczi *et al*. 2012) reported higher toxicity from direct emissions (e.g. from traffic) than from aerosol processed photochemically.

It is imperative to comprehend the degree to which emission sources affect air quality, particularly in urban areas, where the worldwide population has increased from 34% (in 1960) to 56% (in 2014) and is projected to grow further (WHO 2014). Having access to cheaper road transport in developing countries is a deciding cause for percentage share of vehicle types. This has brought about exponential boost in their figures over the few years. Consequently, changes in the percentage share of vehicles plying on urban roads influence traffic and emission characteristics such as average traffic fleet speed, delay due to congestion and fuel consumption. Vehicles running with more than fixed capacity use more fuel leading to higher emissions (Virtanen *et al,* 2004). Too little maintenance of vehicles enhances emission from them: catalytic converters and filters make them even larger emitters of pollutants, especially soot particles (Frey *et al*, 2007; Lawson *et al*, 1990; Stedman *et al*, 1991 and Stedman *et al*, 1994).

This research aimed at determining some heavy metals concentration emitted by commercial vehicles making used of premium motor spirit otherwise known as gasoline and diesel fuel, see if there are statistically significant differences between these metals concentrations in the diesel and gasoline engine vehicles and their attendant's health effect.

II. RESEARCH METHODOLOGY

2.1 Study area

This study was undertaken in Kaduna metropolis which lies at latitude 10^{0}28N and at longitude 7^{0}25E. It is situated in the central region of what is used to be called the Northern Region of Nigeria, Kaduna. Founded in 1917 as governmental head quarter of Northern Nigeria, it is currently one of the most significant cities in the country. The mean annual rainfall in the area ranges from 924.3 to 1,543.6mm. Annual temperature varies between 29 to 38.6^{o}C. It occupies an area of approximately 48,473.2 square kilometers and falls into Guinea Savanna climate, which has distinct rainy and dry seasons. As at 1991 census it had a population of 993,600 but projected to be about 1.56 million people (www.kaduna-state.com., 2018) but by 2006 census it had a population of 6,066,563 which is 4.333% of the total country's population just behind Kano and Lagos (Nigerian muse, 2005)

2.2 Samples collection and pretreatment

Accumulated soot particles were collected from the inner surface of the tailpipe of the vehicles and were considered to have similar characteristics as that of those emitted into the atmosphere. Soot particles were collected by scraping using plastic spatula. Different soot samples were collected from various sources; the carbon soot from diesel vehicle was obtained from Maraban Jos, a town located about 4 km away from Kaduna metropolis along Kaduna – Zaria express road. While the carbon soot from gasoline vehicle were obtained from New Pantaker located along Nnamdi Azikwe Express by-pass, Kaduna which is an automobile based market. The soot samples were scratched from the exhausts and were stored in a pre-wash plastic sample bottle for further study.

2.3 Sample grouping

Table 1.a

GASOLINE ENGINE VEHICLES Sample site: New pantaker	
Sample	**Sample identity**
Sample A	Golf
Sample B	Honda
Sample C	Mercedes Benz

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Table 1.b

DIESEL ENGINE VEHICLES Sample site: Maraban Jos	
Sample	**Sample identity**
Sample D	Iveco
Sample E	DAF
Sample F	Turbo

2.4 Reagents

Analytical grades of 37% Hydrochloric acid, 70% nitric acid and deionised water were purchased from Sigma Aldrich.

2.5 Quality assurance

Quality assurance was adhered by observing all precautions and working guides from the points of sample collection to the analysis. Blanks were taken to ensure precision in the analysis.

2.6 Sample digestion

1.0g of each pretreated sample was weighed and placed in 100ml beaker, after which 25ml of freshly prepared aqua regia (HCl : HNO_3 = 3:2) was added. The mixture was heated until the sample completely dissolves in the aqua regia). The mixture was then allowed to cool and filtered; the residue (unburnt carbon black) was washed with distilled water. The combined aqueous extract was then made up to 50ml volumetric flask with distilled water (Ang and Lee 2005)

2.7 Sample Analysis (AAS Analysis)

The digested samples were analyzed by the atomic absorption spectrometric method employing the use of the atomic absorption spectrometer, model: ICE 3000 C13300129 v1.30 a device of analytical grade whose operation is to determine the concentrations of unknown solutions by comparing the concentrations of known standard solutions to the unknown solutions which results in a calibration curve following the Beer's Lamberts law. The method measures the concentration of atoms of an element by passing light, emitted by a hollow cathode lamp of that element, through a cloud of atoms from a sample. Only those atoms that are the same as those in the lamp will absorb the light from the lamp.

A reduction in the amount of light reaching the detector is seen as a measure of the concentration of that element in the original sample.

The Beers Lambert law states that: A = Ecl

Where: A: is the absorbance at a fixed wavelength (λ)

E: is a constant called molar absorptivity

C: is the solutions concentration

L: is the path length which the light travels usually (1cm)

III. RESULT

The results of the analysis subjected to Atomic Absorption Spectrophotometer were as shown in the table below:

TABLE 2: Result showing the concentration of the heavy metals from the tail pipes exhaust of a gasoline engine vehicle

S/NO	METALS	UNIT	SAMPLE A (Golf)	SAMPLE B (Honda)	SAMPLE C (Benz)	AVERAGE
1	CADMIUM	(mg/kg)	0.054±0.057	0.042±0.021	0.035±0.031	0.044±0.036
2	MERCURY	(mg/kg)	14.235±0.093	1.906±0.090	1.557±0.027	5.899±0.070
3	CUPPER	(mg/kg)	3.680±0.047	3.730±0.016	1.841±0.039	3.083±0.034
4	LEAD	(mg/kg)	0.444±0.022	1.277±0.074	40.571±1.837	14.097±0.644
5	IRON	(mg/kg)	1047.867±0.351	1269.273±0.257	1143.542±0.474	1153.560±0.361

TABLE 3: Result showing the concentration of the heavy metals from the tail pipes exhaust of a diesel engine vehicle

S/NO	METALS	UNIT	SAMPLE A (Iveco)	SAMPLE B (DAF)	SAMPLE C (Turbo)	AVERAGE
1	CADMIUM	(mg/kg)	0.047±0.058	0.034±0.039	0.040±0.014	0.0403±0.037
2	MERCURY	(mg/kg)	3.344±0.027	2.095±0.071	0.692±0.063	2.044±0.054
3	CUPPER	(mg/kg)	0.923±0.062	1.329±0.047	2.108±0.043	1.453±0.051
4	LEAD	(mg/kg)	ND	33.835±0.085	ND	11.278±0.028
5	IRON	(mg/kg)	1263.749±0.819	221.156±0.132	905.542±0.615	796.816±0.522

ND = Not detected

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TABLE 3: *Recommended standard for air emissions (European Commission 1991).*

SUBSTANCE	EMISSION LIMIT	AVERAGING PERIOD
Cadmium and its compound	0.05 mg/Nm^3 expressed as cadmium	30 mins to 8 hours
Mercury and its compound	0.05 mg/Nm^3 expressed as mercury	30 mins to 8 hours
Cupper and its compound	0.05 mg/Nm^3 expressed as cupper	30 mins to 8 hours
Lead and its compound	0.05 mg/Nm^3 expressed as lead	30 mins to 8 hours
Iron and its compound	———	30 mins to 8 hours

Mg/Nm^3 = milligram per normal cubic meter

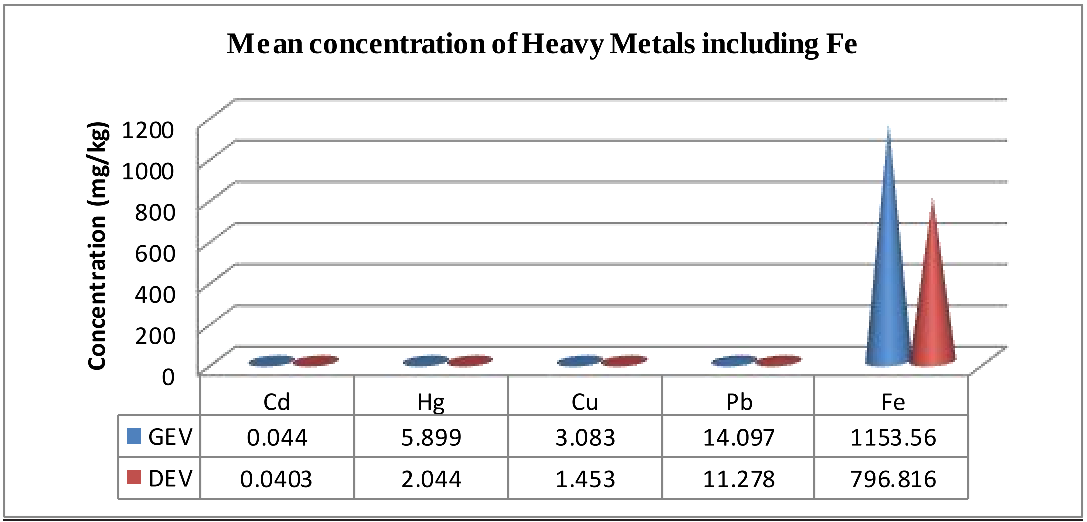

Figure 1: Bar chart representation of the mean data of the whole metals

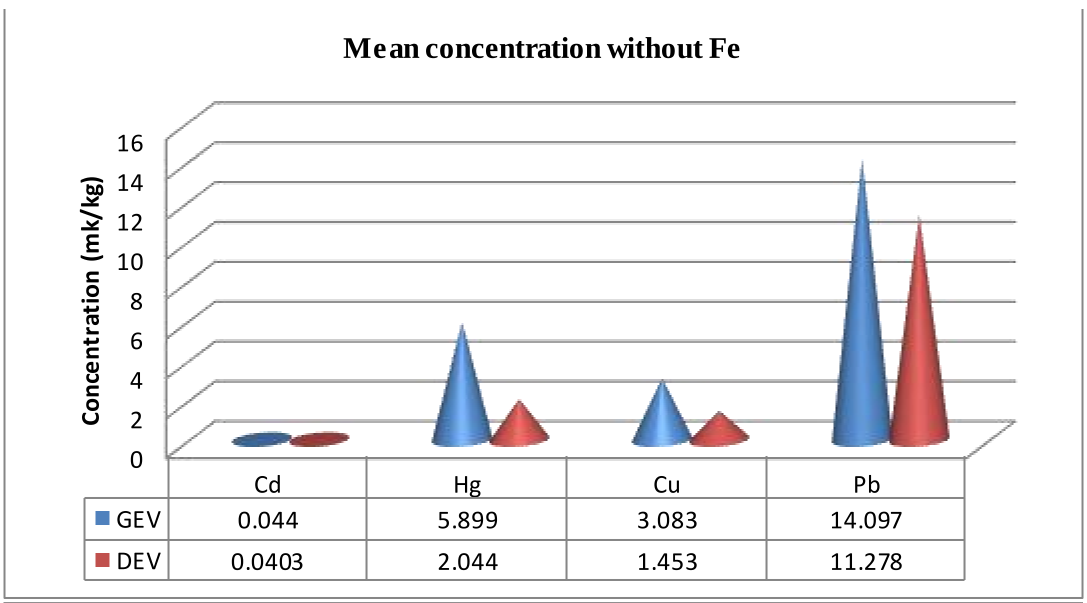

Figure 2: Bar chart representation showing clear distinction for Cd, Hg, Cu and Pb

3.1 Cadmium

Table 1 and 2 shows the Cd concentration in different samples, which were collected from heavy duty and passenger cars sources. The average data of Cd concentration for the gasoline engine vehicle, GEV, soots is 0.044±0.036 (mg/kg) which is 0.004 mg/kg higher than that of diesel engine vehicle, DEV, soots having a concentration of 0.0403±0.037 mg/kg the concentrations of 0.054±0.057

mg/kg to 0.034±0.039 mg/kg. It can be seen that the concentration of Cd in all sample of the two fuel engine were within the maximum acceptable limits for air which is 0.05 mg/Nm^3 of an averaging period of 30 minutes to 8 hours.

3.2 Mercury

The two fuels show some considerable concentration of mercury with the GEV having the highest average concentration, 5.899±0.070 mg/kg, while DEV has the least concentrations of emitted mercury standing at 2.044±0.054 mg/kg. The entire samples exceeded the maximum permissible limit of exposure set at 0.05 mg/ Nm^3 for 30 minutes to 8 hours.

3.3 Cupper

The concentrations of Cu in the GEV are generally higher than those of the DEV and both were high enough to exceed the stipulated maximum acceptable limit for air of Cu, set at 0.05 mg/Nm^3 for 30 minutes to 8 hours. This high concentration of Cu, 3.083±0.034 mg/kg and 1.453±0.051 mg/kg in the two fuels engine (GEV and DEV respectively) may be due to the use of certain Cu alloys in the internal combustion engine which sublimes due to high process temperature.

3.4 Lead

The increased Pb contamination in soot sample C, (40.571±1.837 mg/kg), and sample E, (33.835±0.085 mg/kg), according to Docekal et al. (1992) can be credited to the use of metal lead-based additives that was used as an anti-knock or alkyl-lead contamination compounds. Whereas the lower concentration can be attributed to the use of low level of Pb based additives in Sample A and B of the GEV having the concentration of 0.444±0.022 mg/kg and 1.27680±0.074 mg/kg respectively as compared to sample C and E which can originate from various sources such as engine wear, lubrication oil, fuel, fuel additives or coatings from exhaust gas after-treatment systems (Docekal et al, 1992). In the DEV, there wasn't Pb detection in sample D (Iveco) and sample F (Turbo). This can only means the absence of the use of lead-based additives, fuel and as such, DEV fuel shows more tendency of not emitting Pb.

In contrast to the maximum acceptable limit, all the GEV results were higher than the recommended limit and can be harmful to humans. While from the DEV, only one sample was above the recommended permissible limit.

2.5 Iron

It can be seen from Table 1 and 2 that there is an extremely high concentration of iron being emitted by the two fuel engine of the various vehicle with the concentration as 1269.273±0.257 mg/kg > 1263.749±0.819 mg/kg > 221.156±0.132 mg/kg > 1143.542±0.474 mg/kg > 1047.867±0.351 mg/kg > 905.5416 mg/kg > 221.156±0.132 mg/kg. The same is true for Fe: that the average concentration of Fe in the GEV has closely double that of the DEV. The GEV and DEV average concentration is given as 1153.560±0.361 mg/kg and 796.816±0.522 mg/kg.

IV. DISCUSSION

The research within this study paid attention to particle emissions of inorganic elements such as, Cd, Hg, Cu, Pb, and Fe from commercial vehicles. Gaseous emissions are not reported. Just as Yousaf reported the emission characteristics of heavy metal and the particulate matter from small incineration or ignition were influence by many factors such as operating conditions, fuel capacity etc. Nonetheless, the chief factor in the discharge of metal is the volatility, which increases with temperature as well as with hydrochloric acid production in the flue gases (Yousaf, 2012). But also, metal emissions in vehicle engines emissions happen from fuel additives, engine or exhaust system wear, and metals absorbed into the engine from re-suspended soil, asphalt, or other airborne materials (Docekal *et al*, 1992; Lighty *et al*, 2000).

The result obtain from this research point to the fact that vehicle emissions add immensely to the metal concentrations in the urban and industrial settlement more than rural settlement in terms of increasing vehicular number which can be justify by previous observations such as (Lu *et al*, 2016; Pan *et al*, 2013; Zhou *et al*, 2014; Okorie *et al*, 2010) and tends to contradict what (Visser *et al*, 2015) reported; heavy-duty vehicles appeared to have a larger effect than passenger vehicles on the concentrations of all elements influenced by re-suspension and wearing processes.

Seeing that heavy metals occurred at different phases; as solids, gases or absorbed to particles of aerodynamic sizes (US EPA 1996; Wedepohl, 1991) (Ismal et al., 2018) was able to point out the order of the average concentration of total particulate matter and that of the heavy metals to be Residential < Urban < Industrial. From Ismal findings, it can be deduced that more heavy metals are absorbed by more particulate matter; in view of the fact that industrial areas has more particulate matter: Since therefore DEVs produces more soots than GEVs, more heavy metal can be accumulated from the released of DEVs soots as to GEVs soots which has an enhanced catalytic converters and efficient filters thereby producing lesser quantity of soots. This might be the possible reason on which (Visser *et al*, 2015) assertion was made on heavy duty vehicles appearing to have a larger effect than passenger vehicles on the concentrations of all elements: But taking the same proportions of petroleum soots from both engine vehicles as this research highlight; gasoline engine has higher concentration of element. Another points to consider is a research by (Platt *et al*, 2017) in which gasoline cars was found to produce more carbonaceous particulate matter than modern filter-equipped diesel cars is; (Jeff, 2017) diesel is now better than gas. In share autos, average weight percentage of heavy metals was found to be higher than that in buses (Ravi *et al*, 2016).

4.1 Cadmium

Atiku *et al*. (2011) suspected volatilization and escape of Cd in to the surrounding air as cadmium content in soot is 90% less than the values in the reference Diesel. But Lu shows concentration of Cd obtained to be less than 10 ng/m^3 below the permissible limit of 500 ng/m^3 in the ambience. Irrespective of the concentration of the liberated metals to the ambience, such concentrations are influence by atmospheric conditions as reported by (Lu *et al*, 2016) and also the wind current or wind speed (Abdullah 2015). The Cd concentration obtained from this research just as Lu were within the maximum permissible limit but this same concentration after liberated can be influenced by the factors highlighted by Lu *et al* and Abdullah. The lack of large variation we obtained might simply be due to the nature of the fuel used and dissimilar processing methods. In addition, the low quantity of Cd in all samples might be due to high volatility of Cd as compared to other metals and high temperature facilitating the fly ash generation (Atiku *et al*, 2011; Smith, 1990 and Nogawa *et al*, 1981)

Cd can cause sharp and chronic intoxications (Chakraborty *et al*., 2013). Cd is highly lethal to the kidney and it accumulates in the proximal tubular cells in higher concentrations. Cd can result to bone mineralization by bone damage or by renal dysfunction. Studies on humans and animals have revealed that osteoporosis (skeletal damage) is a critical effect of cadmium exposure along with disturbances in calcium metabolism, formation of renal stones and hypercalciuria. Inhaling higher levels of cadmium can cause brutal harm to the lungs. Cd when ingested in higher amounts, it can lead to irritation of the stomach and result in vomiting and diarrhea. Overtime exposure at lower concentrations, can become deposited in the kidney and finally lead to kidney disease, fragile bones and lung damage (Bernard, 2008).

4.2 Mercury

The presence of Hg to the environment can be attributed to chlor-alkali production waste, plastics, batteries, electronics, and throw away medical devices causing damage to the ecosystem and the human body in the appearance of various compounds (Yang *et al*., 2014).whereas, others traced the source of Hg to be from fluorescent lamps, hospital waste and fossil fuels and burning of these fuels has been acknowledged as the primary anthropogenic source of Hg in the atmosphere (Cooper and Alley, 2002; Manahan, 2005; Migliavacca, 2009; Moreira, 2010). (Habeebullah 2016) identified Hg alongside As to be the most abundant heavy metals in particulate matter of size 2.5 micron ($PM_{2.5}$). Hg among all the investigated metals has the highest toxicity factor of 40 with Cu and Pb having 5 while Cd is 30 (Yang *et al*., 2014). Mercury has the ability to react with other elements to form organic or inorganic mercury. Exposure to elevated levels of metallic, organic and inorganic mercury can be able to harm the brain, kidneys and the developing fetus (Alina *et al*., 2012). Therefore, from the obtainable result with Hg being the second largest dangerous emitted metal among others but having the highest toxicity factor calls for concern toward safeguarding the lives of humanity. One of the probable reasons for the high quantity detected may be attributed to the re-suspended dust developed inside the tailpipes of the exhaust and lower height of the tailpipes in gasoline engine (Ravi *et al*, 2016).

4.3 Copper

Cu rank third in the order of most used metal in the world (VCI 2011). Atmospheric Cu can emanate from wearing of brake and employing copper parts in automotive vehicles (Manahan, 2005; Nogueira, 2006; Kabata-Pendias, 2011). Copper is an essential micronutrient required in the growth of both plants and animals. In humans, it helps in the production of blood haemoglobin. In plants, Cu is especially important in seed production, disease resistance, and regulation of water. The high concentrations of Cu detected in this study may be ascribed to the activities of copper additives which decreases particulate matter emissions, lower the soot combustion temperature and facilitate filter generation as recorded in previous research (DieselNet Technology Guide 2000 and Mayer 1998). Cu is certainly vital, but in high amount it can cause anaemia, liver and kidney damage, and stomach and intestinal irritation. While Cu's interaction with the surroundings is intricate, research points that the majority of Cu introduced into the environment quickly becomes stable and results in a form which does not pose a threat to the environment. In actuality, Cu is not bioaccumulated in the body or in the food chain (Mart´ınez and Motto 2000)

4.4 Lead

The result obtained from this research shows Pb coming first in the discharge as the most behind Fe which agrees with Gunawardena: the use of gasoline with Pb was hindered a decade ago; Pb was the second most commonly detected heavy metal. This is credited to the association of earlier generated Pb with roadside soil and re-suspension to the ambiance (Gunawardena *et.al* 2012). Pb is found as a trace element in diverse fuels, though is not allowed as additive constituent in petrol fuels (Paola *et al*, 2018). In addition to this, (Atiku *et al*, 2011) could not identify the source of Pb in a soot sample whose reference gasoline was absent. According to (Jozef M. Pacyna and Elisabeth G. Pacyna, 2001) combustion of all kinds of gasoline leads to emission of Pb to the ambiance. There are also other trace metals that can be emitted from this source but these emissions are negligible. In the US, more than 100 to 200,000 tons of lead per year is being released from vehicle exhausts. Some is taken up by plants, fixation to soil and flow into water bodies, hence human exposure of lead in the general population is either due to food or drinking water (Goyer, 1990; Marian, 2017). Lead toxicity also referred to as lead poisoning, can be either acute or chronic. Acute exposure leads to loss of appetite, headache, hypertension, abdominal pain, renal dysfunction, weariness, insomnia, arthritis, hallucinations and dizziness. Acute exposure is obtained at place of work and in some manufacturing industries which make use of lead. Chronic exposure of lead can result in mental retardation, birth defects, psychosis, autism, allergies, dyslexia, weight loss, hyperactivity, paralysis, muscular weakness, brain damage, kidney damage and probably death (Martin & Griswold, 2009).

4.5 Iron

The emission of metals found in this work correspond to that obtained by (Alves *et al*, 2015; Nkansah et al, 2017), with Fe having an outrageous concentration as compare to Cd, Hg, Cu and Pd. The levels of emission of Fe can be classified as a class 4 emission which is a very high emission (Klumpp *et al*, 2004). Thus, these emissions pose a great danger to human health if such levels of concentration should be ingested into the body: even though Fe is very vital to the body but then, they still have limit.

Fe happens to be the most abundant transition metal in the world. In nature it is the most imperative nutrient for most animals as a result of being a cofactor for many essential enzymes and proteins. Fe mediated reactions support the majority of the aerobic organisms in respiration processes. When Fe is not secured appropriately, it can catalyze the reactions involving the formation of radicals which can harm biomolecules, cells, tissues and the whole organism. Fe poisoning has for all time been a topic of concern primarily to pediatricians. Children are greatly at risk to Fe toxicity as they are exposed continually to a maximum of Fe containing products (Albretsen, 2006; Monisha *et al*, 2014)

Although the emission level of Fe is very high and as (Paola *et al*, 2018) will find Fe and Al to consist above 50% of the 13 metals concentration analyzed, thus confirming the report that the concentration level of Fe in the ambience is highly influenced by the industrial activities and traffic of vehicle (Sekhavatjou 2010), Fe plays a very vital role in the metabolism of the body. Hence, the National Academy of Sciences (NAS's) dietary reference intake (DRI) for children 1 to 3 years old is 7 mg/day. The median daily intake of dietary iron is roughly 11 to 13 mg/day for children 1 to 8 years old and 13 to 20 mg/day for adolescents 9 to 18 years old (Abdullah 2015; Nowak 2006). The vehicular activities is said to increase the level of Fe in the atmosphere. The high concentration of iron is a clear indication of the wearing out of the moving part of an internal combustion engine, as they are largely made up of iron. It might also be due to different types of fuel used and also due to different process temperature (Ulrich *et al*, 2012).

V. CONCLUSION

In general, gasoline engine vehicle has proven to be more hazardous to health than diesel engine vehicle when exposure to the same quantity of the soot or its particulate matter in terms of metals concentrations. This study has however highlighted the various concentrations of these heavy metals in the environment. Concentrations of most of these metals are above the permissible maximum limit for air quality. These objectionable releases however increase the presence of these metals in air and water bodies. Therefore, the attendant health effect becomes harmful to persons living around the study area. The attendant risk factor of injecting these metals into the body that causes various associated illness has been discussed, varying from stroke, cardiovascular diseases, death, genetic disorder, skeletal damage (osteoporosis), sleep disorder, memory loss, and convulsion etcetera. There is need to identify strategies to limit vehicular emissions of these harmful metals in addition to seeking for alternative fuels that are safer for our health and ecosystem.

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Standard compliance was adhered to

COMPETING INTEREST

The authors declare no competing interest

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Productivity and Profitability Assessment of Hybrid Maize by using Nutrient Expert® Maize Model in Eastern Terai of Nepal

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Abstract— *Low productivity of maize has led to low profitability of maize production in Nepal. Indiscriminate use of fertilizer and lack of site specific nutrient management technology is always been associated with low productivity of maize. Thus, field experiments on farmer's field were conducted on maize to assess the profitability at two sites of Jhapa district viz. Damak and Gauradaha using Nutrient Expert® Maize model from November 2015 to May 2016. The experiment was laid out in single factorial Randomized Completely Block Design consisting twenty replications with two treatments viz. NE (Nutrient Expert recommendation) and FFP (Farmer's Fertilizer Practice). The analyzed datas revealed the significant differences in terms of grain yield, stover yield, gross return, net return and B:C ratio. NE based practices produced higher grain yield (9.22 t ha^{-1}), which was 86.6 percent higher than FFP (4.94 t ha^{-1}). Similarly, the significantly higher stover yield (12.70 t ha^{-1}), gross return (NRs. 224049 ha^{-1}), net return (NRs. 128970 ha^{-1}) and B:C ratio (2.36:1) were recorded in NE based practice. Thus, NE based practice can be adopted for obtaining higher productivity and profitability in eastern terai and similar agro-climatic regions of Nepal.*

***Keywords*— benefit cost ratio, grain yield, gross return, net return, nutrient expert.**

I. INTRODUCTION

Maize (*Zea mays* L.) is one of the most important staple crops in the world. It provides approximately 30% of the food calories to more than 4.5 billion people in 94 developing countries (Jat *et al.*, 2013). Further, it is an important crop for making edible oil and is significant source of bio-fuel production in the world (Nayava and Gurung, 2010). Maize is the second most important cereal crop after rice in Nepal. It is cultivated in 891,583 hectares of land with production and productivity of 2,231,517 tons and 2.5 t ha^{-1}, respectively (MoAD, 2017). It is the major food crop in the hills of Nepal and accounts about 71% of maize production of the country (MoAD, 2017). The demand of maize grain has increased, but the productivity in farm level is almost stagnant around 2-2.5 t ha^{-1} in last decade (MoAD, 2017). The farm level yield of maize (2.5 t ha^{-1}) is not satisfactory as compared to attainable yield (5.7 t ha^{-1}) in Nepal (MoAD, 2017; KC *et al.*, 2015). This lower productivity has also led to low profitability of maize production in Nepal. Indiscriminate use of fertilizer and lack of site specific nutrient management technology is the main cause of low maize productivity in Nepal. Therefore, nutrient management is always the major concern in maize for increasing production in Nepal.

Site specific nutrient management (SSNM) is a plant based approach for supplying crops with nutrients in right amount and time. Based on SSNM principles, a dynamic nutrient management tool, Nutrient Expert® (NE), was developed that can generate farm-specific fertilizer recommendation for maize (Majumdar *et al.*, 2014).

Many researches concerning about SSNM has been carried out around the globe. Similarly, Nutrient Expert has been tested earlier in India (Majumdar *et al.*, 2014), Indonesia and Philippines (Pampolino *et al.*, 2014) and found valid. But, in Nepal, limited research has been carried out concerning about SSNM and Nutrient Expert. Therefore, the present investigation is planned, executed and accomplished with the objective of assessing the productivity and profitability of maize production using Nutrient Expert®-Maize.

II. MATERIALS AND METHODS

The study was carried out at two sites of Jhapa district viz. Damak and Gauradaha from November 2015 to May

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2016. The experiment was laid out in single factorial Randomized Completely Block Design consisting two treatments *viz*. NE (Nutrient Expert recommendation) and FFP (Farmer's Fertilizer Practice) in twenty farmer's field, considering one farmer as one replication. The hybrid maize variety Pioneer 3785 was used for the study. The gross plot and net plot size for each treatment was maintained 100 m^2 and 10 m^2, respectively. The NE plot consist the cultivation of maize under Nutrient Expert-Maize recommended spacing, seed rate, fertilizer dose and other factors of production. FFP plot consist of maize cultivation under farmer's own practice of spacing, seed rate, fertilizer dose and other factors of production. Data of observations on yield attributing characters, grain yield and stover yield were recorded from net plot. Similarly, for profitability analysis, all the cost of cultivation was worked out on the basis of cost incurred according to the prevailing market price for different inputs, laborers, fertilizers and other factors of production. The grain yield and straw yield was converted into gross return (NRs. ha^{-1}) based on the prevailing market price of the producers. Net returns (NRs. ha^{-1}) for each plot was calculated by deducting the cost of cultivation from the gross returns obtained. Similarly, benefit cost ratio (B: C) ratio was calculated by dividing gross return with the cost of cultivation (Reddy and Reddi, 2005). All these recorded data were tabulated in MS-Excel which was subjected to ANOVA (Gomez and Gomez, 1984), after analysis through GENSTAT-C, computer based program at 5% significance level. The grain yield was adjusted at 14% moisture level.

III. RESULTS AND DISCUSSION

1. Grain yield

The grain yield of maize was highly influenced by nutrient management practices (Table 1). The grain yield of maize under Nutrient Expert (NE) (9.22 t ha^{-1}) was highly significant than grain yield of maize under farmer's fertilizer practice (FFP) (4.94 t ha^{-1}). The significant increase in yield attributing characters viz. average cob number per m^2 (8.2), average kernel row cob^{-1} (14.2), average kernel number row^{-1} (42.4) and thousand grains weight (361.4 g) under NE might be mainly responsible for obtaining the higher grain yield of maize under NE. The increase in grain yield of maize under SSNM based practices and NE was also reported in previous experiments (Kumar *et al*., 2014; Majumdhar *et al*., 2014; Pampolino *et al*., 2014; Chauhan, 2015; Kumar *et al*., 2015a; Vikram *et al*., 2015; Sinha, 2016). Further, it was revealed that NE produced 86.6% more grain yield than farmer's fertilizer practice. Similar results were also reported by previous researchers in their studies (Kumar *et al*., 2015b; Pooniya *et al*., 2015; Sinha, 2016).

Table.1: Grain yield and stover yield of maize as affected by nutrient management practices at Damak and Gauradaha, Jhapa, Nepal, 2015/16

Treatment	Grain Yield (t ha^{-1})	Stover Yield (t ha^{-1})
NE	9.22	12.70
FFP	4.94	8.62
SEm (±)	0.14	0.24
LSD $_{(0.05)}$	0.413	0.699
P-value	<.001	<.001
CV (%)	8.8	9.9
Grand Mean	7.08	10.66

The higher yields in NE may be ascribed to efficient adjustments in applying nutrients to accommodate field specific needs of the crops for supplementing plant nutrients (Pooniya *et al*., 2015). The increased availability of nutrients at critical physiological phases results in better translocation of photosynthates from source to sink, resulting better growth and yield attributing characters, and finally increasing the grain yield (Vikram *et al*., 2015). Similarly, broadcasting of seed in FFP had caused patchy growth of crop, characterized by improper spacing. This led to increased incidence of insect, pest and diseases in FFP, which also led to reduced grain yield.

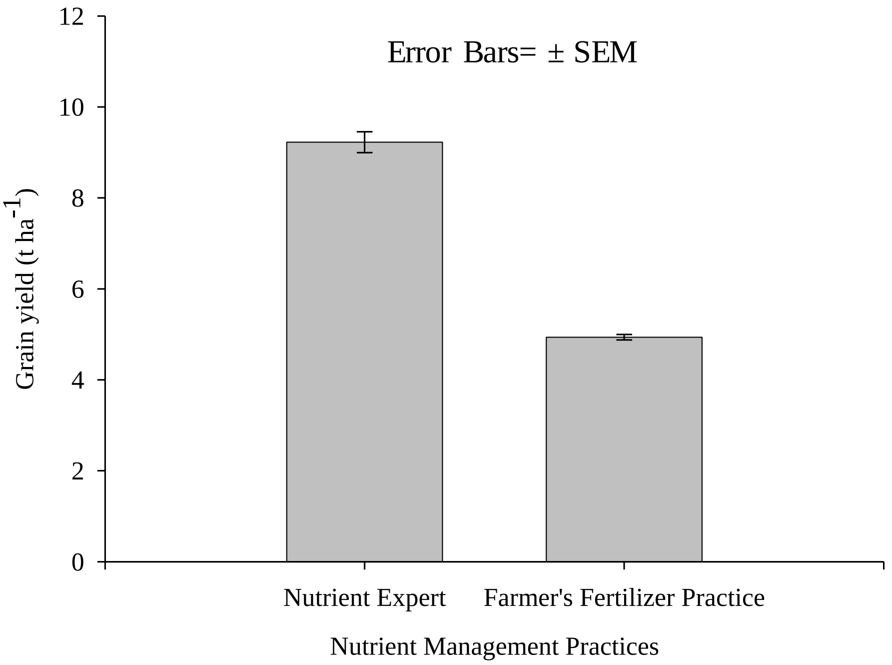

Fig.1: Comparison of grain yield of maize in two nutrient management practices

2. Stover yield

The stover yield was highly influenced by nutrient management practices (Table 1). The stover yield under NE was found to be 12.7 t ha^{-1}, which was highly significant than stover yield under farmer's practice (8.62 t ha^{-1}). Inadequate supply of nutrients in farmer's practice might have led to reduced plant height, leaf area, etc. due to improper growth and development, which in turn results the lower stover yield of maize. Higher stover yield of maize under SSNM based practice was also agreed by earlier experiments (Kumar et al., 2015a; Kumar et al., 2015b; Vikram et al., 2015).

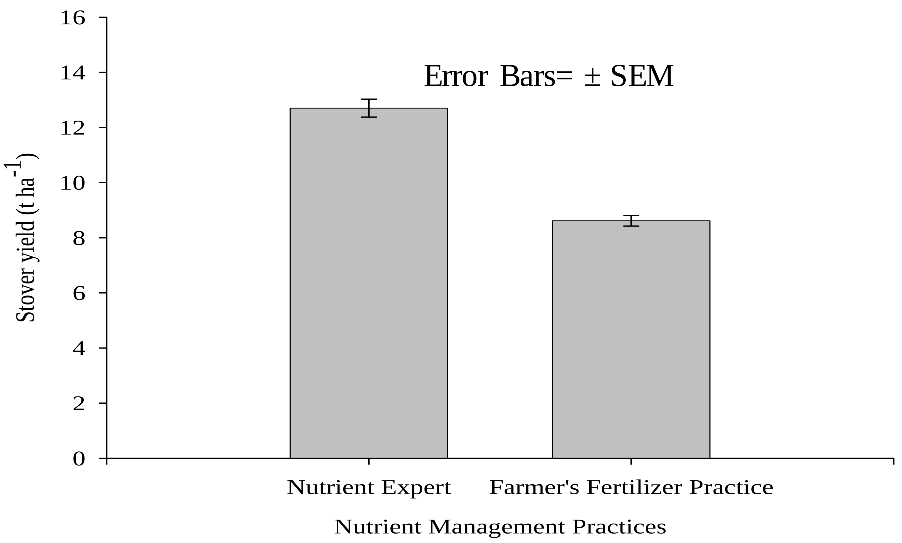

Fig.2: Comparison of stover yield of maize in two nutrient management practices

3. Economic Analysis

3.1 Cost of cultivation

The data on cost of cultivation is presented in Table 2. The data on cost of cultivation revealed that NE practice had the higher cost of production (NRs. 95079 ha^{-1}), followed by farmer's fertilizer practice (NRs. 75470 ha^{-1}). The mean cost of cultivation was NRs. 85275 ha^{-1}.

3.2 Gross return

The total monetary value of the economic produce and the byproducts obtained from the crop is called gross return. It is calculated based on the local market price of the

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products (Reddy and Reddi, 2005). The gross return was significantly influenced by nutrient management practices (Table 2). The gross return of NE practice (NRs. 224049 ha^{-1}) was significantly higher than farmer's fertilizer practice (NRs. 131264 ha^{-1}). Higher gross return under NE practice was due to higher grain yield obtained under NE practice. Similar result was also reported by Jat *et al.* (2013), Pampolino *et al.* (2014) and Satyanarayana *et al.* (2014). Further, higher gross return under SSNM based practice was also reported by Vikram *et al.* (2015).

3.3 Net return

The ultimate product remained after subtracting the cost of cultivation from the gross return is called net return (Reddy and Reddi, 2005). The net return was significantly influenced by nutrient management practices (Table 2). The net return of NE practice (NRs. 128970 ha^{-1}) was significantly higher than FFP (NRs. 55793 ha^{-1}). NE practice produced NRs. 73177 ha^{-1} more net return than farmer's fertilizer practice. Higher net return under SSNM based practice was also reported by Vikram *et al.* (2015).

3.4 Benefit cost (B: C) ratio

Benefit cost (B: C) ratio is defined as the ratio of the gross returns to the cost of cultivation which can also be expressed as return per rupee invested. For any enterprise relating with agriculture sector to be economically viable, a minimum B: C ratio of 1.5 is fixed. Therefore for any agriculture enterprise to be sustainable, it should maintain a B: C ratio of 1.5 (Reddy and Reddi, 2005). The benefit cost ratio was significantly influenced by nutrient management practices (Table 2). The benefit cost ratio under NE practice (2.36:1) was significantly higher than FFP (1.74:1). The higher B: C ratio under NE practice was also reported by Vikram *et al.* (2015).

Table.2: Cost of cultivation (NRs. '000 ha^{-1}), gross return (NRs. '000 ha^{-1}), net return (NRs. '000 ha^{-1}) and B:C ratio of maize as affected by nutrient management practices at Damak and Gauradaha, Jhapa, Nepal, 2015/16

Treatment	Cost of cultivation (NRs. '000 ha^{-1})	Gross return (NRs. '000 ha^{-1})	Net return (NRs. '000 ha^{-1})	B:C ratio
NE	95.08	224.0	129.0	2.36
FFP	75.47	131.3	55.8	1.74
SEm (±)		2.50	2.73	0.03
LSD $_{(0.05)}$		7.41	8.09	0.085
P-value		<.001	<.001	<.001
CV (%)		6.3	13.2	6.2
Grand Mean	85.27	177.70	92.40	2.05

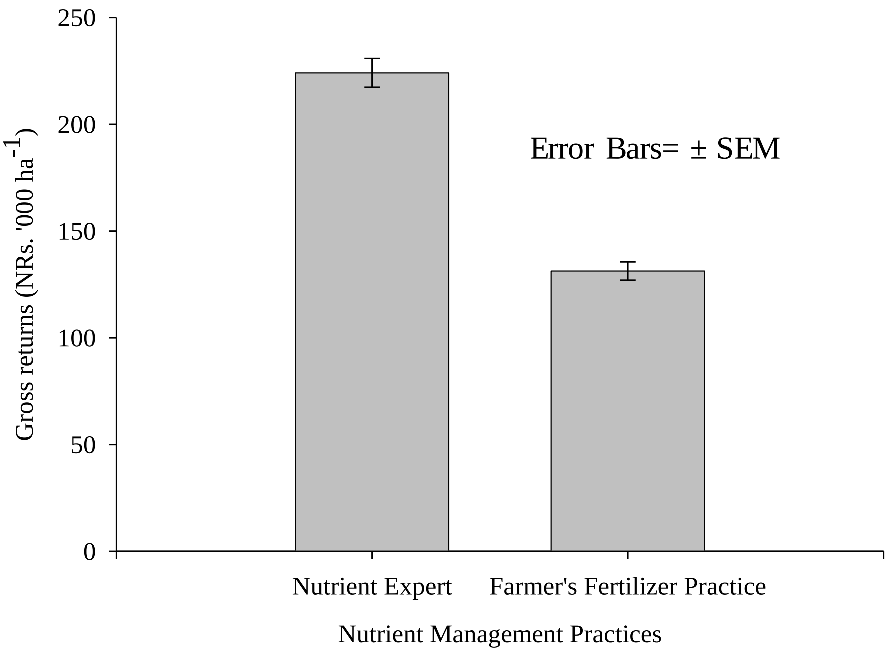

Fig.3: Comparison of gross return of maize in two nutrient management practices

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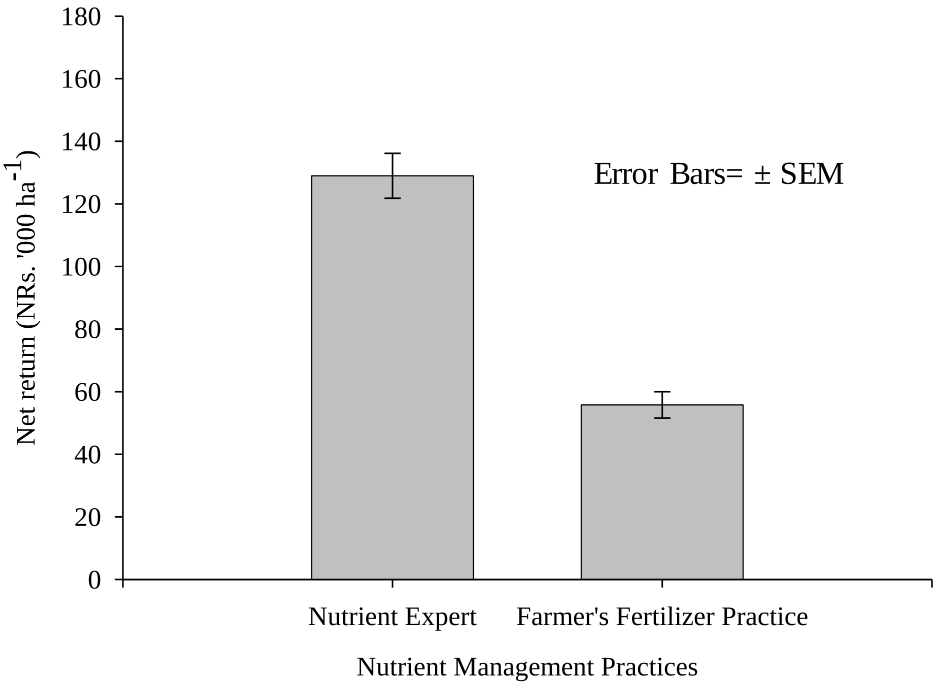

Fig.4: Comparison of net return of maize in two nutrient management practices

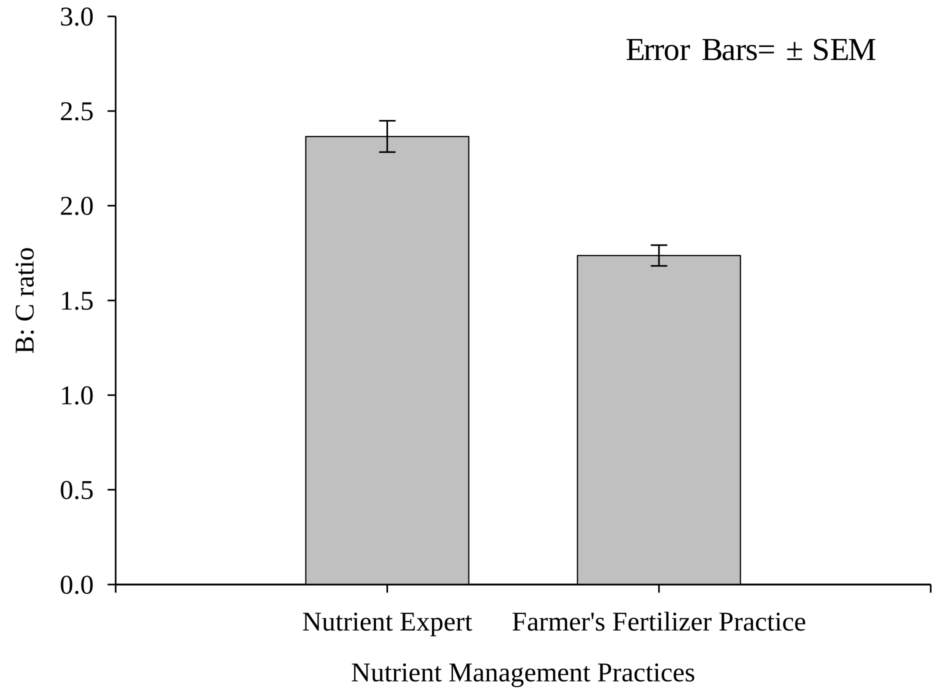

Fig.5: Comparison of benefit cost (B: C) ratio of maize in two nutrient management practices

IV. CONCLUSION

Since indiscriminate use of fertilizer and lack of site specific nutrient management technology is mainly responsible for low maize productivity and profitability in Nepal, these can be increased under NE based nutrient management practice. Thus, NE based practice can be adopted for obtaining higher productivity and profitability for maize production in eastern terai region and similar agro-climatic condition of Nepal.

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Rural Dwellers' Involvement in Livestock Farming in Egbeda Local Government Area of Oyo State

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***Abstract*— *This study investigated the involvement in livestock farming as a mean of livelihood among rural dwellers in Egbeda Local Government Area of Oyo State, Nigeria. Purposive sampling technique was employed to sample 120 rural dwellers while 120 questionnaires were administered and retrieved. The data collected were subjected to descriptive (percentage, mean, mode, std deviation) and inferential (chi-square and correlation) statistics. The result revealed that majority (63.3%) of the respondent were involved in livestock rearing and most of the respondent were highly involved in livestock farming in which goat (58.4%) and poultry (78.9%) were mostly reared. Most of the respondents (70.8%) engage in livestock farming as their primary source of income and livelihood. Inadequate capital (87.5%) and infrastructural (38.3%) were the major constraints facing the respondents in the study area. Chi-square analysis revealed that there is a significant ($p<0.05$) relationship between the constraint and involvement in livestock farming as a means of livelihood. The study therefore concluded that the majority of the rural dwellers were involved in livestock farming for their livelihood. Rural development activities should always be made to encourage getting involved in livestock farming and ensure availability of loan facilities, ensure adult education for the farmers in livestock farming in the study area.*

***Keywords*— Involvement, rural dwellers, livestock.**

I. INTRODUCTION

In Nigeria, before the discovery of oil, rural dweller with farming as occupation contribute significantly to the economy of the nation through the export of cash crop like cocoa, groundnut, kola-nut and rubber. Laah *et al*., (2013) opined that rural dwellers are less vocal characteristic by a culture of poverty as most people lets barely above subsistence level.

Livestock farming represents the only way by which the large parts of natural vegetation can be converted into economic products and plays an important role in export earnings. Animal husbandry mostly provides subsidiary means of livelihood to the farmer as livestock rearing is an integral part of agriculture. Its share in gross state domestic product of agriculture sector during 2009-10 was about 7.8 percent.

The importance of livestock goes beyond it's food production (Birthal *et al*., 2002) it provide draught power and organic manure to crops sector and hide, skin, blood and fiber to the industrial sector. Livestock sector also make significant contribution towards supplement income from crop production and other sources and absorb financial stress due to crop failure. It generates a continuous stream of income and employment and reduces seasonality in livehood pattern (Birthal and Ali, 2005).

Rural poverty is largely concentrated among the landless and marginal households comprising about 70 percent of rural population (kozel and parker 200). In India over of 70 percent of the rural household are small, marginal and landless household small animal like sheep, goat, pig and poultry are largely kept by the

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land sources poor household for commercial purpose. Because of their low initial investment and operational cost (Birthal *et al.*, 2002) these analyze the development of livestock sector in term of population production, trade and employment on one hand and note of livestock sectoring reducing rural poverty on the other.

II. METHODOLOGY

The study was purposively carried out in Egbeda Local Government Area of Oyo State with its Administrative Headquarters situated at Egbeda town because the area consists of people which are predominantly farmers. It comprises of eleven wards and covers a landmass of 185.508 square kilometer with a population density of 1,722 persons per square kilometer. The study targeted the livestock farmer in the local government.

Random sampling technique was used to select four wards out of all the 11 wards in the local government area with three villages randomly selected from each wards for the study. The sampled wards and villages include Ajiwogbo, Aloba and Ataari in ward 1, Olode, Efunwole and Apaso in Ward 2, Ogunbade, Mosefejo and Koroboto in Ward 9 and Osegere, Awowo and Olumakun in Ward 8.

A well-structured questionnaire and interview schedule methods were employed to obtain needed information from the respondents. The questionnaires was grouped into five section which was used to collect information on the following socio-economic characteristics of the household head such as gender, age, educational background, marital status, family size, mean of livelihood of the respondents, type of livestock involved in as well as the level of their involvement in livestock farming.

Data collected were analyzed using both descriptive and inferential statistical tools like mean, mode, percentages, standard deviation and chi-square.

Chi-square model used is expressed below:

Model specification:

$$X^2 = \sum \frac{(O - E)2}{E}$$

Where: X^2 = chi-square

$\sum$ = summation of the frequencies

O = Observed value

E = Expected value

III. RESULT AND CONCLUSION

Table.1: Socio-economic characteristics of respondents.

Variable	Frequency (n=120)	Percentage	Mode	Std. Deviation
GENDER				
Male	81	67.50	Male	0.470
Female	39	32.50		
RELIGION				
Christian	58	48.33	Christian	
Muslim	55	45.83		0.603
Traditional	7	5.83		
AGE				
20-30	11	9.17		
31-40	35	29.17		0.923
41-50	45	37.50	41-50	
51 and above	29	24.17		
MARITAL STATUS				
Single	11	9.17		
Married	92	76.67	Married	0.748
Divorce	3	2.50		

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Widow/ Widower	14	11.67		
FAMILY SIZE				
2	9	7.50		
3	14	11.67		
4	46	38.33	5 And above	0.907
5 and above	51	42.50		
EDUCATIONAL LEVEL				
No Formal Education	49	40.83	No Formal	0.102
Primary Education	35	29.17		
Secondary Education	16	13.33		
Tertiary Education	20	16.67		

Sources: Field survey 2017
Figure in parentheses are percentages.

Table 1 shows that majority (67.5%) of the respondent are male while 32.5% were female. This is in line with the findings of Elzaki *et al*., 2010, who reported that livestock farming is actually managed by the head of the household (Male) and also supported by Grenada, (2000) which says male are committed to agricultural farming than female because livestock farming demand physical energy application especially in area of feeding, castrating, debeaking, culling, vaccinating, other activities. While most (37.5%) of the respondents fall within the age range of 41-50years, followed by 29.17% belonging to the range of 31-40years, 24.17% with the age range of 51years and above and 9.17% for age 20-30years. This implies that most of the respondents were in their productive years which correspond with the research of Oyelami *et al*., (2017) which stated that the younger the farmer, the more active he would be.

The result also show that majority (76.67%) of the respondenst were married, followed by 11.67% (Widowed) and only 9.17% were Single. This agrees with Aluko (2011) who submitted that married people involving in farming needs to diversify in order to cater for their families. Hence, married respondents, especially male find it easier to run livestock farm with the assistance of their wives because women play important role in livestock farming. This corroborates with Singh and Hazell (1993) who said women play significant supportive roles in livestock farm activities like feeding, livestock for marketing, processing, cleaning etc. In respect to educational level 40.83% had no formal education, 29.17% had primary education, 16.67% had tertiary education and 13.33% had secondary education. The result shows that the majority of the respondent in the study area lacked formal education This is an indication that the majority of the livestock farmer in the study area will found difficult to access agricultural innovations and high breed of livestock animals which confirms the report of Aphumu and Akpobasa (2010).

Table 2 shows the mean of the livelihood of the respondent in the study area. The result shows that 61.66% of them were livestock farmers as their primary sources of livelihood while 9.17% and 8.33% were civil servants and crop producers respectively, the rest of the respondent were involved in either trading, artisan, food selling and cassava processing.

Table.2: Respondents on Sources of Primary Means of Livelihood.

Variable	Frequency n=120	Percentage	Mode	Std. Deviation
Crop production	10	8.33	livestock farmer	1.404
Trading	13	10.83		
Civil Servant	11	9.17		

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Livestock farmer	74	61.67
Meat and milk seller	1	0.83
Artisan	6	5.00
Palm tapper	1	0.83
Cassava processor	1	0.83
Food seller	1	0.83
Other	1	0.83
None	1	0.83

Sources: Field Survey, 2017

The result show that the respondents in the study area were involved much in livestock farming than crop production. Perceived higher income per square meter of land and less environmental challenges as observed in earlier studies (Ekong, 1999, Kolawole and Torimiro, 2006 and Oyelami *et al*., 2017).

Table.3: Respondent on Means of Livelihood as a Secondary Source of Income.

Variable	Frequency n=120	Percentage	Mode	Std. Deviation
Crop production	15	12.50	livestock farmer	2.054
Trading	17	14.17		
Civil Servant	3	2.50		
Livestock farmer	72	60.00		
Meat and milk seller	1	0.83		
Artisan	4	3.33		
Palm tapper	1	0.83		
Cassava processor	1	0.83		
Food seller	4	3.33		
Other	1	0.83		
None	1	0.83		

Survey: Field Survey, 2017

Table 3 shows the secondary means of the livelihood of the respondent in the study area. The result show that 60% of them were into livestock farming as their secondary sources of livelihood while 14.17% and 12.5% were trading and crop producer respectively. This agrees with Sodiya (2005) and Oyelami *et al.*, (2017). The rest of the respondents were involved in either, artisan, food selling, and cassava processing. The result also shows that majority of the respondents depend on livestock farming as secondary sources of income.

Table.4: Respondents on kind of livestock kept.

VARIABLE	FREQUENCY	PERCENTAGE	MODE	STD DEVAITION
POULTRY				
Yes	94	78.33	Yes	
No	24	20.0		0.442
Never	2	1.67		
PIG				
Yes	29	24.17		
No	81	67.50	No	0.553
Never	10	8.70		

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CATTLE				
Yes	41	34.17	No	0.555
No	74	61.67		
Never	5	4.17		
GOAT				
Yes	75	62.50		
No	34	28.33	Yes	0.642
Never	11	9.17		
SHEEP				
Yes	63	52.5	Yes	0.704
No	42	35.0		
Never	15	12.5		
RABBIT				
Yes	13	10.83	No	0.5562
No	77	64.17		
Never	30	25.00		
OTHERS				
Yes	22	18.33		
No	76	63.33	No	0.620
Never	22	18.33		

Survey: Field Survey, 2017.

Table 4 shows that majority (78.33%) of the respondents engage in poultry more than any other aspect of livestock. This was closely followed by those that rear goats (62.5%). This is very close to the findings of Oyelami *et al.*, (2017) who reported highest involvement in goat and poultry production in a rural setting. It was also revealed that most of the respondents do not engage in rabbit production as only 10.83% were involved in it in the study area.

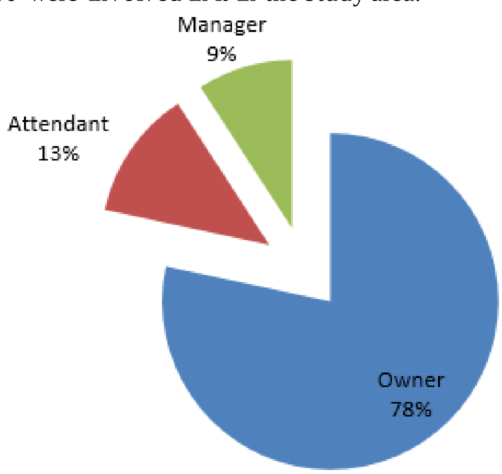

Fig.1: Respondents' Level of Involvement

Figure 1 reveals the respondents' level involvement in livestock farming. It was noted that a good portion of the respondents engage in livestock farming (78.3%) as the owner, working on livestock farm at the management level while those that work at the attendance level were only 12.5% as only 9.16% of the respondents work as the farm managers. This agrees with the report of Ogbosuka *et al*,. (2003) who reported that farmer are actively involved in livestock farming at significant levels and that of Oyelami *et al.*, (2017) who submitted that rural farmers that involve in livestock are usually highly involved. This implies that most of the rural livestock farmers manage their farms by themselves and are fully involved though they still engage in other work.

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Table.5: Perceived constraints faced by respondents involved in livestock farming in the study area.

Variables	Frequency n=120	Percentage	Mode	Std Deviation
Inadequate of capital				
SEVERE	105	87.5	Severe	0.449
MILD	11	9.2		
NOT A CONSTRAINT	4	3.3		
Time of return in the business is long				
SEVERE	14	11.7		
MILD	82	68.3	Mild	0.559
NOT A CONSTRAINT	24	20.0		
High risk involved in the business				
SEVERE	53	44.2	Severe	0,724
MILD	48	40.0		
NOT A CONSTRAINT	19	15.8		
Seasonality of the business				
SEVERE	25	20.8		
MILD	56	46.7	Mild	0.724
NOT ACONSTRAINT	39	32.5		
Inadequacy of necessary infrastructures				
SEVERE	46	38.3		
MILD	36	30.0	Severe	0.838
NOT A CONSTRAINT	38	31.7		
Poor market structure				
SEVERE	37	30.8		
MILD	70	58.3	Mild	0.616
NOT A CONSTRAINT	13	10.8		
Poor government policies				
SEVERE	100	83.3	Severe	O.455
MILD	17	14.2		
NOT A CONSTRAINT	3	2.5		
Disease outbreak				
SEVERE	94	78.3	Severe	0.527
MILD	21	17.5		
NOT A CONSTRAINT	5	4.2		

Survey: Field Survey, 2017

The result in table 5 shows that perceived constraints to livestock farming as affecting the respondents'' involvement in livestock farming in the study area are always noticeable ones such as lack of capital to start a business (finance) which has always been the major problem and 87.5% of the population (respondent) attested to this, so as Inadequacy of necessary infrastructure like communication which receives majority of 38.3% population of the respondent which has also be a serious and major constraints faced by farmers in the study area from the early report (Arowolo *et al*., 2013). Poor government policies on livestock farming is also one of the serious problem notable constraints, as 83.3% believes in that whereas 85.0%, 78.3%,70.8% believe that Inadequate loan facilities for livestock farming, disease outbreak as well as inadequacy of modern equipment for the business respective are also a serious constraints.

Table.6: Chi- square test on Perceived constraints.

Constraints	Value	Df	Asymp Sig.
Inadequate capital to start or expand	159.05	2	0.000xxx
Low return from business	8.60	2	0.014x
Time of return in the business is long	67.40	2	0.000 xxx
High risk is involved in the business	16.85	2	0.000 xxx
Seasonality of the business	12.05	2	0.002 xxx
Nature of the business, not like office setting	51.65	2	0.000 xxx
Rural location of the business	30.05	2	0.000 xxx
Inadequacy of necessary infrastructures like communication and good roads	1.40	2	0.497ns
Marketing of the farm products	40.95	2	0.000 xxx
Poor government policies on livestock farming	137.45	2	0.000 xxx
Inadequate loan facilities for livestock farming	145.40	2	0.000 xxx
Fear of disease outbreak	112.50	2	0.000 xxx
Inadequacy of modern equipment for the business	83.75	2	0.000 xxx
Inadequacy of adequate /necessary government policy	23.45	2	0.000 xxx

The table above shows the correlation between involvement of farmers in livestock farming and constraints to livestock farming. This show that the constraints affect the involvement of farmers in livestock farming activities. They are all significantly affect the involvement of farmers in livestock farming in the study area. Except in the constraint of inadequacy of necessary infrastructure like communication and good roads. This agree with the submission of Umeh and Odom (2011).

IV. CONCLUSION AND RECOMMENDATION

The finding of this study shows that the rural dwellers in Egbeda local government area are well involved in livestock farming as either primary or secondary means of livelihood. The study also revealed that all of livestock farming, poultry farming, is well embraced in the study area. Moreover, most of the respondents are involved in most of the activities in the livestock industry as a number of them occupied position of manager and ownership. On the other hand it was discover that lack of capital. Inadequate Infrastructures as well as inadequate loan facilities constitute the major constraints to rural dwellers involvement in livestock farming in Egbeda local government area of Oyo state.

The government should therefore endeavor to establish policies which are in favour of rural farmers participation in livestock farming in Egbeda local government.

Government should ensure the availability of enough input and capital for rural farmers involving in livestock farming in the study area.

Rural farmers should organize themselves into groups in order to share knowledge and experience for the improvement of livestock farming. This will also help them to secure loan from micro and macro credit institutions.

The government and other stake holders should organize regular sensitization programme on livestock farming for rural farmer in Egbeda local government area as this will increase their awareness of new innovations in livestock farming.

Livestock farming should be encouraged by giving out loans to livestock farmers so as to practice the modern methods of farming system which of course will increase the benefits derived from livestock farming.

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