ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

A Preliminary Investigation on the Effect of Harvesting Frequency on Okro Fruit Yield in Owerri, South Eastern Nigeria

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Abstract
The effect of harvesting frequency on okro fruit yield in Owerri, Southeastern Nigeria was studied under field conditions. The study was aimed at determining the effect of harvesting frequency on number of pods produced, weight of pods produced and shelf life of pods produced. The experiment was carried out in the teaching and research farm of the department of Agricultural Education, Alvan Ikoku Federal College of Education, Owerri. Treatment consisted of four harvesting frequencies: daily (control), 2days interval, 4days interval and 6days interval which corresponded to T_1, T_2, T_3 and T_4. The design used for the experiment was a Randomized Complete Block Design with three replications. Data was collected on: number of pods produced, weight of pods produced and shelf life of pods produced. Data collected was subjected to analysis of variance (ANOVA). Results showed that there were no significant effects of harvesting frequency on number of pods produced, weight of pods produced and shelf life of pods produced. Based on the findings, there is need to carry out further researches on the effect of harvesting frequency on okro fruit yield using other varieties and other locations.

Introduction
Okro (*Abelmoschus esculentus)* is one of the most important vegetables grown in Nigeria. It is an annual crop grown mainly as a fruit vegetable in both green and dried state in the tropics (Gibbon and Ali, 2005). It is valued for its edible green pods which are cooked and commonly assumed as boiled vegetables. Okro or Okra known in many English-speaking countries as ladies' fingers is a flowering plant in the mallow family. It is important because of its edible, nutritious green fruits called pods (Schippers, 2000).
Okro is a warm season crop. It is available in two varieties – green and red okro. The most popular variety in Africa is the green variety (Onuoha *et al.,* 2011). Several reasons are responsible for low yield per hectare of okra, among them is fruit harvest intervals (Maruya *et al.,* 2003). Okro is popularly called "cut and grow plant". Some authors have stated that frequent harvesting depresses yield because of low fruit weight and delayed harvesting depresses marketable yield because over aged fruits become fibrous (Maruya *et al.,* 2003; Talukder, *et al.,* 2013 and Onwu *et al.,* 2014).
Much of the vegetables consumed in South Eastern Nigeria area supplied from Northern Nigeria. As a result, these vegetables are scarce and as such command high prices in South Eastern Nigeria due to high cost of transportation from Northern Nigeria and losses incurred on transit (Poly-Mbah and Agbakaja 2010, Poly-Mbah, Onuoha and Uzowuru, 2010 , Poly-Mbah, Ukaegbu and Ezeobidi 2010 and Poly-Mbah, Obiefuna and Ochie, 2013). There is therefore the need to determine the optimum harvesting frequency that is suitable for okro production in Owerri, South Eastern Nigeria with the aim of investigating the effects of harvesting frequency on fruit number produced at intervals, fresh weight of pods at intervals and shelf life of pods.

Materials and Methods
The experiment was carried out in the teaching and research farm of the Department of Agricultural Education, Alvan Ikoku Federal College of Education, Owerri, Imo State. Owerri lies between latitude $5^o14'^N$ – $6^o35'^N$ and longitude $6^o15'^E$ – $7^o25'^E$. The soil of the area is classified as ultisol. Owerri is located within the

lowland humid rainforest vegetation zone of Nigeria characterized by bimodal rainfall pattern (Nwajiuba and Onyeneke, 2010). The design used for the research was a Randomized Complete Block Design with three replications. Seeds of a popular landrace "Nwaidu", obtained from the Agricultural Development Programme (ADP) was used for the experiment. Treatment consisted of four harvesting intervals of daily (Control), 2days, 4days and 6days which corresponded to T_1, T_2, T_3 and T_4. Agronomic measurements taken were: fruit number produced at intervals, fresh weight of pods at intervals and shelf life of pods. Data collected were subjected to analysis of variance (Anova).

Results and Discussion

Results showed that there were no statistically significant effects of harvesting frequency on fruit number produced at intervals, fresh weight of pods at intervals and shelf life of pods (Tables 1, 2 and 3) This finding contradicts work done by Maruya *et al*. 2003 and Talukder, *et al*. 2013. The contradiction may be as a result of the different varieties used and different locations. Hence, there is need to carry out further researches on the effect of harvesting frequency on okro fruit yield using other varieties and other locations.

Conclusion

This investigation on the effect of harvesting frequency on the fruit yield of okro shows that harvesting frequency did not produce any significant effect on the number of pods produced, pod weight and pod shelf life of "nwaidu" landrace in Owerri, Southeastern Nigeria.

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Table 1: Effect of harvesting frequency on pod number per plant at intervals

S/N	T_1	T_2	T3	T4
4WAP	3.87	3.53	2.86	3.67
5WAP	4.25	3.66	3.97	3.96
6WAP	4.54	3.92	3.62	4.09
7WAP	4.89	4.09	3.82	4.27
8WAP	3.71	3.33	3.09	3.37

$LSD_{0.05}$ = Non significant

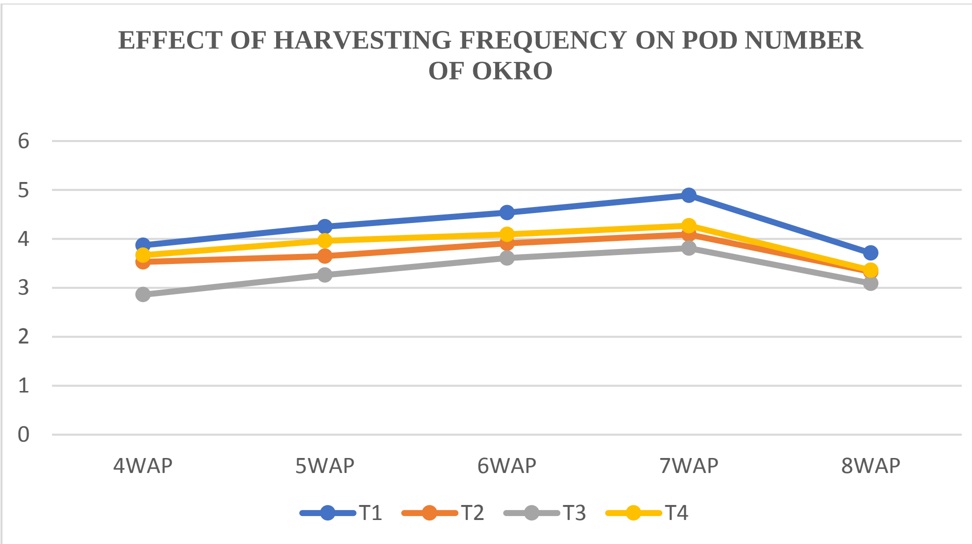

Table 2: Effect of harvesting frequency on pod weight per plant at intervals

S/N	T_1	T_2	T_3	T_4
4WAP	46.33	47.48	44.17	49.27
5WAP	38.50	40.31	39.90	42.87
6WAP	25.00	32.46	36.70	26.50
7WAP	26.51	32.76	33.16	27.10
8WAP	29.10	29.59	23.50	23.50

$LSD_{0.05}$ = Non significant

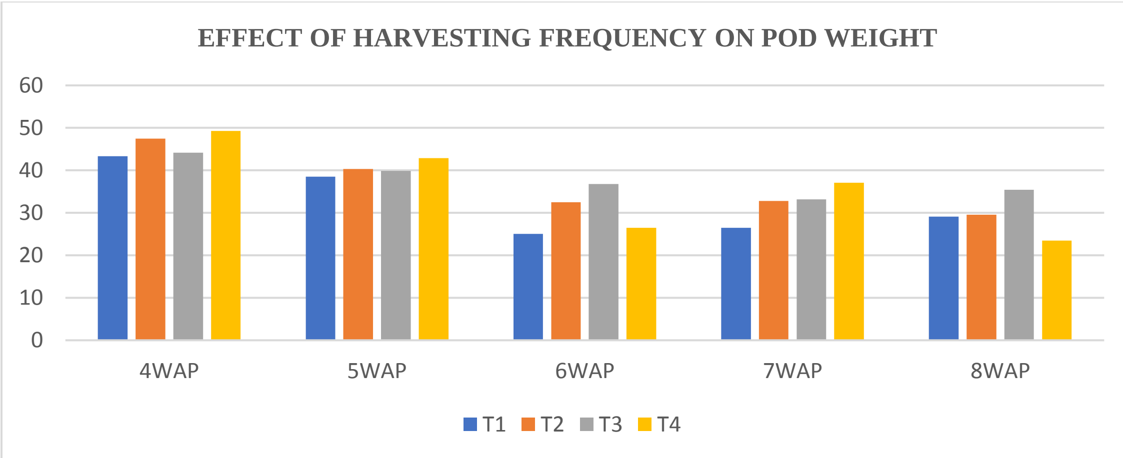

Table 3: Effect of harvesting frequency on shelf life of pods

S/N	T1	T2	T3	T4
1	26.07	26.67	20.33	27.33
2	29.00	17.00	13.00	26.67
3	13.33	11.33	13.67	19.33
Mean	23.00	18.33	15.67	24.44

$LSD_{0.05}$ = Non significant

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Adopting Additive Intercropping for the Production of Maize and Mungbean

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Abstract
A study was conducted between 2017 and 2018 cropping seasons, aimed at determining the influence of additive intercropping on yield and yield components, and productivity of maize and mungbean. The research was carried out at the Department of Crop Production and Landscape Management Farm, Ebonyi State University Abakaliki, Nigeria. The experimental design was a Randomized Complete Block Design (RCBD) with four replications. The main treatments were two sole crops of maize and mungbean and its four additives series intercropping system respectively. The data collected were subjected to Analysis of Variance and means separated using Least Significant Difference (LSD) at the 5% level of probability. The results indicated that mono-cropped maize significantly ($P < 0.05$) produced the highest number of kernels per cob (357.00), fresh cob yield (7.50 t/ha) and grain yield (2.96 t/ha), which is superior to additives three (100% maize + 75% green gram) and four (100% maize + 100% mungbean) respectively. Similarly, sole planted mungbean significantly ($P < 0.05$) produced the highest number of pods per plant (43.00), fresh pod yield (4.46 t/ha) and grain yield (1.93 t/ha), compared to the four additives averaged across the years. The number of pods per plant in the sole cropped mungbean is comparable to that of additives one (100% + 25% mungbean) and two (100% + 50% mungbean) respectively. However, the land equivalent ratio was much higher than one in the four additive intercrops, indicating yield advantage of the additive intercropping system over the mono-cropping. The competitive ratio and aggressivity index values of mungbean were lower than that of maize in all the additive series, which implied that mung bean is less competitive and aggressive than maize. It was concluded that maize and mungbean additive intercropping systems, especially additive two and three do have more efficient land resources use, considerable yield advantage, moderate competitive ratio and aggressivity index values relative to their monocrops, and should be adapted.
***Keywords*: Maize, Mungbean, Diversity, Mixed cropping, Productivity assessment**

Introduction

Mixed cropping had been an age long farming system of the farmers of Abakaliki agro-ecological zone of Southeastern Nigeria. However, with the advent of green revolution and the attendant sole cropping package, the farmers embraced the advance cropping system. But in the recent past the farmers had started recording drastic reduction in yield and even complete crop failures attributed to depletion in soil fertility and the effects of pests and diseases. There is therefore the need to re-examine the green revolution package and adopt a more scientific approach indigenous to the farmers' technology in cropping system. Restoring of a diversified cropping system that is close to nature could be a viable alternative to ensure agricultural sustainability. Many researchers believe that applying intercropping patterns in the cropping ecosystems could be a major means of enhancing the diversity of these systems (Bybee-Finley and Ryan 2018). Intercropping offer numerous benefits through enhanced land use efficiency, increased light capture and use, water, nutrients, weed control, insect pests and diseases management, and increase in length of cropping cycles (Gao et al 2010; Bybee-Finley and Ryan 2018; Chen et al 2018). Among farmers in the Southeastern Nigeria, cereal - legume intercrops are no longer common compared with their corresponding monocrops, as a result of adoption of the green revolution package. Adopting cereal-legume intercropping system or any other certified mixed cropping systems could insure the farmers against complete crop failures since there are always alternative crops in the system to fall back on in the case of a single component crop failure. The objectives of this study were to determine the influence of maize – mungbean additive intercropping on yield and yield components of maize and mungbean, and to quantify their productivity in terms of land equivalent ratio (LER), competitive ratio (CR), and aggressivity index (A).

Materials and Methods

The field experiments were conducted in 2017 and 2018 cropping seasons at the Department of Crop Production and Landscape Management farm, Ebonyi State University, Abakaliki (long. 06^0 45′ N; lat. 08^0 30′ E and elevation of 447m above the sea level), South Eastern Nigeria. The climate is characterized with daily temperature range of 22°C to 32°C. The area has a bimodal rainfall pattern from April to November with peak at July and September. The rainfall ranges from 1700 mm – 2000 mm with a mean of 1800 mm. The relative humidity ranges between 60 – 80% (FDALR 1985) and the soil belongs to the order ultisol.

The experimental was randomized complete block design with four replications. The test crops used in the experiment were maize (Oba Super II) and Mungbean (green gram) from Natural Cereals Research Institute, Badegi, Nigeria. The treatments included two sole cropped maize (Mz;) and green gam (Gg) and four crop mixture using additive intercropping technique according to Ebwongu et al (2001): 100% Mz + 25% Gg, 100% Mz + 50% Gg, 100% Mz + 75% Gg and 100% Mz + 100% Gg.

Minimum tillage method of land preparation was employed. There were six plots, each measuring 6 m^2 (3 m x 2 m). Maize and green gram were simultaneously sown using the plant spacing of 50 x 50 cm for maize and 25 x 50 cm for green gram in early May of 2017 and 2018 cropping seasons respectively. Weeding was done manually by hand at three (3) and six (6) weeks after planting (WAP). Granulated compound fertilizer (NPK 20:10:10) was applied by line method, at 3WAP at the rate of 250 kg per hectare. The insecticide, cypermethrin (10% EC) at the rate of 100 ml per 20 litres of water was used, to control insect pests of green gram at flowering and podding stages. The green gram was harvested in the month of July whereas maize was harvested in August of each planting season, from a net plot area of $2m^2$ (2 x 1 m) in each plot. Soil samples were taken randomly from the experimental area at a depth of 0 – 20 cm. A representative soil sample was collected from the bulk after thorough mixing. The soil samples were analyzed for physical and chemical properties according to the methods of Okalebo et al (2002).

Measurements were taken at harvest on maize cob length (cm), number of kernels per cob, and fresh cob yield per hectare, whereas grain yield per hectare was calculated after thrashing and drying the grains to 15% moisture content. Data taken on green gram were pod length (cm), number of pods per plant, fresh pod yield per hectare and grain yield per hectare, after thrashing and drying to 15% moisture content.

The productivity assessment of the intercrop system was determined from the mean yield data of both monocrop and the intercrop, using the following indices as provided by Mbah and Ogbodo (2013). Land equivalent ratio (LER) was calculated; LER = $pL_m + pL_{mb} = [(Y_{im}/Y_{sm}) + (Y_{imb}/Y_{smb})]$, where pL_m and pL_{mb} = partial LERs of crops ‘m’ (maize) and ‘g’ (green gram), Y_{im} and Y_{ig} are the yields of intercropped maize and green gram respectively, while Y_{sm} and Y_{sg} are the yields of mono-cropped maize and green gram respectively. Competitive ratio (CR) was determined; $CR_m = [(LER_m / LER_g) + (Z_{gm} / Z_{mg})]$ for species m (maize), and $CR_g = [(LER_g / LER_m) + (Z_{mg}/ Z_{gm})]$ for species g (green gram). Where LER_m = land equivalent ratio for maize, LER_g = land equivalent ratio for green gram. Z_{mg} = proportion of maize grown in association with green gram, Z_{gm} = proportion of green gram grown in association with maize. Aggressivity (A) index was calculated. A_{mg} (maize) = $[Y_{mg} / (Y_{mm} \times Z_{mg})] - \{Y_{gm} / (Y_{gg} \times Z_{gm})]$ and A_{gm} (green gram) = $[Y_{gm} / (Y_{gg} \times Z_{gm})] - [Y_{mg} / (Y_{mm} \times Z_{gm})]$, where Y_{mm} and Y_{gg} are yields of maize and green gram as monocrops respectively, Y_{mg} and Y_{gm} are yields of intercropped maize and green gram respectively, while Z_{mg} and Z_{gm} are proportions of maize and green gram respectively.

Results And Discussion

Soil physcico-chemical characteristics: The soil class for the experimental area was sandy loam. The soil was acidic and very low in fertility status. Such soils definitely would require adequate amendments in order to support any meaningful crop production (Table 1). There is the indication that the inclusion of legume crop in the cropping mixture did not ameliorate the low fertility status of the soil. This reflected in the observation that mono-cropped maize had higher yield compared to maize-green gram intercrop. The high soil acidity and low cation exchange capacity (CEC) adversely affected soil nutrient availability, expectedly buffer capacity and crop yield.

Yield components and yield: The mono-cropped maize (100% maize) significantly produced the highest number of kernels per cob (357), fresh cob yield (7.50 t/ha) and grain yield (2.96 t/ha), compared to

additives three (100% maize + 75% green gram) and four (100% maize + 100% green gram) respectively. The superior yield components of the monocropped maize did not differ significantly with additives one (100% maize + 25% green gram) and two (100% maize + 50% green gram) treatments respectively. The percentage increase of sole maize relative to additive three and four were 8 and 17% for number of kernels per cop, 25 and 30% for fresh cob yield and for grain yield, 21 and 25% respectively.
Similarly, sole planted green gram (100% green gram) significantly produced the highest number of pods per plant (43.00), fresh pod yield (4.46 t/ha) and grain yield (1.93 t/ha), compared to additive one (100% + 25% green gram), additive two (100% + 50% green gram), additive three (100% + 75% green gram) and additive four (100% + 100% green gram) averaged across the years. The number of pods per plant in the sole cropped mungbean is comparable to that of additives one (100% + 25% mungbean) and two (100% + 50% mungbean) respectively. The percentage increase of monocropped green gram compared to its intercrops for number of pods per plant were 8 and 15% for three and four additives, for fresh pod yield were 45, 50, 53 and 61%, and for grain yield were 46, 50, 61 and 73% for additives one, two, three and four respectively.
Among the additive intercropping, highest yield components and yield were achieved under maize-additive one followed by additive two, while maize-additive four had the least yield components and yield, which may due to the highest planting population density and the attendant competition for feeding area, nutrient resources and light. Banik and Sharma (2009) ascribed such reduction in green gram yield and its components under additive intercrop of maize probably due to shading effect of maize on green gram.

Productivity assessment: The partial land equivalent ratio (pLER) shows that the intercropped maize and green gram produced higher yields on the equal land area than their monocrops. The results revealed that between 36 and 43 % of more land would be required under mono-cropping systems to obtain a similar amount of yield compared to intercropping. The finding agrees with studies by Mbah and Ogbodo (2013) as well as Manu-Aduening and Boa-Amponsem (2006). The changes in crop performance between the intercrop treatments could be assigned to difference in total crop population per unit land area, particularly for green gram, resulting in variations in the inter-plant competition.

Competitive ratio and **aggressivity**: intercropped maize always had a better competitive ratio than the intercropped green gram, indicating that maize has higher competitive ability compared with the green gram (Table 3). The aggressivity index values revealed maize as the predominant species in the crop mixture, except at 100 % maize intercropped with 100 % green gram. Maize exhibited its dominance in the intercrops, because it is a tall stature and exhaustive plant when compared to green gram that has short stature (Banik and Sharma 2009).

Conclusion

The maize-green gram additive intercropping systems, especially additive two and three should be adopted because they have more efficient land resources use, considerable yield advantage, moderate competitive ratio and aggressivity index relative to their mono-cropping.

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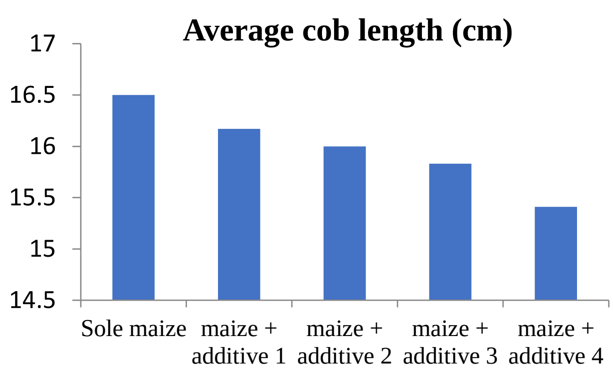
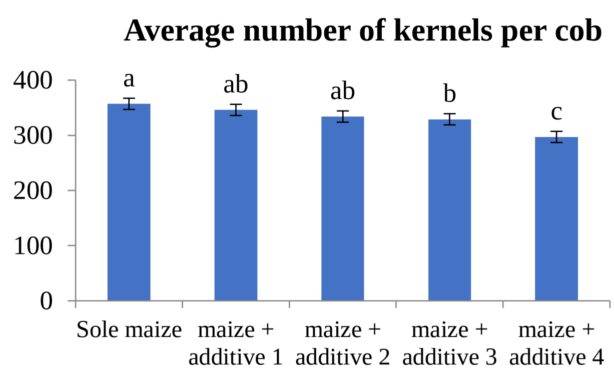
Table 1: Soil Physical and Chemical Characteristics

	Pre-Cropping	Post-Cropping
Physical properties		
Sand (%)	58.00	56.00
Silt (%)	27.47	31.40
Clay (%)	17.00	17.80
Textural class	Sandy loam	Sandy loam
Chemical properties		
pH (H_2O)	4.23	4.10
Available Phosphorus (mg/kg)	25.3	21.50
Total Nitrogen (%)	0.08	0.09
Organic carbon (%)	1.58	1.55
Calcium (Cmol/kg)	1.38	1.12
Magnesium (Cmol/kg)	0.87	0.86
Potassium (Cmol/kg)	0.18	0.15
Sodium (Cmol/kg)	0.08	0.06
Exchangeable Acidity (Cmol/kg)	0.39	0.46
ECEC(Cmol/kg)	2.90	2 .65





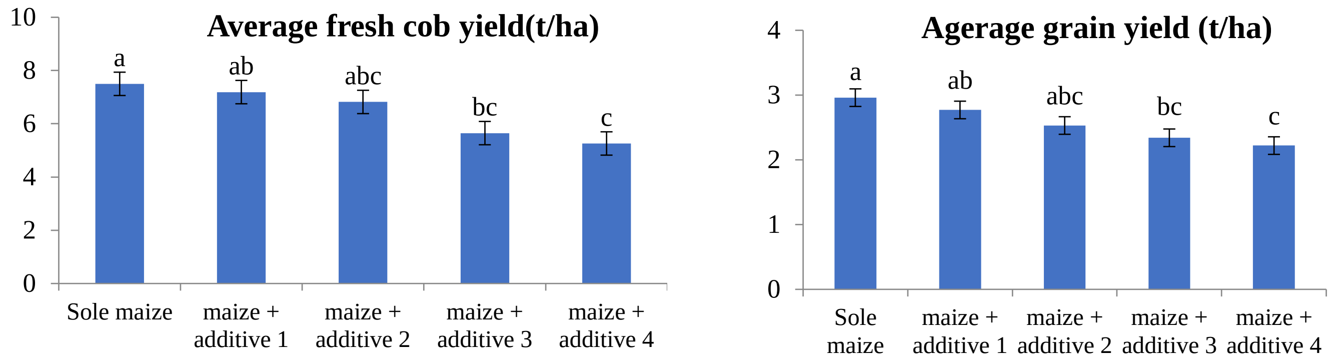


Fig. 1. Effect of additive intercropping on yield and yield components of maize.

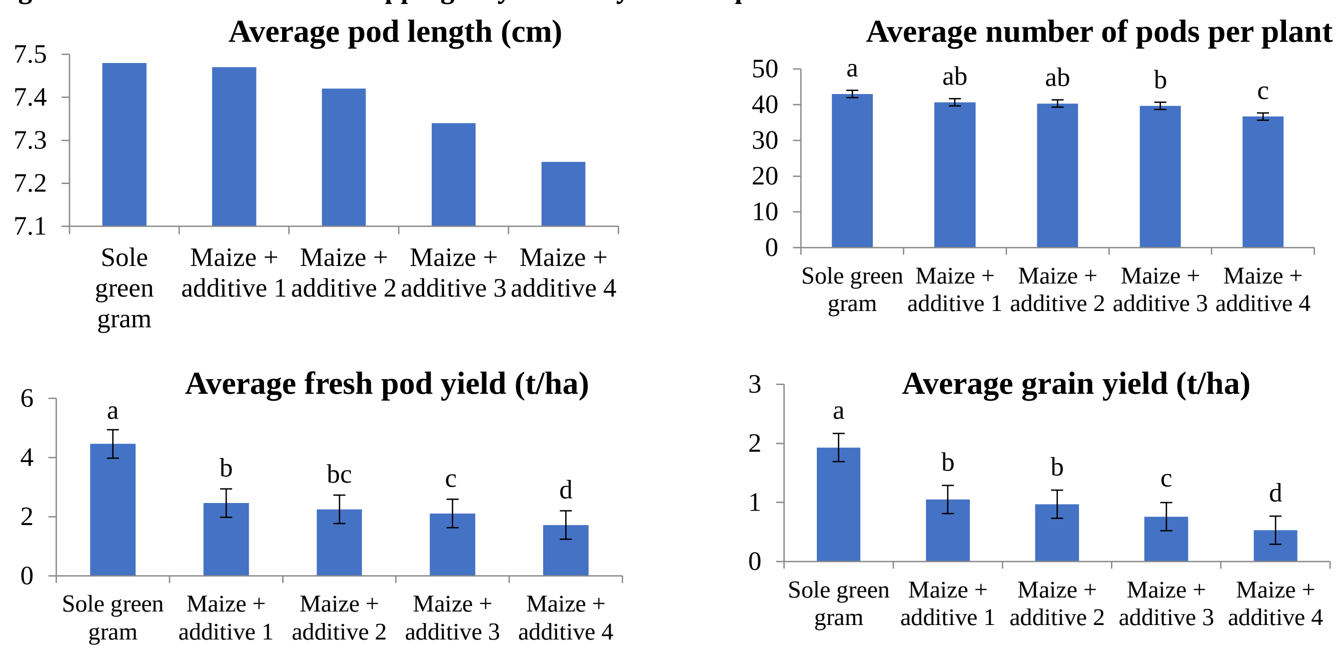


Fig. 2. Effect of additive intercropping on yield and yield components of green gram.
Sole maize and green gram (100%); Maize + Additive 1 = 100% maize + 25% green gram; Maize + Additive 2 = 100% maize + 50% green gram; Maize + Additive 3 = 100% maize + 75% green gram; Maize + Additive 4 = 100% maize + 100% green gram; Means (n = 4) that do not share a letter are significantly different at P < 0.05.

Table 3. Land equivalent ratio (LER), competitive ratio ((CR) and aggressivity (A) index in maize-green gram additive intercropping system.

Treatment	Land equivalent ratio			Competitive ratio		Aggressivity	
	Partial		Total	Maize	Green gram	Maize	Green gram
	Maize	Green gram					
Sole maize	1.0	-	1.0	-	-	-	-
Sole green gram	-	1.0	1.0	-	-	-	-
Maize + additive 1	0.88	0.51	1.39	4.68	0.22	0.69	0.27
Maize + additive 2	0.82	0.59	1.41	3.93	0.33	0.20	0.08
Maize + additive 3	0.79	0.64	1.43	3.21	0.39	0.11	0.04
Maize + additive 4	0.64	0.72	1.36	2.62	0.44	- 0.09	0.03

Sole maize and green gram (100%); Maize + Additive 1 = 100% maize + 25% green gram; Maize + Additive 2 = 100% maize + 50% green gram; Maize + Additive 3 = 100% maize + 75% green gram; Maize + Additive 4 = 100% maize + 100% green gram.

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Comparative Effects of Mineral Fertilizer, Broiler Manure and Local Chicken Manure on the Growth Parameters and Yield of Maize/Soybean Intercrop

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Abstract
Maize/soybean intercrops were established in the experimental farm of NCRI Badeggi. The design of the experiment was RCBD, with eight treatments and three replicates. The experiment was designed to investigate comparative effects of mineral fertilizer, broiler manure and local chicken manure on the growth parameters and yield of maize /soybean intercrop. The study evaluated the effects broiler and local chicken manure applied each at the rates of 0 T/H, 2 t/h, 4t/h and 6t/h with or without inorganic fertilizer (NPK) Data were separatelly collected on vegetative and yield parameters of both maize and soya beans. Agronimic activities such as weeding, thinning were appropriately carried out. Local chicken manure integrated with NPK fertilizer enhanced the growth and yield parameters of both maize and soybean in maize soybean intercrop. Local chicken manure tended to be more effective than broiler manure in the yield of maize over and above both broiler manure and sole NPK fertilizer. Aside from increase in yield, integrating NPK fertilizer with local chicken manure enhanced efficiency of both compared to sole application

Introduction
In Nigeria and other tropical countries, research interest recently shifted to utilization of organic wastes as nutrient source in crop production. This is due to high cost and scarcity of mineral fertilizers. However, because of huge quantity of the organic wastes required, it has become necessary to combine the different types. It is also necessary to integrate chemical fertilizers into the organic sources to reduce the quantity required and enhance nutrient release. Therefore studies are required into integrated application of organic and inorganic fertilizers. Studies by Awodun and Olafusi (2007) have shown the superior effect of nutrient supply in integrated nutrient source over sole use of either inorganic or organic source in terms of balanced nutrient supply, improved soil fertility and crop yield.

Poultry manure contains nutrient elements that can support crop production and enhance the physical and **chemical properties** of the soil. It increases the moisture holding capacity of the soil and improves lateral water movement, thus improving irrigation efficiency and decreasing the general droughtiness of sandy soils. Poultry manure has been reported to contain more plant nutrients than all other organic manures (Ali, 2005). Poultry manure application improves soil retention and uptake of plant nutrients. It increases the number and diversity of soil microorganisms, particularly in sandy conditions. This effect enhances crop health by increasing water and nutrient availability, as well as suppressing harmful levels of plant parasitic nematodes, fungi and bacteria.

et al. (2002) revealed that poultry litter contains a considerable amount of organic matter due to the manure and the bedding material. Litter can also have an impact on **soil pH** and liming due to varying amounts of calcium carbonate in poultry feed. Poultry manure improved soil **physical properties** significantly by reducing soil bulk density and temperature and increasing total porosity and **moisture content** in Nigeria (Agbede *et al*., 2008).

However, most of the chickens raised in Nigeria are indigenous and they scavenge for their feed. Report by RIM (1992) indicates that Indigenous chicken constitutes 80% of the 120 million poultry type raised in the rural areas in Nigeria. They are self-reliant and hardy birds with the capacity to withstand harsh weather condition and adaptation to adverse environment. They scavenge for major parts of their food and possess appreciated immunity from endemic diseases. In village chicken production system, it is difficult to estimate the economic and/or physical value of this input because there are no direct methods of estimating the scavenged feed resource which constitutes most of the feed input. Izunobi (2002) reported that poultry manure, especially those produced in deep litter or battery cage house are the richest known farmyard manure supplying greater amounts of absorbable plant nutrient. Schroeder (1980), observed that the quality value of manure as a substrate for microbial growth is directly related to the feed the animal received. The concentrated feed gives higher value than the fibrous feed. Generally, the value of the manure, in increasing order is: cattle, sheep and goat, followed by pig, chicken and ducks.

The nutrient composition of poultry droppings as reported by Atif, et al., (2015) is 1:0-1.8% N, 0.4-0.8% P and 0.5-1.9%. **Sims (1987)** reported that corn grain and stover removed 16% of N per year from the slowly mineralized fraction of broiler litter, which left considerable part of soil N. The nutrient content of poultry manure will vary with the digestibility of the ration, animal age, amount of feed wasted, the amount of bedding used, and the number of times the poultry house is cleaned in a year. Feed resources are a major input in poultry production systems, estimated to account for about 60 percent of total production costs in the commercial poultry sector. Indigenous chickens are widely distributed in the rural areas of tropical and sub-tropical countries where they are kept by the majority of the rural poor. Indigenous chickens in Africa are generally hardy, adaptive to rural environments, survive on little or no inputs and adjust to fluctuations in feed availability. Chickens largely dominate flock composition and make up about 98% (**Gueye**, 2003) of the total poultry numbers (chickens, ducks and turkeys) kept in Africa.

Local chicken is endowed with genetic potential for feed efficiency due to lower maintenance requirement (Ogbu and Omeje, 2011). Application of poultry manure increases carbon content, water holding capacity, aggregation of soil, and decreases bulk density (Egerszegi, 1990). Ibeawuchi *et al,* (2006) reported that 8 t/ha of poultry manure resulted in significantly higher grain yield, dry matter and increased leaf area of maize. Fagimi and Odebode (2007) reported that poultry droppings applied at the rate of 10 t/ha and 20 t/ha, increased plant height, number of leaves and fruit yield of Pepper, while the incidence and severity of Pepper Veinal Mottle Virus (PVMV) was reduced.

Materials and Methods

This study was conducted on station at NCRI experimental field. The experiment was carried out in a Randomised Complete Block Design (RCBD) with eight treatments and three replicates. Plot sizes were 8.0m x 3.0m (24 m^2). It was designed to investigate comparative effects of mineral fertilizer, broiler manure and local chicken manure on the growth parameters and yield of maize/soyabean intercrop. Maize (sammaz 37) was planted on the ridge with a spacing of 1.0 m x 0.5m while soybean (T G X 1448) was drilled on ridge crest 1.0m apart. Maize was thinned to two plants per stand. All agronomic practices like weeding and application of insecticides were carried out as need arised. The treatments were; 60 Kg/ha NPK + 0 t/h BM + 0 t/h LCM, 0 Kg/ha NPK + 6 t/h BM + 0 t/h LCM, 20 Kg/ha NPK + 4 t/h BM + 0 t/h LCM, 40 Kg/ha NPK + 2 t/h BM + 0 t/h LCM, 0 Kg/ha NPK + 0 t/h BM + 6 t/h LCM, 20 Kg/ha NPK + 0 t/h BM + 4 t/h LCM, 40 Kg/ha NPK + 0 t/h BM + 2 t/h LCM, 0 Kg/ha NPK + 0 t/h BM + 0 t/h LCM, (Where; BM= Broiler Manure, LCM = Local Chicken Manure). Data collected were plant height, number of leaves, leaf lengh, plant vigour, days to50% tasseling, days to 50% flowering, as well as number of pod per plant and grain weight. Laboratory analysis was carried out on the two manure samples. Analysis of data was carried out by means of ANOVA.

Results and Discussion

Growth and yield parameters of maize, in response to different levels of inclusion of broiler manure and local chicken manure, integrated with commercial fertilizer is presented in table 2. There was significant difference among treatments, in days to 50% silking, number of cobs per plot, cob length, weight of cob per plot, grain weight per plot, weight of one thousand grains and days to maturity. Results indicated least number of days to 50% tasseling (50 days), least number of days to 50% silking (53 days) and least no of days to maturity (81 days) obtained from maize plants under 20 kg/ha NPK, 0 t/h broiler manure and 4 t/h LCM treatment. Early maturity and lower number of days to 50% silking were demonstrations of superiority of local chicken manure over broiler manure, being in line with Ibeawuchi *et al,* (2006) and Fagimi and Odebode (2007). The efficiency of local chicken manure over broiler manure even at equal rates of application (that is, 4 tonnes per hectare) and equal rate of integration with NPK fertilizer (20 Kgha-1), could not be unrelated to the fact that Local chicken is endowed with genetic potential for feed efficiency due to lower maintenance requirement as pointed out by Ogbu and Omeje (2011). Hence application of poultry manure has increased the carbon content, water holding capacity, aggregation of soil, and decreases bulk density (Egerszegi, 1990). Hence Local chicken manure would have surpaass broiler manure in impacting greater effects on the soil, thereby enhancing performance of maize plant.

This result implies that lower quantities of local chicken manure could be used to obtain better results compared with broiler manure, even at equal levels of integration with NPK fertilizer. The efficiency obtained from local chicken manure over broiler manure could be because of its higher Total Nitrogen content (Table 1) in conformation with Atif H. N. (2015) and Sims (1987) on high content of poultry manure and subsiquent effects on plant performance. Sole application of broiler manure even at highest rate of 6 t/h without integrating with NPK gave lower performance in almost all the parameters compared to plants treated with sole local chicken manure at same rate of 6 t/h without NPK. The better performance obtained from plants treated with local chicken manure over those treated with broiler manure is a reflection of efficiency of one manure type over the other.

The economical interplay of the two manure types implies that, with equal quantities a farmer will attract more profit from local chicken manure over and above broiler manure. The superiority of local chicken manure over broiler manure could be as a result of higher nutrient content as seen in (table1).

However, plants that received sole NPK at 60 kg/h demonstrated worst response in days to 50% tasseling (55days) and days to 50% silking (59days). This clearly indicates the fact that poultry manure either applied as sole, or integrated with fertilizer even at low quantity is more effective to maize plant than sole NPK. Yield Parameters of maize also indicated highest values for cob length (15.05cm) were obtained from 40 kg/h NPK and 2 t/h broiler manure, while highest values for number of cob per plot (28.67), weight of cob per plot (0.39kg), weight of straw per plot (2.23kg), grain weight per plot (1.67kg) and weight of 1000 grains (0.37kg) were all obtained from plants treated with 40 kg ha-1 NPK, 0 t ha-1 broiler manure and 2 t ha -1 LCM

Table 3:- Growth and yield parameters of soya bean in response to various treatments are presented in table 3. Significant difference among treatments were noticed from only two parameters, that is days to 50% flowering (45 days) and weight of 1000 grains of soyabean (0.15kg) both obtained from plants treated with 6 t/h and 2 t/h local chicken manure respectively. The insignificant results obtained from soyabean could be based on the fact that soya bean is less dependent on manure as nutrients source, compared to maize. Although without significant difference plants treated with local chicken manure either sole or integrated with NPK maintened superiority of performance in parameters such as plant vigour at three weeks after planting (78.33%), number of days to maturity (95 days), number of pods per plant (73.07), pod length (4.15cm) , plant vigour at 6 weeks after planting (78.33%) as well as weight of 1000 grains (0.15kg) thereby proving availability of more plant nutrients (Sims 1987). Plants that received 4 t/h broiler manure supplemented with 20 kgha-1 fertilizer were highest in grain weight per plot (1.53kg) and straw weight per plot (2.07kg), while those plants that received 2 t/h broiler manure supplemented with 40 kg ha-1 NPK were among the best in days to 50% flowering (45 days). Plants treated with sole broiler manure at 6 t/h were also among the best in days to 50% flowering.

Highest number of days to 50% flowering (47) obtained from plants in the control treatment and highest number of days to 50% podding (65) obtained from plants that received 2 tha-1 broiler manure, supplemented with 40 kgha-1 fertilizer were demonstrations of inferiority of those treatments. Plants under the control treatment had lowest values for plant vigour at 3 weeks after planting (51.67%), plant vigour at 6 weeks after planting (55.00%) and highest number of days to maturity (99). Plants that received the control treatment also demonstrated poor performances in grain weight per plot (0.80 kg), straw weight per plot (1.20kg) and weight of 1000 grains (0,11kg).

Conclusion

Local chicken manure integrated with NPK fertilizer enhanced the growth and yield parameters of both maize and soybean in maize soybean intercrop. It tended to be more effective than broiler manure in both vegetative and yield parameters of maize. Combination of both NPK fertilizer and local chicken manure tend reduce cost of production for farmers as each will be applied at less quantity.

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Table 1: Nutrient Composition of Experimental Faeces

Sample Description	Organic Carbon	Organic Matter	Total N	Available P	Exchangeable Cations			
					Na	K	Ca	Mg
	%	%	%	Ppm	CmolKg^{-1}	CmolKg^{-1}	CmolKg^{-1}	CmolKg^{-1}
Local Chicken Manure	1.56	2.71	1.20	58.75	0.20	0.23	1.26	1.36
Broiler Manure	1.37	2.36	1.12	47.25	0.13	2.23	0.18	1.08

Table 2: Agronomic and Yield Parameters Of Maize

TREATMENTS (Kgha-1) / (tha-1)	Days to 50% tasselling	Days to 50% silking	Number of cob /plot	Cob length (cm)	Wt of cob/plot (kg)	Straw wt/plot (kg)	Grain wt/hec (kg)	Wt of 1000 grains (Kg)	Days to maturity
NPK-BM-LCM (60-0-0)	55	59	18	13.03	0.20	1.10	0.73	0.30	85
NPK-BM-LCM (0-6-0)	54	58	17	11.33	0.33	1.20	0.77	0.34	83
NPK-BM-LCM (20-4-0)	52	56	19	12.88	0.22	1.60	0.87	0.36	82
NPK-BM-LCM (40-2-0)	51	55	22	15.05	0.33	1.98	1.18	0.35	84
NPK-BM-LCM (0-0-6)	51	56	22	12.13	0.25	1.57	1.10	0.36	83
NPK-BM-LCM (20-0-4)	50	53	20	14.37	0.28	1.57	1.13	0.35	81
NPK-BM-LCM (40-0-2)	52	53	28.67	14.17	0.39	2.23	1.67	0.37	82
NPK-BM-LCM (0-0-0)	54	59	12	9.53	0.06	0.93	0.33	0.21	86
LSD 5%	NS	1.39	7.67	1.89	0.18	NS	0.49	0.78	1.07
CV	4.0	2.3	22.1	8.4	39.6	35.4	28.9	13.5	0.7

Table 3: Agronomic/Yield Parameters of Soybean

	50% flowering (Days)	50% podding (Days)	Plant vigor		Maturity (Days)	No of pod/ plant	Pod length cm	Grain wt/plot kg	Straw wt/plot kg	Wt 1000 grains kg
			Wk3 %	Wk6 %						
NPK-BM-LCM (60-0-0)	46	63	51.67	61.67	98	40.60	4.12	1.37	1.57	0.12
NPK-BM-LCM (0-6-0)	46	63	61.67	58.33	96	44.33	4.04	1.50	1.80	0.14
NPK-BM-LCM (20-4-0)	47	62	65.00	75.00	96	54.33	3.88	1.53	2.07	0.14
NPK-BM-LCM (40-2-0)	45	62	58.33	61.67	97	35.19	3.96	1.27	1.97	0.12
NPK-BM-LCM (0-0-6)	45	62	78.33	71.67	96	42.81	3.90	1.50	1.90	0.13
NPK-BM-LCM (20-0-4)	46	61	61.67	61.67	95	73.07	4.15	1.43	1.77	0.15
NPK-BM-LCM (40-0-2)	45	62	58.33	78.33	95	56.30	3.86	1.50	1.87	0.13
NPK-BM-LCM (0-0-0)	46	65	51.67	55.00	99	32.58	3.80	0.80	1.20	0.11
LSD 5%	NS	NS	15.05	NS	NS	NS	NS	NS	NS	0.17
CV	1.2	1.8	14.1	14.4	2.4	29.2	7.2	19.7	24.3	7.6

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Date Palm Production: A Review of its Past, Present and Advances in Cultivation in Nigeria

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Abstract
Date palm is an important and popular tree crop in the dry and barren regions of the world. Date palm is one of the greatest producers of food per hectare, producing more than 3000 calories per kg. Date palm was introduced into Nigeria in the early 17th century through trans-Saharan trade from east by the traders. Nigeria has vast land areas and favourable climatic conditions to produce date palm in large quantities. The Nigerian date palm industry has the potential to generate employment and promote economic development. However, date palm production in Nigeria is low and it become difficult for the industry to perform it role in promoting economic development. This review identified the problems confronting date palm industry and proffer solutions to them. The problems identified include; lack of capital, lack of government assistance in term of loans, inputs, low budgetary allocation to farmers and land to cultivate. Others were pests and diseases, lack of good planting materials, lack of education and extension services, lack of technology, and lack of managerial approach. The study recommended that government should assist farmers by supplying incentives, acquire large hectares of land for increase production and budgetary allocation to date palm research institutions, while extension services should provide useful information in the potential of date palm to farmers and the public.

Keyword: Date palm, Problems, Solution, Advances, cultivation

Introduction

The date palm (Phoenix dactylifera L.) tree belongs to the family Arecaceae, and is commonly known locally as "Eyop ikpat" in Ibibio, "Ubochi nkwu" in Igbo, "Dibino" in Hausa and "Dabino" in Yoruba. According to Pantuliano and Wekesa (2008), date palm is an important and popular tree crop in the dry and barren regions of the world, being a symbol of life in the desert, as it tolerates high temperatures, water stress and salinity more than many other fruit crops. It is one of the oldest cultivated plants (Wisegeck, 2011, Omokhdu *et al*, 2016). The exact origin of the date palm is considered to be lost in antiquity. However, it is certain that the date palm was cultivated as early as 4000 B.C. since it was used for the construction of the temple of the moon god near Ur in Southern Iraq – Mesopotamia (Popenoe, 1973, Sanusi *et al*, 2014). More proof of the great antiquity of the date palm has been found in Egypt's Nile valley, where it frond has been used as the symbol for years in Egyptian hieroglyphics (Dowson, 1982). According to Zaid and deWet (2002), the date palm (*P. dactylifera* L.) evolved from *P. reclinata*, native of the tropical Africa or *P. sylvestris* in India, or a hybrid between the two species. Sanderson (2000) postulates that, the wide distribution of date palm recorded in ancient history extending over the Nile valley and the Horn of Africa, implies its evolution in a more limited geographic place from where it was spread by human agency to regions with varied but favourable geographic, soil and climatic conditions.

Date palm is a dioecious, monocot, perennial plants that grows to a height of 24m and survive over 100 years. It is a palm characterized by a crown of 100-120 feathery pinnate leaves with many leaflets on each side of a common petiole which is similar to the oil palm. The fronds, with average length of 4m carry the spines. The trunk is erect and columnar of the same girth all the way up. The girth does not increase once the canopy of the fronds has fully developed, except the terminal bud experience an abnormal growth caused by a nutritional deficiency or drought conditions, which will lead to shrinkage of the trunk. The trunk produces true suckers at the base. The inflorescences are auxiliary with branched panicle enclosed in a deciduous flower spathe. The male inflorescence has 10-30 branches and becomes elongated and pendulous as fruits develop. The fruit is single, one seeded, hard, green, oblong-shaped berries, 2.5-7.5cm long which later turns soft and yellow to reddish-brown in colour; which ripens in 5 months. The seeds are cylindrical in shape, about 2.5cm long with hard endosperm.

The Date Palm Environment

Date palm (*Phoenix dactylifera* L) is produce mainly in the hot arid and semi-arid regions of Southern Asia and North Africa, and it is probably the most ancient cultivated and marketed desert tree crops worldwide (Botes and Zaid, 2002). A desert environment is typically ideal for a date palm tree to grow (Wisegeck, 2011). The tree can usually withstand hot temperatures and generally does not wither when placed in direct sunlight, though it normally performs well in an oasis setting because, there is often an ample supply of water for the roots uptake (Dada *et al*, 2012, Sanusi, 2016). Date palm requires relatively low rainfall- desert rainfall of 100-200mm per annum is adequate under ample sunlight. It can withstand strong desert winds and can grow in almost any type of soils, from almost poor sand to heavy alluvial soils, provided they furnish the basic needs of anchorage to the palms; minerals, water penetration and drainage. However, the best soils for date palm are found in the Middle East with deep sandy loam.

The Place of Date Palm in Nigeria

Date palm production in Nigeria started at about 17th century ago but its cultivation and marketing has been under subsistence level. In 1964, NIFOR (Nigeria Institutes for Oil Palm Research) was given the mandate to carry out research and developmental work on palms including date palm and all other palms of economic importance in the country. Omamor *et al* (2000) reported that pilgrims brought date palm into Nigeria from North Africa during trans-Saharan trade and from the Middle East. Though Nigeria is not a major dates producer in the world, the crop strives well in Northern parts of the country particularly regions above latitude 10^{0}N of the equator (Okolo *et al*, 2000). Nigeria has a vast land mass and suitable climatic conditions to produce date palm in large quantities considering the fact that, it has two fruiting season in a year. It grows in all the states of the federation, but will perform better and produce fruits in the Guinea and Sudan savanna vegetations that span across 15 states in the northern part of the country (Zaid and deWet, 2002).

Economic Importance and Nutritional Value of Date Palm

Economic Importance: Date palm is a high valued economic fruit tree. In Nigeria, date palm produces 10-70kg of fruits per plant per annum at full maturity, depending on variety (AbdulQadir *et al*, 2011). Date palm fruits are high energy staple food crop, widely consumed directly in Nigeria, and the fruits can be processed into different products like jam, syrup, confectionaries, non-alcoholic fruit juice, wines and organic acids. Date palm provides shelter; timber products and all the parts can be used in one way or the other. Date palm fronds are use to produce broom, baskets, ropes and mats. Date palm fruits are used for breaking of fast during Ramadan, use as medicine as well as making sweeteners and snacks (Sanusi *et al*, 2016). Date palm, which is an irreplaceable tree in an irrigable desert land, provides protection to undercover crops from heat, wind and even cold weather and plays a big role to stop desertification and to give life to desert areas. Desert travelers do take advantage of its shade provision to rest. It can be used as ornamental plant in the South. Date palm is a tree that has a potential of providing foreign exchange to Nigeria as compared to other tree crops. The kernels are used as animal feed (65% hemicelluloses, 7% oil, and 5.2% protein). Date palm is one of the greatest producers of food per hectare.

Date Palm in Religion

Date palm also has religious importance as dates and date palms were mentioned in the three most recognized religion in the world of Christianity, Jewish and Islam. In Christianity, the palm leaves are used for celebration of Easter Sunday (Zolany *et al*, 2012). In Islam, dates are mentioned in the Quran where they are used usually to break long fasting days in the month of Ramadan (Al-Farsi and Lee, 2008).

Nutritional Value of Date Palm Fruits

Date palm fruits contains carbohydrates, protein, fibres, fats, various vitamins and minerals that make the fruits an important food security crop for the people, especially the agro-pastorialist in the Northern States, which are malnourished and food unsecured. According to Zaid and deWet (2002), the availability of high amount of sugar makes the fruits one of the most nutritious foods available to the people in arid and semi-arid regions of the world. Considering the daily requirements of macro and micro elements by human, date palm fruits would provide more than 80% of the daily body requirement as shown in Table 1.

Constraints of Date Palm Production in Nigeria

Despite the advantages that Nigeria has in terms of favourable climate and human resources, date palm potentials and the capacity of the crop to provide income, raw materials, food and foreign exchange earnings, date palm the production is low (Sanusi *et al*, 2014, 2016, 2017), making it difficult for the industry to grow. Nigeria is currently a major importer of Date palm fruits to meet local demand due to many problems affecting the industry as follows:

Socio-Economic problems:

Lack of capital: The major challenge facing date palm industry in Nigeria is finance. The major source of money to fund date palm production by the farmers is their personal savings and lending from relatives or money lenders (Sanusi *et al*, 2016). The money received from these sources is inadequate to establish date palm plantation that can increase production. Money needed for acquisition of land, clearing of such land, provision of seedlings, field establishment, plantation management and harvesting. This amount received cannot be raised by the local farmers. Banks are not ready to invest in a long term production, thus, hinder production.

Land Tenure System (LTS): Land tenure system is a serious factor affecting date palm production in the country. In Nigeria, lands are not easily obtained by the farmers. The agricultural production system in Nigeria generally is largely determined by the way in which land is owned and shared out for use by the farmers. Studies have shown that farmer's farm size is less than 4 hectares (Sanusi *et al*, 2016), which is not adequate for date palm establishment. The land owned by the farmers are scattered as a result of land tenure system, which date palm plantation required large expanse of land.

Lack of Awareness of the Potentials of Date Palm

The importance and its utilization are not clearly known by the people. Date palm has a lot of potentials and uses from environmental, economic, social, medicinal and industrial uses if harnessed. There is no awareness on the importance and its usefulness to attract farmers and investors attention.

Biological Factors

Pests and Diseases: Pests and diseases constitute major problems of date palm production. The incidence of pest and disease does not only increase the cost of production, it discourages farmers who have no money for the control. The attack of pests and diseases also lead to the reduction in quality and quantity of the fruits and products, invariably results in low income and hunger.

Gestation Period: The long gestation period of date palm is another problem. Investors may not have the patience to wait for so long to recuperate their money. This undoubtedly discourages investors on date palm production.

Agronomic/Cultural Factors

Lack of Improved Planting Materials: Many date farmers do not know where and how to obtain improved planting materials. The unavailability of improved planting materials has been identified as one of the major problems of date palm production.

Nursery Management: Many farmers of date palm do not necessarily engage in a good nursery practice. They plant their seed directly on the field resulting in poor germination and establishment. Research shows that nursery management technology utilization is low in this aspect (Kabiru and Fadeke, 2018).

Lack of Pollination Technology: Date palm farmers do not have the basic skill on how to increase yield of date palm in the field, using pollination techniques. According to FAO (2006), increase in fruit setting required fertilization of the female flowers by male pollen. This should not be left for the wind and insect alone, but should be done manually by man, by way of inserting a piece of a spikelet of male flower on the female flower when the female flower opens. This is done because the female flowers do not mature at the same time.

Education and Extension Services

Lack of Research: Most of the date palm farmers are not educated, making them not to accept technological changes or new ideas in production. Besides, the budgetary allocation in the country for date palm research is not adequate. For instance, date palm research is under the Nigerian Institute for Oil Palm Research (NIFOR), with the mandate crop such as oil palm, coconut palm, Raffia palm and other palms of economic importance, including date palm. These institutes do not have enough resources to carryout research and generate technologies on date, thereby transferring the technologies to the farmers.

Poor Extension Services: The extension workers are people that disseminate information especially result findings, to farmers about new development and technologies in agriculture, and feedback to the research workers farmers complain. There has been poor linkage between the research and the farmers. There are a lot of research findings that have been developed by researchers in the research Institutes and the Universities etc that are yet to get to the farmers because of the poor extension welfare in the country.

Government Attitude/Policy

Lack of Government Assistance: Government of both Federal and States do not show interest in assisting the local farmers by providing farm inputs such as improved seedlings from the research institutes, fertilizers, pesticides, herbicides, loans etc. Date palm production is capital intensive, thus requires huge sum of money. The government should assist the farmers by subsidizing farm inputs to encourage the farmers.

Lack of Government Attention: The development of date palm production in the country is extremely low where the exact annual production is registered in any statistical database due to less attention of the government of Nigeria compared to other countries. No researches and extension activities have been conducted by governmental as well as non-governmental organizations. Date palms in the producing regions are produced by the agro-pastoralist using traditional farming practices, which they acquired from their fore-fathers over time. No training session or extension services by stakeholders are given to the farmers on cultivation, management and postharvest handling practices on date palm.

Strategies in Solving the Problems and Meeting the Demand of Date Palm production in Nigeria

Research Training

- Research work in the research institutes, Universities, Polytechnics and Colleges should be organized and financed properly.
- Training of skilled farmers on the production of mandate crops.
- Development of improved production, processing, handling and marketing protocol
- Organized farmers' field day, seminars, workshops, conferences and farmers to farmers exchange programme.
- Breeding of high yielding, pest and disease resistant varieties

Government Policy

- The Federal and State government should promote date palm production through adequate funding, supervision to stimulate private partnership participation (PPP).
- Promote exportation of date palm products
- Establish national date palm growers' council with zonal offices at different producing areas for a comfortable dissemination of information
- Provide appropriate mechanisms to manage any surplus from date palm farmers.
- Government should assist date palm farmers by subsidizing farm inputs such as tolerant seedlings, pesticides, fertilizers as well as providing infrastructures.

Advances and Prospects in Date Palm Cultivation

Advances: Although economically important, date palms are a much neglected plant group in term of understanding the development and propagation potentials thereof. Progress in the field of breeding, genetics, crop improvement and expansion of commercial plantings for palm has been restricted by the habit and long-lived nature of these monocotyledonous trees. The techniques used in propagating date palm commercially are; seed propagation, offshoot propagation (traditional methods), and recently the development of tissue culture technique methods, involving embryo culture, in-vitro culture (shoot-tips and buds), leaf culture, stem culture, inflorescence culture and root culture.

Prospect: Significant progress continues to be made in the advancement of date palm research. Research and review articles are steadily filling in the knowledge gaps. Since 2014, books entitled "Date palm Genetic Resources and Utilization" (Al-Khayri *et al.*, 2014, 2015a and b), and "Sustainable Pest Management in Date Palm" (Wakil *et al*, 2016) have been published. In addition, a number of articles on date palm, too numerous to mention here have appeared in general plant Science and other journals. Special scientific journal issues and proceedings on date palm, such as the Agricultural Society of Nigeria (ASN) proceedings, Horticultural Society of Nigeria (HORTSON) proceedings and the present one also make valuable contributions by grouping together research and review articles for reading access of date palm prospects. Date palm seedling commercialization technology in the Nigerian Institute for Oil Palm Research (NIFOR) is on-going. The technology involves the raising of Date palm seedlings for 9-12 months, and farmers are encouraged to study and adopt the innovation for commercialization of date palm in Nigeria.

Conclusion and Recommendations

Date palm is in a position to providing food, income, foreign exchange, shelter and employment to a large number of people in the producing areas of the country. From the above discussion, it is clear that date palm tree needs maximum attention as far as production, processing, handling, packaging and storage and other practices are concerned, if high yield production is to be attained. Government assistance in term of funding will help solve the problem of lack of capital to purchase farm inputs to improve yields, and control of pests and diseases of the date palms. Government should also acquire large hectares of land for date palm production to solving the problem of land tenure system affecting its establishment. Budgetary allocation should be increased for the Institutions to solving the problem related to research and supplying improved seedlings from research to the farmers. Researchers/Scientist should collaborate with scientist of different discipline to develop comprehensive programme for date palm tree. Extension services should rise to the occasion by providing information on the importance, potentials and uses of date palm to the farmers and the general public on the benefits and need to embrace its production in Nigeria. Also, extension workers should provide information on where improved seedlings are purchased. This review article will be informative to extension workers, farmers and those that may be interested in date palm production in the country and will serve as tool to making a good decision on best approach to follow in order to move the industry forward.

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Table 1: Nutritional Value per 100g of Date Palm

Composition	Value (per 100g)	Vitamins	Quantity	%DV+	Minerals	Quantity	%DV+
Energy	1.178KJ	Vit A Equv.	0%	-	Calcium	39mg	4
Carbohydrate	75.03g	Thiamine (B_1)	0.053mg	5	Iron	1.02mg	8
Sugar	63.35g	Riboflavin (B_2)	0.066mg	6	Magnesium	43mg	12
Dietary fibre	8g	Niacin (B_3)	1.274mg	8	Manganese	0.262mg	12
Fat	0.39g	Pantothenic acid(B_5)	0.589mg	12	Phosphorus	62mg	9
Protein	2.45g	Vitamin B_6	0.165mg	13	Potassium	656mg	14
-	-	Folate B_9	19µg	5	Sodium	2mg	0
-	-	Vitamin C	0.4mg	0	Zinc	0.29mg	3
-	-	Vitamin E	0.05mg	0	Water	20.53g	-
-	-	Vitamin K	2.7µg	3	-	-	-

Source: FAOSTAT, 2006. µg = micrograms, mg = milligrams, IU = International units, DV = dietary value, Vit A Equiv = Vitamin A Equivalent

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Determinants of farm-level productivity of cassava farmers under sole and mixed cropping systems in Niger State, Nigeria

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Abstract
Study on determinants of farm-level productivity of cassava farmers under sole and mixed cropping systems was conducted in Lapai and Wushishi Local Government Areas of Niger State, Nigeria. A multi-stage sampling technique was used to select 120 croppers while cross-sectional data for the 2017/2018 production season were collected through a well-structured questionnaire with the assistance of extension agents and trained enumerators. Analytical tools included descriptive statistics, and total and partial productivity indices. The results of the summary statistics revealed that the mean output of farmers under mixed cropping system was higher than that of the sole cropping system and that sole croppers operated mostly on small-scale while mixed croppers operated beyond small-scale. The mean inputs used by mixed croppers were mostly higher than that of the sole croppers. The result of the factors affecting the farm level productivity of the cassava farmers revealed that farm size, agrochemical, age, sex and household size were common determinants for both cropping systems while sole cropping system had additional determinants which included labour, stem cuttings, capital inputs, educational level, marital status, years of farming experience, and membership of cooperative society at different probability levels
Key words: Productivity, inputs, cropping systems

Introduction
Nigeria is the world largest cassava producing country at about 54.8 million metric tonnes annually (FAO, 2014). Cassava is Africa's second most important staple food after maize in terms of calories consumed (Nweke, 2004). It is widely cultivated in the country and the crop plays a vital role in the food security and rural economy because of its capacity to yield under marginal soil conditions and its tolerance to drought (Ezedinma *et al.,* 2006). Crop production is a branch of agriculture that deals with growing crops for use as food, fibre and income generation (Barth, 2017). Just like other crop farms, cassava farms in Nigeria are the small-scale types which are characterize by low productivity and despite all human and material resources, the crucial issue Nigeria has, as the largest cultivator of cassava is that of low productivity (Federal Department of Agriculture, 2000). Cassava based cropping system is prevalent in Nigeria and when intercropped with other crops it insures them against total crop losses. Moreso, producing cassava under different mixed cropping conditions also impacts on resource-use in cassava production and consequently crops' yields. It is, therefore, necessary to examine the productivity of cassava farmers under different cropping systems as this will help highlight those areas or variables that could be better managed to improve the productivity of cassava farms in Nigeria. Hence, understanding crop production systems and the determinants of farm-level productivity of cassava under these systems will give insight into how farmers' outputs could be expanded with existing levels of conventional inputs and technology.

Material and Methods
The study was conducted in Lapai and Wushishi Local Government Areas of Niger State, Nigeria. The State lies on latitude 8° 20 N and 11° 30 N and longitude 3° 30 *and* 7 °40 E of the equator and it is bordered on the North-east by Kaduna State, and on the South West by the Federal Capital Territory Abuja. It is also bordered on the North, West, South West and South by Zamfara, Kebbi, Kogi and Kwara State respectively. It has an

estimated land area of 86,000km square of which about 85% is arable. The State's potential for *Fadama* development, and pasture and range management are also enormous.

Sampling Procedure

A multi-stage sampling technique was used for this study. Niger State has 25 LGAs and is divided into three agricultural zones A, B and C. The first stage involved the selection of zones A and C. Lapai and Wushishi LGAs were then purposively selected from each of the selected zones in the second stage based on their agrarian nature and large production of cassava (Wikipedia 2010). In the third stage, 2 town/villages were randomly selected from each of the selected LGAs which included Cheche and Duma in Lapai, and Lokogoma and Madegi in Wushishi. The total number of farmers selected in each of the LGAs was obtained from total number of registered cassava farmers in the study area using the Yamane's formula at 5% limit or tolerable error. The selected farmers were further stratified into two, that is, sole croppers and mixed croppers based on their response/indication during the data collection. There were 37 sole croppers and 83 mixed croppers given a total of 120 croppers.

$$n = \frac{N}{1 + N(e)^2}$$

Where

N = sample size

N = population size (registered farmers)

e = limit or tolerable error

Method of Data Collection

Primary data were used for this study. The cross-sectional data for the 2017/2018 production season were collected from the sampled cassava farmers in the study area with the aid of structured questionnaire. This was complimented with interview schedules. Resident extension agents and trained enumerators were employed to assist during the data collection.

Analytical Techniques

Analytical tools included descriptive statistics, and total and partial productivity indices. The analysis involved two stages. The first stage involved the determination of the farm-level productivity of the cassava farmers using the total factor productivity index. The total factor productivity index (TFPI) formula used was adopted from Mohammad (2017) and modified thus:

Farm size productivity $= \frac{Total\ cassava\ output\ (kg)}{Total\ farm\ size\ (ha)}$

Labour productivity $= \frac{Total\ cassava\ output\ (kg)}{TotalLabourused\ (manday)}$

Seed productivity $= \frac{Total\ cassava\ output\ (kg)}{Quantity\ seed\ used\ (kg)}$

Agrochemical productivity $= \frac{Total\ cassava\ output\ (kg)}{Quantity\ of\ agrochemical\ used\ (litre)}$

Total Factor Productivity Index $= \frac{Value\ of\ cassava\ output\ (₦)}{Value\ of\ inputs\ employed\ (₦)}$

The second stage involved the analysis of the determinants of farm-level productivity of the farmers with the use of ordinary least square regression analysis. The model is specified implicitly as:

$Y=f(X_1, X_2, X_3, X_4, X_5, X_6, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14})$

The explicit form of the model is specified as:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \cdots + \beta_n X_n + \mu$ (Linear)

$lnY = ln\beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \cdots + \beta_n lnX_n + \mu$ (Double-log)

$lnY = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \cdots + \beta_n X_n + \mu$ (Exponential)

$Y = ln\beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \cdots + \beta_n lnX_n + \mu$ (Semi-log)

Where,

Y = Total Factor Productivity Index

X_1 =Farm size(Ha)

X_2=Labour (Manday)

X_3=Stem cuttings (kg)
X_4= Capital input (Depreciation) (₦)
X_5=Agrochemicals (Litre)
X_6= Age of farmers (Years)
X_7= Sex (Male=1, 0 otherwise)
X_8= Household size (No.)
X_9= Educational level (Years of schooling)
X_{10}= Marital status (Married=1, 0 otherwise)
X_{11}= Farming experience (Years)
X_{12}= Amount of credit accessed (₦)
X_{13}=Extension contact (No.)
X_{14}= Membership of association (Member=1, 0 otherwise)
e_i= Random error term Cassava output (kg)
β_0=Constant
$\beta_1-\beta_n$=regression coefficients
X_1-X_n= Independent variables
Ln=Natural Logarithm

Results and Discussion

Summary statistics of inputs used and the corresponding cassava output under sole cropping system
The summary statistics of input used by the cassava farmers under sole cropping system in the area and the corresponding output are presented in Table 2. It revealed that cassava output among the farmers ranged from a minimum of 747.96kg to a maximum of 9469.04kg and the average output was estimated to be 3356.26kg. The farm size cultivated also ranged from 0.4ha to 4.0ha with a mean of 1.56ha. This is an indication that cassava farmers were small scale farmers. The total labour used ranged from 15mandays to 351.25mandays with a mean of 146.63mandays while the average amount spent on stem cutting planted by farmers was about ₦2345.95. The estimated average agrochemicals and capital input used by the farmers were 10.32liters and ₦4601.48, respectively. All these manifested the characteristics of small-scale farming in developing countries and hence, confirmed that the cassava farmers under the sole cropping system were small-scale farmers.

Summary statistics of inputs used and the corresponding cassava output under mixed cropping system
The summary statistics of input used by the cassava farmers under mixed cropping system in the study area and the corresponding output are presented in Table 3. It revealed that cassava output of the farmers ranged from a minimum of 747.96kg to a maximum of 13975.3kg and the average output estimated to be 3811.89kg. The farm size cultivated also ranged from 0.4ha to 6.0ha with an average of 1.68ha. For labour, the results revealed an average of 177.23mandays with the usage amount ranging from 6 mandays to 859.75mandays. More so, the average amount spent on stem cutting planted by farmers was about ₦3872.17. The estimated average agrochemicals used by the farmers was 9.21liters. Results further showed an average capital input of ₦4400.61 while the maximum farm size of 6 ha showed that some of the farmers operated beyond small-scale farming when compared with sole cropping system.

Analysis of productivity indices of cassava farmers under sole and mixed cropping systems: Effort was made to ascertain the cassava farmers' productivity in study area particularly taking into consideration the various input employed. The result of the analysis of the productivity is as presented in Table 4. It was revealed that the partial productivity of most of the inputs were higher in mixed cropping system than in sole cropping system except for farm size productivity. In mixed cropping system the highest partial productivity was agrochemical while the lowest was seed. In sole cropping system however, the highest partial productivity was farm size while the lowest was also seed productivity. The total productivity index which takes into account the monetary value of the total inputs employed in the cassava production and the corresponding output was estimated to be 4.72 when pooled together. This showed that the value of cassava output is at least 4 times greater than the value of input employed. It therefore implies that the productivity of cassava in study area was relatively high. Summarily, for both cropping systems, the cassava farmers were productive in the use of the available resources at their disposal. However, there is still room for improvement.

Factors affecting the farm level productivity of cassava farmers under the sole cropping system

The result of the factors affecting the farm level productivity of the cassava farmers under the sole cropping system is shown in Table 5. Four functional forms of the ordinary least square regression model were analyzed and the double log function was chosen as the lead equation based on R^2 value, the number of significant variables and value of the F-Ratio. The higher the value of R^2, the better the "goodness of fit" of the regression plane to the sample observations. The R^2 value of 0.8927 implied that 89.27% of the variations in the productivity level of the cassava farmers was explained by the include explanatory variables while the 10.73% deficit was as a result of factors not accounted for in the research as well as error in estimation. Out of the 14 explanatory variables included in the model, 10 of the variables were significant at various probability levels. Farm size, level of education and years of cassava farming experience were all positive and significant at $p < 0.01$; labour and capital inputs were positive and significant at $p < 0.05$ while membership of cooperative society was also positive and significant at $p < 0.10$. This implied that a percentage increase in all of these variables led to 1.21, 0.10, 0.39, 0.06, 0.05 and 0.09 percent increase in the productivity level of the cassava farmers. It is expected that productivity will increase if more experienced and educated farmers cultivate greater hectares of farm land. Education plays a key role in dissemination of information and communication on new technologies and thus will aid higher productivity of the farmers. This is in consonance with the findings of Atagher and Okorji (2014) who reported that educational level increased the productivity level of farmers in the area. However, age and agrochemicals were both negative but significant at $p < 0.01$ and $p < 0.05$, respectively. That is, a one percent increase in any of these variables led to 0.89% and 0.11% decrease in the productivity level of the cassava farmers in the area, respectively. This follows the *a priori* expectation because the older the farmer, the lower the productivity level. In the same vein, an excess application of agrochemicals could have negative effect on the farmers' output and hence, lowered the productivity level of farmers. This finding is in agreement with the findings of Kingsley and Charles (2013) who reported that increase in chemicals application to crops decreases the productivity of farmers and that age plays a negative role in productivity.

Factors affecting the farm level productivity under cassava mixed cropping

Result in Table 6 revealed the determinants of productivity of the farmers under the mixed cropping system. The semi-log function gave the best fit based on R^2 value, the number of significant variables and the significance of the coefficients which was used for further discussion. The R^2 value of 0.5435 implied that 54.35% of the variations in the productivity level of the cassava farmers under mixed cropping system were explained by the included independent variables. The result revealed that three variables namely farm size, agrochemical and household size were found to be statistically significant at $p < 0.01$, respectively. This implied that a one percent increase in farm size increased the total factor productivity of farmers by 0.026%. Farmers who had the monetary resources and able to increase their farm size had the tendency to increase farm output and productivity. This agrees with the findings of Atagher and Okorji (2014), Obasi *et al.* (2013) and Mohammed and Mehmet (2018) who asserted that increase in farm size and household size increased the productivity of the farmers. Furthermore, age was negative but significant at $p < 0.05$ and sex at $p < 0.10$ levels, respectively. Table 5 further showed that agrochemical was negative but significant at 1% with a estimated coefficient of -0.6486. This was an indication that as agrochemical increased by one percent, holding other variables constant, the total factor productivity reduced by 0.065%. This is in agreement with the findings of Obasi *et al.* (2013) who reported that increase in chemicals decreased the productivity of farmers. Age with an estimated coefficient value of -4.6618 was negative but significant at $p < 0.05$. This implied that as age increased by one percent, the total factor productivity decreased by 0.047%. As the cassava farmers advanced in age they became less efficient in farming activities.

Conclusion and recommendation

The results of the summary statistics revealed that the mean output of farmers under mixed cropping system was higher than that of the sole cropping system and that sole croppers operated mostly on small-scale while mixed croppers operated beyond small-scale. The mean inputs used by mixed croppers were mostly higher than that of the sole croppers. The result of the factors affecting the farm level productivity of the cassava farmers revealed an R^2 of 89% for sole croppers and 54% for mixed croppers which showed that most of the variables included in the model for sole croppers explained the variation in the productivity of the cassava farmers. 'Furthermore, for both cropping systems, farm size, agrochemical, age, sex and household size were common determinants while sole cropping system had additional determinants which included labour, stem cuttings, capital inputs, educational level, marital status, years of farming experience, and membership of cooperative society at different probability levels. In the light of the findings of the study, it is recommended that farmers in the study area should be encouraged to practice cassava mixed cropping production as this will not only increase their productivity level and net farm income but help in income diversification as a coping strategy against production risk.

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Table 1: Distribution of sample size from sample frame

Agricultural zone	LGA	Villages	Sample frame	Sample size
Zone 1	Lapia	Cheche	43	30
		Duma	36	25
Zone 3	Wushishi	Lokogoma	41	29
		Madagi	52	36
Total			**173**	**120**

Source: Agricultural Development Programme, 2018

Table 2: Summary statistics of inputs used and the corresponding cassava output under sole cropping system

Variables	Mean	Standard deviation	Minimum value	Maximum Value
Output(kg)	3356.26	1878.76	747.96	9469.04
Farm size(ha)	1.56	0.72	0.40	4.00

Labour(man day)	146.63	91.72	15.00	351.25
Stem cutting(₦)	2345.95	2543.36	0.00	8000.00
Capital input(₦)	4601.48	2063.81	121.00	10837.50
Agrochemicals(litres)	10.32	6.89	0.00	30.00

Source: Field Survey, 2018

Table 3: Summary statistics of inputs used and the corresponding cassava output under mixed cropping system

Variables	Mean	Standard deviation	Minimum value	Maximum value
Output(kg)	3811.90	2203.37	747.96	13975.30
Farm size(ha)	1.68	0.95	0.40	6.00
Labour (man day)	177.23	144.06	6.00	859.75
Stem cutting (₦)	3872.17	3939.14	0.00	17000.00
capital input (₦)	4400.61	2477.35	1287.14	16747.00
Agrochemicals(litres)	9.21	7.40	0.00	40.00

Source: Field Survey, 2018

Table 4: Factor productivity indices of cassava production in the study area

Variables	Sole	Mixed	Pooled
Farms size productivity(kg/ha)	9470.95	11668.44	10990.88
Labour productivity (kg/man-day)	51.88	87.10	76.86
Stem cutting productivity(kg/Naira)	2.09	3.47	3.12
Agrochemical productivity(kg/Litre)	1168.02	1953.31	1710.58
Total factor productivity	4.09	4.18	4.72

Source: Field Survey, 2018

Table 5: Multiple regression results of factors affecting the farm level of productivity in cassava sole cropping

Variables	Linear Coefficient (t- value)	Double-log Coefficient (t- value)	Exponential Coefficient (t- value)	Semi-Log Coefficient (t- value)
Constant	2.2732 (1.14)	4.0584 (4.65)	0.8679 (2.62)	16.3332 (2.81)
Farm size	3.2078 (4.17)***	1.2172 (7.17)***	0.5713 (4.47)***	6.3647 (5.63)***
Labour (manday)	0.0021 (0.54)	0.0580 (2.12)**	0.0002 (0.23)	0.2742 (1.50)
Seed/stem cutting	0.0002 (1.11)	0.0092 (1.34)	0.0001 (1.69)*	16.3333 (2.81)**
Capital input	0.0001 (0.12)	0.0496 (2.68)**	5.73e-06 (0.21)	0.2323 (1.89)*
Agrochemicals	-0.1140 (-2.16)**	-0.1077 (-4.54)***	-0.0252 (-2.88)**	-0.6029 (-3.81)***
Age	-0.1127 (-2.01)**	-0.8857 (-2.89)**	-0.0207 (-2.23)**	-3.8732 (-1.90)*
Sex	-0.6777 (-0.63)	-0.8201 (-2.24)**	-0.0180 (-0.10)	0.5719 (-2.35)**
Household size	-0.0357 (-0.44)	-0.1985 (-1.59)	-0.0030 (-0.22)	-1.3924 (-1.68)*
Educational level	0.1406 (1.86)*	0.1004 (4.26)***	0.0327 (2.61) **	0.4912 (3.13)***
Marital status	1.3420 (1.05)	0.1300 (2.44)**	0.1495 (0.71)	0.8403 (2.37)**
Farming experience	0.1918 (3.29)***	0.3878 (4.30)***	0.0374 (3.87)***	1.9480 (3.24)***
Accessibility to credit	-6.53e-06 (-0.57)	-0.2484 (-1.54)	-1.62e-06(-0.86)	-0.0845(-0.79)
Extension service	0.0129 (0.12)	0.0061 (0.36)	0.0024 (0.13)	0.0346 (0.31)
Cooperative membership	1.2044 (0.92)	0.0896 (1.68)*	0.2735 (1.26)	0.3118 (0.88)
R^2	0.7706	0.8927	0.8327	0.8199
R^2 Adjusted	0.6246	0.8244	0.7262	0.7053

F ratio	5.28	13.07	7.82	7.16

Source: Field Survey, 2018

Table 6: Determinants of farm level productivity ofcassava farmers under mixed cropping system

Variables	Linear Coefficient (t- value)	Double-log Coefficient (t- value)	Exponential Coefficient (t- value)	Semi-Log Coefficient (t- value)
Constant	6.5970 (4.26)	3.5623 (2.48)	1.5794 (5.13)	21.1933 (2.89)
Farm size	1.510404 (2.62)**	0.4540 (3.10)***	0.2579 (2.24)**	2.6046 (3.49)***
Labour(man day)	0.0003 (0.10)	0.0727(0.81)	0.00000453 (0.01)	0.5716 (1.25)
Seed stem	0.00001 (1.48)	0.0195 (2.38)**	0.000015 (1.12)	0.0845 (2.02)
Capital input	0.00008 (0.62)	0.0046 (0.04)	0.000011 (0.44)	0.0866 (0.16)
Agrochemical	-0.1669 (-3.30)***	-0.1004 (3.60)***	-0.02307 (-2.29) **	-0.6486 (-4.56)***
Age	-0.1086 (-2.26)**	-0.6061 (-1.76)*	-0.0150 (-1.57)	-4.6618 (-2.50)**
Sex	1.2944 (1.55)	0.0368933 (1.12)	0.2759 (1.68)	0.1975 (1.71)*
Household size	0.1270 (2.24)**	0.3464 (2.92)**	0.0186 (1.75)	2.1416 (3.54)***
Education level	-0.1440 (-2.41)	-0.0034 (-0.16)	-0.0292 (-2.46)**	-0.0575 (-0.52)
Marital status	1.0186 (1.19)	-0.0136 (-0.35)	0.2505251 (1.48)	-0.1519 (-0.78)
Farming experience	0.0682 (1.23)	-0.0037 (-0.03)	0.0096 (0.87)	0.1355 (0.21)
Credit	-0.00000229 (-0.12)	0.0134869 (0.79)	0.0000006 (0.17)	0.0735 (0.84)
Extension service	0.0237 (0.32)	0.0079 (0.50)	0.0026 (0.18)	0.0123 (0.15)
Cooperative member	-0.1986949 (-0.18)	-0.0246 (-0.43)	0.0170 (0.08)	0.2601 (0.89)
R^2	0.4722	0.5061	0.4113	0.5435
R^2 Adjusted	0.3635	0.4044	0.2901	0.4496
F ratio	4.35	4.98	3.39	5.75

Source: Field Survey, 2018

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Decomposed Banana Peels and NPK Fertilizer on Soil Fertility Properties, Growth and Yield of Groundnut (*Arachis hypogaea*) in Unwana, South Eastern Nigeria

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Abstract
The study to investigate the effect of decomposed banana peel (DBP) and NPK fertilizer on soil chemical properties, growth and yield of groundnut was carried out in the Green House, Teaching and Research Farm of the Department of Horticulture and Landscape Technology, Unwana. The treatments comprised of three rates (0, 1 and 2 ton ha^{-1} DBP) and three rates (0, 1 and 2 ton ha^{-1} NPK) arranged in a factorial pattern. Results showed that at ($p < 0.05$), the application of these materials as lone and combined treatments significantly influenced soil chemical properties including organic carbon, organic matter, total nitrogen, available phosphorus, exchangeable bases, exchangeable acidity, effective cation exchange capacity and base saturation. Similarly, plant parameters such as plant height, number of leaves and number of pods were significantly improved. Two ton ha^{-1} DBP and 1ton ha^{-1}NPK gave the best results in both soil chemical properties and plant growth properties, thus it is therefore recommended for profitable and sustainable groundnut production in Unwana, Southeastern Nigeria.

Keywords: Banana peels, soil fertility and Groundnut

Introduction
Soil fertility deterioration as a result of intensive cropping and high leaching potentials of ultisols of South-eastern Nigeria has not only adversely affected crop production but has become a threat to food security and national integrity. Sustained crop production in this highly weathered acidic soil will be a mirage if external fertilizer input is not done regularly. Studies have shown improved crop productivity when fertilizer materials either minerals or organic are applied to these soils (Azu *et al*., 2017; Osodeke and Ubah, 2005)). Mineral fertilizer consists of about 85% of the global fertilizer use (FAO, 1976). However, persistence mineral fertilizer use has most times resulted into loss of soil quality and serious environmental pollution. Due to soil acidity and nutrient imbalance often created by the aggressive use of inorganic fertilizers, there is renewed interest in the use of organic manures as soil improvers and source of nutrients (Awodun, 2007).Organic fertilizers increase the organic carbon pool and soil pH; improves the soil structure, decreases bulk density, provides macro and micro nutrients, enhances microbial activity and provides soil with long term fertility effect (Ghabbour and Davis, 2001). The increased generation of agricultural wastes such as banana peels, rice husk etc. in South-eastern Nigeria has become a problem to human beings and the environment and therefore calls for effort to be geared towards its alternative meaningful utilization. Under this circumstance, it is essential to consider using some of these wastes as organic manures in fertilizing the soils to enhance crop production. One of such locally available organic matter source which has received little or no attention in this agro-ecological zone is banana peel. Banana peel is rich in several nutrients thus can provide a healthy nutrients source to soil (Neha, 2015). Just like most other organic materials, the problem in the use of banana peel may be difficulty in obtaining large quantity for commercial crop production (Azu *et al*., 2017). Therefore, the alliance for green revolution in Africa has adopted integrated soil fertility management as base for increasing crop productivity and restoring soil fertility. This strategy aims to combine organic and inorganic fertilizers, which results in a synchronized nutrient release and uptake by the crop. Study has

shown lower cost benefit ratio and superior effect with the supplementation of organic and inorganic fertilizers compared toeither of the amendment alone. (Ano and Asumugha 2000).

Groundnut (*Arachis hypogaea*) is one of the most important oil seed traditionally grown by smallholder farmers in the tropics. It is an important food crop and a source of both fat and protein and mostly locally utilized for nutrition (Ibrahim and Eleiwa, 2008; Okello*et al*., 2010) as well as raw material for industrial produce such as animal feed and confectionery. Groundnut production in South-eastern Nigeria in recent years has declined. This low productivity has been attributed to declining soil quality especially, loss of organic matter, soil acidity and inappropriate mineral fertilizer application practices (Compaore, 2011).
In view of this situation, there is urgent need to increase the organic matter base of these soils and also to provide proper, rational and sustainable fertilizer management policies and strategies for profitable groundnut production in South-Eastern Nigeria. This study therefore seeks to establish information on the integrated effect of decomposed banana peel (DBP) and NPK fertilizer on soil chemical properties and yield of groundnut in Unwana, South-eastern Nigeria

Materials and Method
The study was carried out in the Green House of Akanu Ibiam Federal Polytechnic, Unwana, (latitudes 5 ^{o} 48N and longitude 7 ^{o} 55E). The climate and vegetation types are generally humid tropical rainforest with mean annual rainfall of about 3,500mm and mean daily temperature range of 27^{o}C to 38^{o}C (Njoku 1996).. Most soils of this area belong to the order “Ultisol” and are classified as typic Hapludult (Ebeniro, 2009). The soil sample for the experiment was collected from the Research Farm of Horticulture and Landscape Technology Department using soil auger at 0 – 20cm. 5Kg of each was weighed into 27 polyethylene bags perforated at the bottom. The banana peels were collected from the waste dump sites in the Polytechnic and Unwana community. The peels were decomposed in a closed perforated container for two months. Adequate turning and watering to promote microbial decomposition were observed during the incubation period. Appropriate weights of decomposed Banana peels and NPK fertilizer were added to each polyethylene bag (plant pot). The treatments comprised of three rates (0, 1 and 2 t/ha) DBP and three rates (0, 1 and 2 t/ha) NPK fertilizer arranged factorially in Complete Randomised Design in three replications. Two Groundnut seeds were sown in each of the polyethylene bag (planting pot) one month after treatment application and later thinned down to one seedling per pot, two weeks of germination. The following growth and yield parameters were taken three months after planting:Plant height, Numbers of leaves, Numbers of pods.Post-harvest soil samples were collected from each pot and the following chemical analysis were carried out: soil pH was determined in soil to water and soil to $CaCl_2$ at a ratio 1:2 soil water and soil $CaCl_2$ respectively using glass electrode P^H meter (Udo *et al*; 2009).Organic carbon was determined by the wet oxidation method according to Pansu and Gautheyrous (2006) and converted to organic matter by multiplying by 1.792. The total nitrogen determination was done by the macro Kjeidahl digestion method (Simmone *et al.,* 1994). Available P was determined using the Bray II method of Bray and Kurtz (1945) as described by Udo *et al*; (2009). Exchangeable acidity was determined by the nikel extraction procedure as described by Udo *et al*., (2009). Exchangeable basic cations (K^+, Ca^{2+}, Mg^{2+}, Na^+) were determined by the ammonium acetate method (Carter and Gregoich, 2008). Ca and Mg in the extract were determined using the atomic absorption spectrophotometer, while K and Na were determined using the flame photometer. Effective cation exchange capacity **(**ECEC) was obtained by summation of all the exchangeable cations and exchangeable acidity as described by Udo, *et al*; (2009). The base saturation was obtained mathematically with

$$BS (\%) = \frac{\text{Total cation}}{\text{ECEC}} \times \frac{100}{1}$$

Statistical Analysis: Data from agronomic parameters and soil chemical properties were subjected to analysis of variance (ANOVA) and the means separated using FLSDO 0.005.

Results and Discussion
The textural class was a clayey-loam and the pH indicated acidic both in water and in $CaCl_2$(Table 1). These results corroborated with the findings of earlier researchers on soils of Unwana, (Azu*et al*., 2017; Azu *et al*., 2016). While the organic carbon, organic matter and total nitrogen were moderately high, the available phosphorus was low (7.53 mg/Kg). The high clay content with their corresponding high concentrations of Fe^{2+} and Al^{+3}oxidesfavour Psorption and thus low available P (Osodeke and Ubah, 2005; Azu *et al*., 2017;

Cessa*et al*., 2008). Total exchangeable bases were moderately high, with (Ca^{2+}) occurring more than others (3.21 cmol/Kg). This may be related to high occurrence of limestone in most soils of Ebonyi State. The exchangeable acidity was high (3.04 cmol/Kg), owing to the high concentration of sexquoxides in the soil. The effective cation exchange capacity (ECEC) and base saturation were moderately high (8.36 cmol/Kg and 63.64% respectively). Results showed that the DBP was alkaline (Table 1) both in water and salt (8.50 and 7.40 respectively) which is an indication of its potentials in reducing soil acidity and a suitable replacement for commercial lime.Organic carbon and organic matter were high. Other researchers have also reported high concentration of organic carbon and organic matter in banana peels (Hapsoh and Muhammad, 2015; Neha, 2015).

The nitrogen, available P and the basic cations were high. The high nutrient content in banana peels if appropriately harnessed can provide nutrients to both soil and growing plants in the nutrient deficient and poor structured soils of South-eastern Nigeria.

Effect of Composted Banana Peels and NPK on Soil Chemical Properties: Significant ($p < 0.05$) effect on pH by the addition of both fertilizer materials was observed. Composted banana peel (DBP) consistently showed greater increases in pH than NPK fertilizer (Table 2). This observation may be due to the high organic matter and cations (K^+, Ca^{2+}, Mg^{2+}) content of banana peels (Khaerunnisa and Rahmawati, 2013). Other researchers have reported alkalinity in soils treated with compost made from banana peels (Nur, 2008; Hapsoh and Muhammad, 2015).Organic carbon and organic matter were greatly improved by the application of DBP than NPK and the improvement increased with increased rate of addition.At ($p < 0.05$), only the effect of DBP was significant in influencing both organic carbon and organic matter. Banana peel, being a plant material contains high amount of organic matter (Neha, 2015; Hapsoh and Muhammad, 2015), thus can improve the carbon content of soils. The total nitrogen content of the soil was increased by the application of DBP and NPK both as lone treatments and as combined treatment. The main and interactive effects of the treatments were statistically significant ($p < 0.05$) in influencing the nitrogen content of the soil. Significant variation on P with CBP and NPK as single and combined treatments was observed. The high occurrence of organic matter in banana peel must have influenced the available P content since organic matter reduces phosphorus fixation by competing with phosphorus at the adsorption site of soil minerals (Azu *et al*., 2017).Exchangeable bases were increased by the application of DBP and NPK with DBP showing superior effect.Similarly, the high organic matter content and the subsequent mineralization to release nutrients such as cations may be responsible to this observation (Azu*et al*., 2017).Hapsoh and Muhammad, (2015) and Neha, (2015) have also reported high cations in composted banana peels and therefore recommended its inclusion as soil improvers. The ECEC and base saturation where significantly influenced by DBP application. The basic cation concentration and percentage base saturation were highest in the treatment that had 2 ton ha^{-1} DBP and 1 ton ha^{-1} NPK. These results agreed with the findings of other researchers (Awodun, 2007; Azu *et al*., 2017) who reported greater improvement when organic manures are integrated with mineral fertilizers in the farming system than when they are applied singly.

Effect of Composted Banana Peels and NPK on Number of Leaves, Plant Height, and Number of Pods: The mean number of leaves, plant height and number of pods of Groundnut as affected by DBP and NPK fertilizer application at different rates is presented in Figure 1.The highest number of leaves (84.62) and plant height (58.00) on the average occurred in pot treated with 2tons ha^{-1} each of DBP and NPK. However, the mean highest number of pods (46.00) was observed in pot treated with 2tons ha^{-1} CBP and 1tons ha^{-1} NPK fertilizer. The significant increase on the growth and yield parameters groundnut observed with the application of both fertilizer types as compared with the control might be due to the high nutrient content in both materials especially nitrogen, potassium and phosphorus.

Conclusion

Soil fertility restoration in the mist of current fertility decline occasioned by excessive weathering, leaching and plant removal in ultisols of South-eastern Nigeria is a necessary option for improved soil fertility and sustained crop production. Banana peel is an organic matter source which has remained under utilized. This study investigated the integrated effect of banana peel and NPK fertilizer on some soil fertility indices, growth and yield of groundnut. The results obtained showed that the application of the fertilizer materials both as lone and combined treatments improved the soil chemical conditions and the yield of groundnut. The application of DBP specially increased the organic carbon, organic matter and the other nutrient elements more than the NPK fertilizer. Treatment combination of 2 ton ha^{-1} DBP and 1 ton ha^{-1} NPK proved to be superior to other treatment combinations in influencing the properties studied and is therefore recommended for optimum yield of groundnut in Unwana.

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Table 1. Some properties of the Soil and Decomposed Banana Peels used for the Study

Properties	Soil	Composted Banana Peel
Sand %	39.98	-
Silt %	16.35	-
Clay %	43.67	-
Texture	Clayey-loam	-

pH (H_2O)	5.14	8.50
pH ($CaCl_2$)	4.08	7.40
Organic Carbon %	2.55	4.90
Organic Matter %	4.42	8.49
Total Nitrogen %	0.23	1.37
Available Phosphorus mg/kg	7.53	19.36
Ca^{2+}Cmol/Kg	3.21	4.17
K^{+}Cmol/Kg	0.16	6.63
Mg^{2+}Cmol/Kg	1.94	3.32
Na^{+}Cmol/Kg	0.01	4.25
TEACmol/Kg	3.04	-
ECECCmol/Kg	8.36	-
BS %	63.64	-

TEA = Total Exchangeable Acidity, ECEC = Effective Cation Exchange Capacity, BS = Base Saturation.

Table 2. **Soil Chemical Properties as Influenced by Composted Banana Peels and NPK**

Treatments	Soil Properties									
CBP + NPK	pH H_2O	pH Cacl₂	OC %	OM %	TN %	AP mg/kg	TEB Cmol/kg	TEA Cmol/kg	ECEC Cmol/kg	BS %
0 + 0	5.06	4.04	2.04	3.54	0.13	6,33	4.03	3.04	7.07	56.97
0 + 1	4.98	4.03	1.85	3.20	0.22	6.96	3.85	2.93	6.87	56.08
0 + 2	4.89	3.88	1.95	3.37	0.26	7.07	3.80	2.75	6.54	57.97
1 + 0	5.26	4.98	2.67	4.63	0.19	6.81	4.78	2.66	7.44	64.25
1 + 1	5.41	4.98	2.91	5.05	0.23	7.26	5.06	2.55	7.61	66.51
1 + 2	5.22	5.07	2.69	4.67	0.29	8.00	4.96	2.47	7.43	66.72
2 + 0	6.15	4.95	3.36	5.82	0.24	7.40	6.16	2.28	8.43	73.00
2 + 1	6.32	5.36	3.60	6.25	0.28	8.27	7.37	2.19	9.57	76.79
2 + 2	6.18	5.62	3.50	6.07	0.31	8.85	6.71	2.08	8.79	76.33
Mean	5.50	4.88	2.73	4.73	0.24	7.44	5.19	2.55	7.52	66.07
LSD(0.05)CBP	0.057	0.072	0.119	0.205	0.013	0.117	0.433	0.058	0.456	1.245
LSD(0.05)NPK	0.057	0.072	NS	NS	0.013	0.117	NS	0.058	NS	NS
(CBP X NPK)	NS	0.125	NS	NS	0.022	0.203	0.119	NS	NS	NS

Where CBP is composted banana peel, OC is organic carbon, OM is organic matter, TN is total nitrogen, AP is available phosphorus, TEB is total exchangeable bases, TEA is total exchangeable acidity, ECEC is effective cation exchange capacity and BS is base saturation.

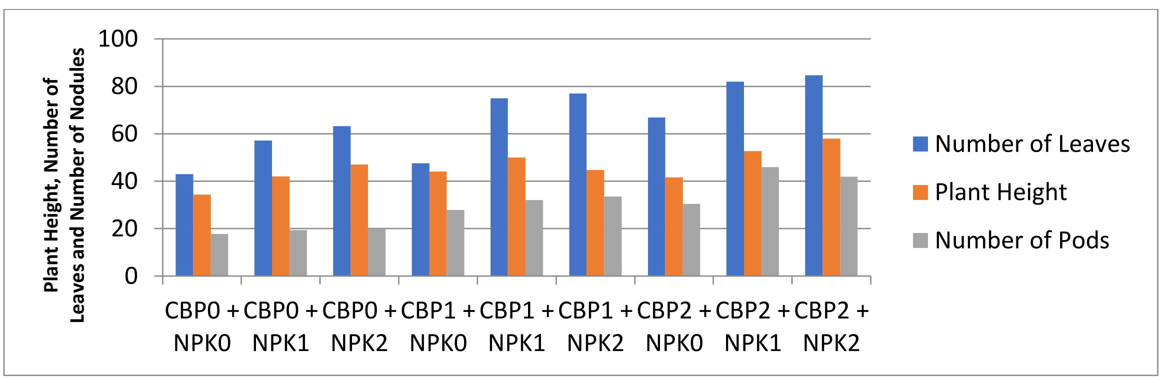

Figure 4.4: Effect of Composted Banana Peel and NPK on Plant Height, Number of Leaves and Number of Nodules.
CBP = Composted Banana Peel, NPK = Nitrogen-Phosphorus-Potassium Fertilizer.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effect of Different Levels of Phosphorus on Growth and Yield of Chickpea (*cicer arietinum* l.) Varieties in Sudan Savanna Agro Ecology

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Abstract
The research was conducted at the Jigawa State College of Agriculture Research Farm Hadejia, (Latitude of 12^0 22′N and 12^0 24′ N and longitude of 7^0 46′ E and 10^0 E) and Jigawa State Research Institute Farm Kazaure (latitude of 12^o 28’ and 12^o 32’ and longitude of 8^o 10’ and 8^o 38’ E), in the Sudan savannah ecological zone of Nigeria. The aim was to study the effects of phosphorus fertilization on growth and yield of three chickpea (*Cicer arietinum* L.) varieties. The treatments consisted of combinations of three chickpea varieties (ICCV 97105, ICCV 93954 and ICCV 95423), and four levels of phosphorus (P_2O_5) (0, 20, 40 and 60kg/ha). The treatments were factorially combined and arranged in a split plot design; Varieties were assigned to the main plots while levels of phosphorus were placed in the subplots with three replications. Based on the results of this study, chickpea variety ICCV 93954 outperformed other varieties ICCV 97105 and ICCV 95423 in terms of growth and yield characters all through. phosphorus application at 40kg P_2O_5 ha^{-1} seems to be optimum for chickpea growth at both Hadejia and Kazaure. Chickpea variety ICCV 93954 was superior to ICCV 95423 and ICCV 97105 because it responds more to phosphorus application and therefore yielded higher than other two varieties. Phosphorus fertilization at the rate of 40kg P_2O_5 ha^{-1} was found to be significantly superior for the crop’s growth and yield.

Key words: Chickpea Varieties Growth Yield and Phosphorous

Introduction

Chickpea (*Cicer arietinum* L.) is a grain legume crop belonging to the fabaceae family (Kupicha, 1981) believed to have originated from Asia and Mediterranean region (Kay, 1979). It is mainly grown during summer in temperate countries and as a winter crop in tropical climates. The crop is one of the most important among pulses in the Indian subcontinent and in North Africa where it is cultivated on residual soil moisture, under irrigation or as a rain fed legume. In Nigeria, it is cultivated on a minor scale in parts of Jigawa, Kano, Yobe and Bauchi State (Anonymous, 1988). The crop is grown primarily for its nutritional value. Due to its high protein content, it is an economic source of quality vegetable protein in the human diet. Chickpea seed contains 21% protein, 61% carbohydrate, and 2.2% oil (Muhammad 1998). In the Indo-Pakistan subcontinent, the seed is eaten as split peas or ‘dhal’ while in Europe and U.S.A it is cooked and eaten whole in salads. In Nigeria, *“moi moi”* and *“akara”* have successfully been prepared with chickpea. The crop has high digestibility and relative freedom from flatulence factors. It is also richer in calcium and phosphorous than other grain legume (Pushpamma and Gervani, 1987). Chickpea is a herbaceous annual 30 - 70cm in height. It has a deep tap root system with lateral roots which develop nodules with symbiotic *Rhizobium spp.* The nodules (slightly flattened, fan-like lobes) are visible about one month after plant emergence, and generally confined to the top 15cm of the surface. The plant surface is densely covered with fine hairs known as trichomes. They have 1 – 8 primary, secondary and tertiary branches. Plants could be erect, semi-erect, semi-spreading, spreading and prostrate. The erect and semi-erect varieties enable mechanical harvesting. The leaves are imparipinnate with 5 – 7 serrated leaflets that arise on alternate nodes from the third. Some varieties have simple leaves. Temperature, day length and availability of moisture are the three major abiotic factors affecting flowering. In general, flowering is delayed under low temperatures and also under short-days. Chickpea is sensitive to extreme temperatures and prefers temperature range of 35-15°C for optimum growth (Guar *et al*., 2010). Chickpea seedlings emerge hypogeally in 7-15 days after sowing depending on soil temperature and sowing depth. The duration of vegetative growth before flowering ranges from 40 to 80 days depending on the variety, location, availability of soil moisture and humidity and temperature. Chickpeas have typical papilionaceous flowers. Most cultivars produce a single flower at each flowering node. A few cultivars with two flowers per node (twin or double flowered) are also found. The flowers are pink, white or blue in color. Under favorable conditions, the time taken from fertilization to the first appearance of pod (pod set) is about 6 days. After pod set, pod wall grows rapidly for first 10 to 15 days while seed growth occurs later. Soon after development of pods and seed filling, senescence of subtending leaves begins. If there is plenty of soil moisture, flowering and podding will continue on upper nodes. Chickpea is harvested when 90% of the stems and pods lose their green color and turn light golden yellow (Guar *et al*. 2010). There are two types of chickpea, '*Desi*' and '*Kabuli*' types (Saxena, 1990). Although they are botanically similar, the seeds of '*Kabuli*' are larger and light coloured with ram head shape, smooth surface and white flowers. Application of phosphorus to legumes improves seed yield considerably (Hussain, 1983). Studies have shown that seed yield was increased significantly with *Rhizobium* inoculation and phosphorous application (Raut and Kohire, 1991). It has also been reported that nitrogen as a starter dose, along with phosphorous and seed inoculation, has a beneficial effect on the yield of chickpea (Patel and Patel, 1991). In view of the paucity of data on chickpea production in Nigeria, this study which is a preliminary step toward finding ways of increasing the crop's production, was carried out with the specific objectives to determine the growth and yield responses of chickpea varieties to inoculation and phosphorous fertilizer rates in Nigeria.

Materials and Methods

The experiment was conducted during 2018 rainy season at Binyaminu Usman Polytechnic Hadejia Research Farm (Latitude 12^0 22′N and 12^0 24′N and Longitude 7^0 46′ E and 10^0 E) and Jigawa State Research Institute Farm Kazaure. (Latitude 12^0 28′N and 12^0 32′N and Longitude of 8^0 10′E and 8^0 38′E). The soils of the sites were sandy loam. The treatments consisted of three chickpea varieties (ICCV 97105, ICCV 93954 and ICCV 95423), and four phosphorus levels (0, 20, 40 and 60kg $P_2O_5ha^{-1}$) arranged in a split plot design with three replications. Factorial combinations of variety were assigned to main plots while phosphorus occupied subplots. Main and subplots sizes were $12m^2$ and $8m^2$ respectively. Chickpea varieties used were sourced from International Crops Research Institute for Semi-Arid Tropics (ICRISAT).

ICCV 93954: semi erect, basal branching variety with small-sized and brown seeds. It is a *desi* chickpea adapted to rain-fed, irrigated and late-sowing situations with medium duration (80-100 days). It flowers between 35 to 45 days with potential seed yield of 3570kgha^{-1}(ICRISAT 1991). It has 21 % crude protein content and mean 100-seed weight of 18g (Khan, 2002).

ICCV 95423: *kabuli* type chickpea characterized by white or beige-colored seeds with ram's head shape, thin testa, smooth seed surface, white flowers, and lack of anthocyanin pigmentation on stem. The *kabuli* types have large sized seeds and commends higher market price than *desi* types. The price premium of *kabuli* chickpea increases with seed size (Guar *et al.,* 2010). The variety is resistant to insect pests, pod borer (*Helicoverpa armigera*). It is adapted to rainy and irrigation condition with potential grain yield of 2,850kgha^{-1}.

ICCV 97105: *desi* variety with brown seeds larger than ICCV 93954. It matures earlier and flowers within 40 days. It is suited to both rain-fed and irrigated conditions and adapted to medium and late sowing with a mean potential grain yield of 3220kgha^{-1} in India. Phosphorus fertilizer was broadcasted before sowing per treatment using single super phosphate (18% P). The experimental site was cleared and ploughed and harrowed to a fine tilth. The plots were laid out in form of basins with borders. Two seeds were sown per hole manually at 40cm inter row spacing and 20cm intra row spacing first week of August. All plots received a uniform basal application of nitrogenous fertilizer at 20kgNha^{-1} using Urea (46%N) as starter dose incorporated into the soil at planting. Crops were kept free of weeds by hand hoeing at 10 and 20 days after emergence and afterwards as need arose. Harvesting was done at maturity last week of November when pods dried and leaves senescence. The cut plants with pods were sun-dried before the pods were picked, threshed and winnowed manually.

Soil samples were collected randomly at depths of 0-15 and 15-30cm using tabular auger before fertilizer application. The samples were analyzed for physical and chemical properties using standard procedures. Ten plants were randomly tagged for growth data collection and yield was determined at harvest. All growth parameters were taken at 11 WAS except stand count taken at 4 WAS and at harvest. Stand count (plants m^{-2}), plant height (cm), number of branches per plant, number of days to 50% flowering, number of days to physiological maturity, number of nodules per plant, fresh weight of nodules per plant (g) and grain yield ($kgha^{-1}$). Data collected were subjected to analysis of variance (ANOVA) as described by Snedechor and Cochran (1967) using SAS version 9.1 (SAS, 2003). Treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Table 1 presents treatments variations on parameters assessed. Chickpea variety ICCV 93954 produced significantly higher number of nodules per plant and nodule fresh weight followed by ICCV95423, while the least value was recorded by ICCV 97105. The difference in number of nodules per plant among various phosphorus levels was also significant at both locations. Treatment with 60kg P_2O_5 ha^{-1} produced the higher number of nodules in Hadejia which was statistically at par with 40kg P_2O_5 ha^{-1}. The least number of nodules per plant was recorded in 0kg P_2O_5 ha^{-1} (control) which was statistically the same with treatment 20kg P_2O_5 ha^{-1}. Similar trend was recorded for Kazaure. Treatment interactions in number of nodules per plant were not significant at both locations Increasing phosphorus levels up to 40kg P_2O_5 ha^{-1} significantly increased number of nodules.. However, when the latter treatment was examined at fixed phosphorus level, The results also revealed that ICCV 93954 significantly outperformed ICCV 95423 and ICCV 97105 in all the yield characters studied at both Hadejia and Kazaure.. Phosphorus application significantly influenced all yield characters except number seeds per pod and 100-seed weight at both locations.

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Table 1: Response of chickpea varieties as influenced by phosphorus at Hadejia and Kazaure, Northwest, Nigeria 2018.

Treatment	Hadejia						Kazaure					
	Nodule number plant^{-1}	Nodule fresh weight plant^{-1} (mg)	Average pod weight	No of seeds pod^{-1}	100 seed weight	Grain yield (kg ha^{-1})	Nodule number plant^{-1}	Nodule fresh weight plant^{-1} (mg)	Average pod weight	No of seeds pod^{-1}	100 seed weight	Grain yield (kg ha^{-1})
Variety (V)												
ICCV 93954	18.7a	610.2a	18.8	1.1b	16.2b	3158.8a	18.8a	630.5a	19.9	1.3b	17.5b	3323.4a
ICCV 95423	17.3b	543.5c	19.6	1.5a	18.3a	2583.3c	17.5b	552.2c	20.4	1.4a	19.4a	2698.0c
ICCV 97105	17.7c	575.1b	18.9	1.5a	16.8b	3025.7b	17.9c	582.6b	19.2	1.7a	17.7b	3159.1b
SE±	0.44	42.21	0.43	0.07	0.81	420.02	0.98	26.23	0.58	0.15	0.90	260.24
Phosphorus (kg P_2O_5 ha^{-1})												
0	17.4b	553.8b	18.6b	1.2	17.1	2327.6c	18.0b	576.4b	19.4b	1.3	17.3	2454.2c
20	17.8b	578.9ab	19.0ab	1.3	17.8	2418.3c	18.5b	580.2ab	20.0ab	1.6	17.8	2592.1c
40	19.0a	590.2a	20.0a	1.4	18.6	2929.2a	19.9a	582.5a	21.5a	1.7	18.9	2994.2a
60	19.4a	598.2a	18.7b	1.3	17.3	2815.2b	19.6a	592.8a	19.9b	1.5	17.4	2880.1b
SE±	0.74	13.24	0.34	0.05	0.89	287.54	0.89	10.58	0.61	0.10	0.67	225.46
Interaction												
V X P	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	**

Means followed by the same letter (s) are not significant at 5% level of significant of probability using Duncan multiple range test (DMRT). NS = Not Significant

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effect of different organic manure on the growth and yield of Eggplant (Solanum melongena) in Umuagwo, South-Eastern Nigeria

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Abstract
The experiment was conducted in 2016 cropping season at the teaching and research farm of Imo state Polytechnic Umuagwo-Ohaji to ascertain the effect of different organic manure on the growth and yield of eggplant *Solanummelongena*. Randomized complete block design was used with four replications. The treatments were 0kg/ha (control), 10kg/ha poultry droppings, 10kg/ha pig dung, 10kg/ha wood ash. Data were on plant heights, number of branches, number of leafs, number of flowers and fruits. The results revealed that manure treatments had significant effect (p =0.05) on the overall performance of eggplant. The highest plant height (36.6cm) at 6 weeks after transplanting (WAT) was obtained from the plots that were treated with 10kg/ha of poultry droppings which is statistically similar to other values obtained from the control plot. The highest number of fruits (36.1), number of leaves at 4WAT, 6WAT and 8WAT were 21.2, 36.6 and 43.9 respectively and were obtained from the plot that received 10kg/ha of poultry droppings.

Keywords: organic manure, growth and yield, Eggplant, Southeastern Nigeria

Introduction

The *Solanum melongena* (eggplant) as a member of the solanacae family is a native of India (Daunay*et al.,*2004). It has been cultivated in Southern and Eastern Asia, since prehistory. It is believed to have been introduced throughout the Mediterranean area by Arab in the early middle ages (Daunay *et al.,* 2004). According to (Okita *et al.,*2004), eggplant is most popular in southern Nigeria particularly in lgbo land because of the both cultural and traditional importance. Eggplant is a very good source of Dietary, Fiber, Potassium, Cupper and Vitamin B, Foliate and Niaci (Whitaker and Sommel, 2003). In Nigeria, though there are no official figures recorded for *Solanum melongena* production, the crop has a wide distributionas a garden crop (Dauda*et al.,* 2005). In order to obtain high yield of this crop in Nigeria, there is a great rise to augment the nutrient status of the soil to meet the crop needs (Dauda *et al.,* 2005). One of the ways of increasing the fertility of the soil is by boosting the soil nutrient content. This can be achieved by either using of organic material, such as Cow dung, Goat manure,Pig dung, Ash, Poultry manure, Sheep manure and compost etc. (Dauda *et al.,* 2005). Okita *et al.,* (2004) stated that most tropical soil exhibit rapid depletion of organic matter and consequently soil. Poultry manure which is essential for establishing and maintaining optimum soil physical condition and important plant growth, resistant to microbial degradation, a good source of nitrogen for sustainable crop production due to its slow release and its availability remains an important issue due to its bulky nature (Rahman, 2004). Pig dung as organic manure is reported to contain dry matter contents in the range of 3 – 12% (Mulongony*et al.,* 1993). Many researchers indicated satisfactory yields substituting mineral fertilizer partially or completely (Rahman, 2004). Sieling and Sieling, (1998) reported that nitrogen can be gained through adequate pig dung and also aid in the reduction of nitrate which contaminate the growth and profit margin.

The application of nitrogen a major component of poultry manure has been reported to improve the yield of eggplant (Dauda *et al.,* 2005). Boating *et al.,* (2006) also reported based on bromass determination, that biomass was highest on plants with poultry manure, the higher rate (i.e. 4, 6 and 8/ha respectively) have more biomass than the lower rate 92 ton/ha.In order to obtain high yield of this crop in Nigeria, there is need to augment the nutrient status of the soil to meet the crop needs (Dauda*et al.,* 2005). One of the ways of increasing the fertility of the soil is by boosting the soil nutrient content. This can be achieved by either using of organic materials such as poultry manure, pig dung, ash etc (Dauda *et al.,* 2005). The use of inorganic fertilizer has been the conventional way of application to crops, however the rising cost of fertilizer have compelled farmers to look for other alternative to sustain cultivation. Application of organic manure which is relatively more environmental friendly could be the best alternative.This study will help in exploring other organic manure to improve soil fertility and reduce over dependence on only organic fertilizers in this way the full potential of organic manure as soil fertility.The objective of this study was to evaluate the effect of different organic manure on the growth and yield of *Solanummelongena*.

Materials and Methods

Experimental Site

The research was carried out at Teaching and Research Farm, Imo State Polytechnic, UmuagwoOhaji during the 2016 farming season. This location lies within the rain forest zone of Nigeria with an annual rain fall varying from 1.500mm – 2,200mm. The soil is sandy loamy, well drained with layer of organic matter with characteristic deep yellowish red color, friable and free from stones.

Land Preparation

The land was ploughed and Harrowed with tractor, stumped manually with the help of machete and Hoe. The size of the study area is 9m x 9m, each plot measuring 1.5m x 1.5m with 1m inter and intra path way.

Experimental Design

A Randomized Complete Block Design (RCBD) with four replicates. Each replicate contains four (4) beds with each having an area of 2.5m x 1m, there was sixteen (16) beds in the entire layout.

Experimental Material

Solanum melongena seed was procured from National Root Crop Research Institute (NCRI) Seed Service Umudike.

Experimental Treatment

T0	0kg/ha
T1	10kg/ha Poultry dropping
T2	10kg/ha Pig dung
T3	10kg/ha Ash

Planting

The seedlings were transplanted two weeks after the manure had been incorporated into the beds. They were transplanted with the planting spacing of 50cm x 50cm at the rate of one seedling per stand.

Weed Control

The plot was weeded manually with weeding hoe four weeks after transplanting and four weeks after the first weeding to prevent the weeds from competing with the crops for nutrients, sunlight and water.

Data Collection

The following parameter were measured;

Plant Height

The height in centimeter was measured from the ground level to the tip of the main stem at 4 weeks, 6 weeks and 8 weeks.

Number of Leaves

The number of leaves per plant was computed by counting the total number of leaves harvested per plant.

Number of Branches

The number of branches of the sample plot was computed and was later subjected to statistical analysis.

Number of Flowers and Fruits

Days to 100%flowering and fruiting were recorded from the date of emergency till when 100% of the plants produced flowers and fruits respectively.

Results and Discussion

Effect of Different Organic Manure on Plant Height of *Solanum melongena*

The result on the effect of different organic manure on plant height of *S. melongena*shows that 10kg/ha of poultry dropping gave the highest plant height followed by 10kg/ha pig dung, 10kg/ha of ash and the lowest was 0kg/ha at 4WAT, 6WAT and 8WAT at P = 0.05 level (Table 1).

Table 1: Mean Plant Height of *Solanummelongena*

Treatments	Mean Plant Height (cm)		
(Organic Manure)	4WAT	6WAT	8WAT
0kg/ha zero treatment	5.4	22.6	24.4
10kg/ha poultry dropping	15.3	38.6	42.5
10kg/ha pig dung	12.4	33.6	38.4
10kg/ha Ash	8.1	28.4	32.7
LSD(0.05)	2.3	3.1	3.7

Effect of Different Organic Manure on Number of Leaves of *Solanummelongena*

Table 2 shows the result on the effect of different organic manure on mean number of leaves of *Solanummelongena*at 4WAT, 6WAT, 8WAT after planting shows that 10kg/ha of Poultry dropping gave the best performance than 10kg/ha of Pig dung, 10kg/ha of zero treatment of organic manure respectively.

Table 2: Mean Number of Leaves of *Solanummelongena*

Treatments	Mean Number of Leaves		
(Organic Manure)	4WAT	6WAT	8WAT
0kg/ha zero treatment	8.1	20.1	28.4
10kg/ha poultry dropping	21.2	36.6	43.9
10kg/ha pig dung	18.3	31.6	38.7
10kg/ha Ash	14.2	27.4	34.7
LSD(0.05)	2.6	3.2	3.9

Effect of Different Organic Manure on Number of Branches of *Solanummelongena*

The mean number of branches of *Solanummelongena*shows that 10kg/ha of Poultry dropping was the highest at 4weeks after transplanting at P = 0.05 level. The same trend shows at 6weeks after transplanting and 8weeks after transplanting (Table 3).

Table 3: Mean Number of Branches of *Solanummelongena*

Treatments	Mean Number of Branches		
(Organic Manure)	4WAT	6WAT	8WAT
0kg/ha zero treatment	4	6	10
10kg/ha poultry dropping	13	16	22
10kg/ha pig dung	10	13	18
10kg/ha Ash	7	10	14
LSD(0.05)	2.2	2.9	3.1

Effect of Different Organic Manure on Number of Flowers and Fruits of *Solanummelongena*

Table 4 shows the mean number of flowers and mean number of fruits of *S. melongena*.The highest mean number of flowers was recorded at 10kg/ha of Poultry dropping (39) followed by 10kg/ha of Pig dung (31), 10kg/ha of ash (22) and 0kg/ha of zero treatment (14) respectively. The same trend shows on mean number of fruits of *Solamummelongena*at P = 0.05 level.

Table 4: Mean Number of Flowers and Fruits of *Solanum melongena*

Treatments (Organic Manure)	Mean Number of Flowers	Mean Number of Fruits
0kg/ha zero treatment	14	13.6
10kg/ha poultry dropping	39	36.1
10kg/ha pig dung	31	27
10kg/ha Ash	22	16
LSD(0.05)	5.1	2.8

The plant height of *S. melongena*varied significantly for different types of organic manure a mean height of 5.4cm was observed for 0kg/ha which significantly differed (<0.05) from 15.3cm for poultry droppings, 12.4cm for pig dung, and 8.1cm for ash, it can be said that poultry droppings at the rate of 10kg/ha gave the highest plant height at 4weeks after planting. Similar result was observed for 6 weeks and 8 weeks after planting.

The mean number of leaves varied significantly (<0.05) with poultry droppings having the highest number of leaves (21.2) at 4weeks after planting, the least number of leaves were recorded for zero kg/haof manure (8.1). This trend also occurred at 6 weeks and 8 weeks after planting.

The mean number of branches varied significantly for different types of organic manure, 10kg/ha of poultry droppings gave the highest mean number of branches at 4 weeks after planting (13) followed by 10kg/ha of pig dung(10) and then 10kg/ha of ash(7), the least number of branches was recorded for 0kg/ha treatment(4). This trend was also observed at 6 weeks and 8 weeks after planting.There was a significant difference(<0.05) in the mean number of flowers among different organic manure types, poultry manure at 10kg/ha gave the highest number of flowers while the least number of leaves was recorded for 0kg/ per ha at 4 weeks, 6 weeks and 8 weeks after planting respectively.The highest number of fruits per plant for*S. melongena was o*bserved for poultry droppings and lowest for 0kg/ha at 4weeks, 6 weeks and 8 weeks after planting respectively.

The result obtained from this study showed that the various manure type and their rates of application significantly influenced the performance of eggplant. It was observed that greater numbers of branches were obtained from plots that received 10kg/ha of poultry dropping compared to other treatment plots. The same trend was observed for the plant height where taller stands was recorded from the plot that received 10kg/ha of poultry dropping.However, leaf production is not in line with the stem performance, the greater quantities of leaves were observed from the plots that were treated with poultry dropping at 10kg/ha and 10kg/ha of pig dung whereas, the quantity of leaf produced by ash treated plots were lesser.

This could be attributed to the superiority of poultry manure to other source of organic manure in terms of nitrogen supply according to Madukwe*et al.,* (2008) who stated that poultry manure is superior to other sources of organic manure. In similar trend, the greater yield of leaf was recorded from poultry dropping treated plots which could mean that poultry manure among other treatment was able to supply greater quantity of nitrogen which was in a limited supply in the soil and is essential for the production of leaves in plants.Consequently, fruits production was greater in plots that received 10kg/ha of poultry manure treatment.

Conclusion

The result of the research showed in Umuagwo-Ohaji, eggplant treated with poultry manure at the rate 10kg/ha produced the highest plant height, number of leafs, number of branches, number of flowers and fruits.This indicates that the use of poultry dropping is a sustainable strategy to increase high yield of eggplant production.The researcher therefore recommend to farmers who may embark on large scale production of eggplant cultivar should treat it with poultry dropping to ensure maximum yield of the crop.

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ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Different Rates of NPK 15:15:15 on Growth and Yield Performance of Maize (*Zea mays*)

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Abstract
Field experiment was conducted to evaluate the effect of different rate of NPK 15:15:15 fertilizer of the performance of maize in Ikorodu Agro-ecological zone. The experiment was laid out in Randomized Complete Block Design (RCBD**)** with **f**our (4) rates of NPK 15:15:15 fertilizer (0, 150, 200, and 250 kg ha^{-1}) and replicated 3 times. Data were collected on number of leaves, plant height (cm) and stem girth at 4, 6, 8 and 10 WAP, number of days to 50% anthesis, number of days to 50% silking, cob length, cob weight, cob diameter hundred kernel weight. The fertilizer applied drastically reduced the soil organic matter, available phosphorus and total nitrogen; while organic carbon, Na^+ and K^+ were increased in post soil analysis. Plant height was significantly affected by fertilizer application, while non-significant effect was observed for number of leaves, stem girth, days to 50% anthesis, days to 50% silking and yield attributes. However, 200 and 250 kg ha^{-1} gave an improved performance and therefore recommended for farmers in the study area.

Keywords: Anthesis, Cob weight, Organic carbon, Silking, Yield

Introduction

The demand for food is increasing because of increasing population; the problem of food scarcity is increasing. Maize (*Zea mays L.*) as an important crop in Nigeria is a better option to mitigate the threat of food shortage, as it is a high yielding crop that provides food and forage. It is Nigeria's third most important cereal crop after sorghum and millet (FAO, 2016). Maize crop requires an adequate supply of nutrients particularly nitrogen, phosphorus and potassium for optimum growth and yield (Uyovbisere *et al.,* 2011). However, a major reason for low yields in maize production is the poor organic matter and available nutrients of most soils in the humid tropics because of continuous cropping, and consequently reduction in sustainable soil productivity (Zingore *et al.,* 2013). Long-term cultivation has further depleted the soil organic matter content and fertility status of the soils (Agba *et al.,* 2015). This phenomenon is amidst other constraints like drought, poor crop management, diseases and pest. Efforts aimed at obtaining high yield of maize would necessitate the augmentation of the nutrient status of the soil to meet the crop's requirements for optimum productivity and maintain the soil fertility (Uyovbisere *et al.,* 2011). The nutrient status of the soil may be achieved by boosting the soil nutrient content with the use of inorganic fertilizers such as NPK.

The availability of sufficient growth nutrients from inorganic fertilizers lead to improved cell activities, enhanced cell multiplication and enlargement and luxuriant growth (Fashina *et al.*, 2012). Therefore, this study is conceived to evaluate the effect of varying rate of NPK 15:15:15 fertilizer on the growth and yield performance of maize in Ikorodu area of Lagos state.

Materials and Methods

Experimental location: The experiment was carried out at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu, Lagos State Nigeria. The experimental site has been under continuous cultivation for over three years without any forms soil amendments. The land was ploughed and harrowed to a fine tilt using a disc plough and harrow.

Experimental design and Treatments: The experiment was laid out in Randomized Complete Block Design (RCBD) on a total area of land measuring 159.5m^2 which was divided into 3 blocks of 14.5m x 3m (43.5m^2), each plot size was 3m x 3m (9m^2) to give a total number of 12 plots. Four (4) rates of NPK 15:15:15 fertilizer (0, 150, 200, and 250 kg ha^{-1}) was replicated 3 times and was applied to the plants two (2) weeks and four (4) weeks after sowing by side placement method.

Planting and maintenance: Maize seeds (Oba Super variety) was planted at two (2) seeds per hole at a spacing of 60 x 45cm and later thinned to one seedling per stand two weeks after planting (WAP) Manual weeding was carried out at biweekly intervals. Pest and disease was control using Cypermethrin and DD-Force at seven (7) days interval to ensure effective chemical control on devastating pest of Maize Fall Army worm *(Spodoptera frugiperda).*

Soil analysis: The soil of the experimental site was analyzed twice, the first one before planting (pre-planting soil analysis) and the second after harvesting (post- planting soil analysis). Soil samples were randomly collected with soil auger from different locations in the study area and were composited, air-dried and sieved through a 5mm sieve and their physiochemical characteristics were determined before and after application of treatments following standard laboratory procedure (Parr *et al* 2015).

Data collection and Statistical Analysis: Six (6) plant stands was randomly sampled and tagged per plot for data collection on growth and yield parameters. Data collected include: number of leaves, plant height (cm) and stem girth at 4, 6, 8 and 10 WAP, number of days to 50% anthesis, number of days to 50% silking, cob length, cob weight, cob diameter hundred kernel weight.

Data collected were subjected to Analysis of Variance (ANOVA). Means of treatments were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability using SAS 9.1 statistical software.

Results and Discussion

Pre-planting and post-planting soil analysis: The physiochemical properties of the experimental site soil prior to cropping and at harvest is presented in Table 1. The soil at the commencement of the study is sandy clay loam in texture and slightly acidic (pH 5.70). The Result revealed that the pre-cropping soil is low in fertility and this implies that NPK 15:15:15 fertilizer could serve as good amendment materials in ameliorating the poor fertility status. Post-planting soil analysis result showed that application of NPK 15:15:15 fertilizer drastically reduced the soil organic matter (Table 1). The post-planting soil analysis reveals the soil in T_1 and T_2 to be high in organic carbon (0.92% and 0.82%) than T_3 and T4 (0.52% and 0.40%). Available phosphorus and total nitrogen was greatly reduced in each treatment plot compared to its level before cropping. while Na^+ and K^+ were increased in the post-soil analysis due to the fact that maize requires little of these nutrients compared to N. The reduced in N and P level is due to its uptake by the maize plant. This confirm the role of maize plant as nitrogen exhausting plant (Fageria and Baligar, 2005).

Effect of different levels of NPK 15:15:15 on Maize growth: Table 2 shows that plant height of maize was significantly ($p \le 0.05$) affected by different levels of NPK 15:15:15 fertilizer at 4, 6, 8 and 10WAP and was not significantly ($p \ge 0.05$) affected at 2WAP. At 4, 6, 8 and 10 WAP, the result shows that 150 kg ha^{-1} has the tallest plant repeatedly followed by 200 kg ha^{-1} and 0kg/ha having the shortest plant.

Number of leaves was not significantly ($p \ge 0.05$) affected by different level of NPK 15:15:15 fertilizer (Table 2). At 2 and 6 WAP 200 kg ha^{-1} and 250 kg ha^{-1} has the highest number of leaves, while at 8 and 10WAP control plot 0 kg ha^{-1} has the highest number of leaves with 150 kg ha^{-1} having the least number of leaves. The decreases might be due to defoliation during reproductive stage of the plant.

Stem girth was not significantly ($p \ge 0.05$) affected by different levels of NPK 15:15:15. However, 200 kg ha^{-1} was recorded the highest, follow by 150 kg ha^{-1} then 250 kg ha^{-1} with 0 kg ha^{-1} having the least (Figure 1). This is in line with the research of Kolawole *et al* (2018) who reported that increasing level of fertilizer application increase the growth and yield of plant.

Effect of different levels of NPK 15:15:15 on days to 50% anthesis and days to 50% silking of Maize: The result in (Figure 2) shows that despite application of NPK 15:15:15 fertlizer to the plant there was non-significant ($p \ge 0.05$) influence on days to 50% silking and anthesis of maize. This was in accordance with Abd-allah *et., al* 2011; Bayoumi, 2015; Ehaliotis *et., al*, 2015: Who reported that Fe, Zn, and Mn encourages vegetative growth, total chlorophyll and the photosynthetic rate of plants which enhance early flowering and fruiting, leading to an increase early maturity.

Effect of different levels of NPK 15:15:15 on Yield attributes of Maize: The result in (figure 3) shows that cob weight, cob length, cob diameter and hundred kernel weight was not significantly ($p \geq 0.05$) affected by different levels of NPK 15:15:15. It was recorded that 0 kg ha^{-1} has the highest cob weight, cob length and cob diameter. While 250 kg ha^{-1} has the highest number of hundred kernel weight (30.7g) and 150 kg ha^{-1} having the least (25.7g). This result seems to prove some facts wrong as soil with no amendment have the highest yield of maize. The control plot that had low fertility level perform better than any other treatment plots in terms of yield. Although, the experiment was carried out during the dry season. There was low level of rainfall which might have delay the mineralization of inorganic fertilizer applied to the soil necessary for plant use which should lead to vigorous growth and high yield of crop. These report agree with previous from Ayoola and Adeniran (2016) that variation in nutrient source among treatments will result in a significant variation of fruit length, weight and diameter per plant in most crops.

Cost analysis of Maize production: Table 2 shows the cost analysis of maize production. The total cost of production of maize for the whole project was ₦5345.6. The cost of seed was ₦1000:00, land preparation ₦500:00, bed construction ₦600:00, fertilizer application ₦450:00, total cost of fertilizer ₦345:60, weeding cost ₦1050:00, pest and disease control ₦1150:00 and cost of harvesting ₦250:00.

Analysis for Gross Margin of Each Treatment: Table 3 shows the gross margin analysis of the treatments. 0, 150, 200 and 250 kg ha^{-1} has gross margin greater than ₦1:00 which makes their production profitable.

Conclusion and Recommendation

The results obtained from this study clearly indicated that NPK 15:15:15 is a valuable material for amending soils and also a source of maize crop nutrition. NPK 15:15:15 at the rate of 250 kg ha^{-1} was found the best in terms of cost of production and yield. It is therefore recommended for Maize production in Ikorodu Local Government Area of Lagos State.

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Table 2: pre-cropping and Post-planting soil analysis result

Parameters		Post cropping soil analysis T_1	T_2	T_3	T_4	Pre cropping soil analysis
pH		6.45	5.90	6.72	6.47	5.70
Organic Carbon(%)		0.92	0.80	0.52	0.40	0.77
Organic Matter (%)		0.58	1.38	0.89	0.69	1.63
Total Nitrogen (%)		0.08	0.07	0.05	0.04	0.14
Basic Anions (mg/kg)	Mn	74	74	98	78	28.4
	Cu	1.4	2.9	2.3	2.5	1.7
	Zn	8	8	8	6	5.7
	Fe	120	260	160	160	6
Available P (mg/kg)		0.58	4.11	1.02	0.57	30.71
	Sand	64.5	70.5	74.5	68.5	74.5
Particle size (%)	Clay	7	27	23	27	17
	Silt	4.5	2.5	2.5	4.5	8.5
Textural class		Sandy clay loam				Sandy clay loam
Exchangeable Bases (Cmol/kg)	Na^+	5.58	2.64	2.61	3.76	1.374
	K^+	0.023	0.023	0.007	0.023	0.012
	Ca^+	0.99	0.10	0.40	0.80	3.393
	Mg^+	0.30	0.43	0.26	0.11	2.410

Table 3: Effects of different levels of NPK 15:15:15 on plant height of Maize at Ikorodu in 2019

	Plant Height (cm)					Number of leaves				
Treatments	**2WAP**	**4WAP**	**6WAP**	**8WAP**	**10WAP**	**2WAP**	**4WAP**	**6WAP**	**8WAP**	**10WAP**
0 kg ha^{-1}	6.80	14.50b	36.50b	54.90b	55.60b	1.76a	1.84a	2.92a	3.86a	3.30a
250 kg ha^{-1}	7.27	16.19ab	42.70ab	56.40ab	59.44ab	1.82a	1.96a	3.01a	3.53a	2.70a
200 kg ha^{-1}	7.54	17.29ab	43.02a	56.80ab	60.80a	1.83a	2.46a	3.20a	3.77a	3.05a
150 kg ha^{-1}	6.90	19.59a	44.99a	60.24a	63.40a	1.83a	2.62a	3.54a	3.51a	2.63a

Means with similar letter(s) in the same column are not significantly different at 5% (DMRT).

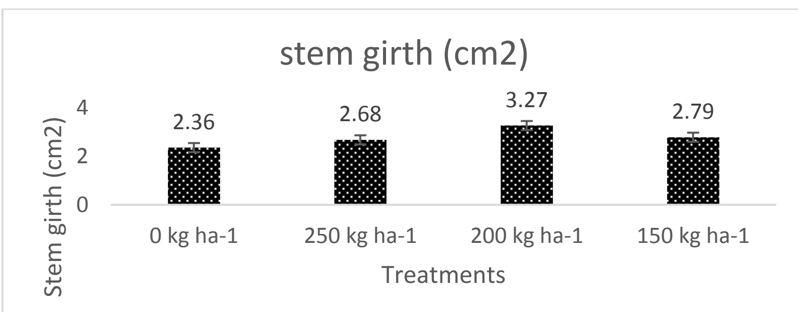

Figure 1: Effect of different levels of NPK 15:15:15 fertilizer on maize stem girth

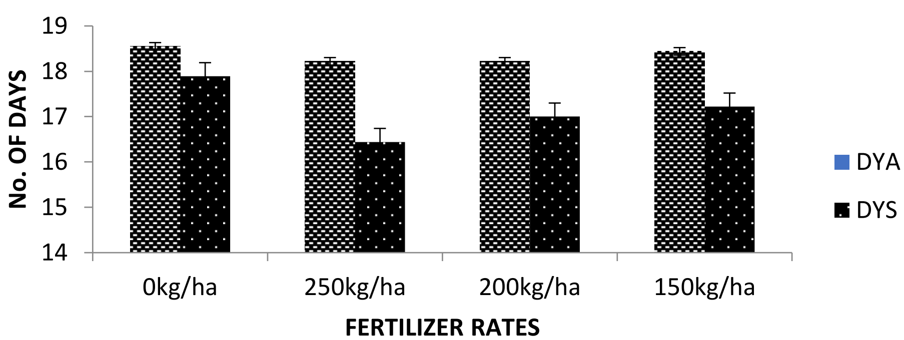

Figure 2: Effect of different levels of NPK 15:15:15 on days to 50% anthesis and days to 50% silking of Maize.

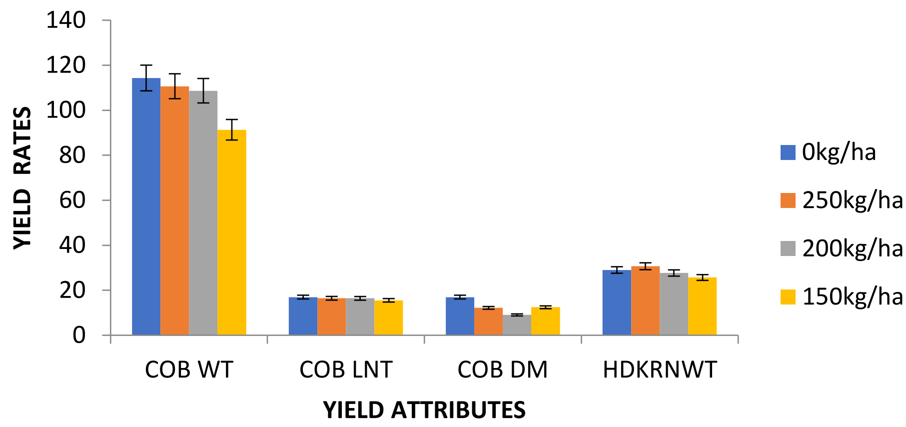

Figure 3: Effect of different levels of NPK 15:15:15 on Yield attributes of Maize

Table 2: Cost analysis of Maize production

Input	Description	Treatments	Quantity	Price
Seed	Can(₦1000)		1	₦ 1000:00
Land preparation	11m x 14.5m (₦500)		1	₦ 500:00
Bed construction	3m x 3m (₦50)		12	₦ 600:00
Fertilizer application	Per bed (₦65)		9	₦ 450:00
Cost of fertilizer + Transportation	Per 5kg bag (₦800)	0kg per hectare	0	₦0:00
		150kg per hectare	0.54kg	₦86:40
		200kg per hectare	0.72kg	₦ 115:20
		250kg per hectare	0.9kg	₦144:00
Cost of manual weeding	11m x 14.5m (₦350)		3	₦1050:00
Cost of pest control	Chemical and spraying labour (₦230)		5	₦1150:00
Cost of harvesting	Labour (₦250)		1	₦250
Total				₦ 5345:60

Source: field survey 2019.

Table 3: Analysis of Gross Margin per hectare

Treatment	Cost of production (₦)	Yield per hectare (kg)	Price per kg (₦)	Total revenue (₦)	Gross margin (₦)
0 kg ha^{-1}	1250:00	118	50:00	5900:00	4650:00
150 kg ha^{-1}	2600:00	82	50:00	4100:00	1500:00
200 kg ha^{-1}	3050:00	101	50:00	5050 :00	2000:00
250 kg ha^{-1}	3500:00	112	50:00	5750:00	2250:00

Source: field survey 2019

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effect of Hot Water and Dilute Acid Treatment on Breaking the Seed Dormancy of African Locust Bean (*Parkia biglobosa* L.) and Tamarind (*Tamarindus indica* L.)

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Abstract
A study was carried out in the Botanical Garden of the Department of Agronomy Bayero University, University Kano, to determine the most effective method of breaking seed dormancy in Tamarind and African locust bean. The treatments comprised of two type of seeds (fresh and dried seeds sourced from local market in Kano state), two different methods of breaking seed dormancy; seeds soaked in dilute Hydrochloric of acid (for 30 minutes) and seeds soaked in hot water of 50^0C and 100^0C (each for 30 minutes) and the control (seeds were not treated). The treatments were laid out in a completely randomized design with three repetitions. Germination rate (%), plant height and number of leaves were measured at 2 days interval (beginning from 21 days after planting) for a period of eight weeks. The results showed that boiling water and acid treatments with Tamarind had higher germination rate of 100% and 70%, respectively at 29 days after planting compared to the control. The boiling water treatment also had taller seedlings as at 29 days after sowing which were higher than those of the control the control The seeds treated with dilute acid recorded poor seed germination and generally performed lower than those treated with hot water. The findings of this study revealed that seed dormancy of *Parkia biglobosa* and *Tamarindus indica* are caused by hard seed coat which prevents water permeability of the seed coats. Hence water at 100^0C was found to be effective in breaking seed dormancy of Tamarind than on Parkia compared to 50^0C and dilute acid treatments.

Introduction

Seed dormancy is defined as nature's way of setting a time clock that allows seeds to initiate germination when conditions are normally favourable for germination and establishment of the seedlings (Baskin and Baskin, 2004). Viable seeds that do not germinate are said to be dormant. Therefore, dormancy is a mechanism that plants use to prevent germination during unsuitable conditions, that is, when the probability of seedling survival is low (Ali *et al*., 2011). A number of problems are encountered with regard to germination of fruit trees which are naturally hardy and very difficult to germinate especially under unfavourable environmental conditions. Different mechanisms used to break dormancy in nature include physical rubbing of the seed coat to make it thinner so that water and gases can diffuse into seed, seeds passing through the gut of animals, long wet and or frosty conditions and fire. However, some of the conventional methods used are scarification, treatment of seeds with chemicals like acids, soaking of seeds in water. Hot water seed treatment is a very simple and effective method to control seed transmitted bacterial and some fungal pathogens. Hot-water treatment can kill bacteria inside and on the outside of seed. Freshly harvested seed withstand the heat treatment better than 1- or 2-year old seed (Okunola, 2011). Hot water seed treatment is one such step that has shown to be effective on certain diseases of small seeded crops like peppers, tomatoes, brassicas (broccoli, brussel sprouts, cabbage, etc), onions, radishes, and carrots. The goal of hot water seed treatment is to sterilize or kill the disease-causing organism without damaging the seeds ability to germinate, effectively preventing the disease from entering your soil and farm. Hot water treatment is a highly underutilized integrated pest management (IPM) tool, which is also allowed under organic rules.

Acid treatment is a useful method for increasing speed and uniformity of germination in several plants. Acid treatment can affect seed germination, cell growth, stomatal opening, expression of gene associated with senescence and fruit production (Klessing *et al*., 2008). in view of the importance of the crops under study and their nutritional value, there is need to devise a way of easing their germination and subsequent seedling establishment.

Materials and Methods

Pot experiment was conducted at the screen house of the Department of Agronomy, Faculty of Agriculture, Bayero University Kano (11^0 $58N^0$, 8^0 $25E^0$ and 475 m above sea level) within the Sudan savannah zone of northern Nigeria. The materials used for the experiment were polybags, top soil, manure, beakers, meter rule, dilute Hydrochloric Acid (HCl), distilled water and seeds of *Parkia biglobosa* and *Tamarindus indica*. The soil for the experiment was mixed with manure in the ratio of 3:1 and placed inside the polybags. The seeds were washed and subjected to treatments as follows:

- **Acid Treatment**: The seeds for the two plants under study were soaked in 60ml of dilute HCl for 30 minutes after which they were removed and dried. They were then sown at the rate of 3 seeds per polybag and watered.
- **Hot Water Treatment**: The seeds were soaked in hot water of 50^0C and 100^0C for 30 minutes after which they were removed, cooled and dried. They were then sown in the polybags at the rate of 3 seeds per bag.
- **Control**: The untreated seeds were only washed with water and sown at the rate of 3 seeds per polybag.

The experiment was then laid out in a Completely randomized Design (CRD) and repeated three times. Data were collected on germination rate, number of leaves and seedling height per plants in the pot and these were subjected to analysis using descriptive statistics of percentages, tables and charts to show differences between the treatments and the crops under study.

Results and Discussion

Germination Percentage: The result obtained from the study shows that there was increase in the number of seeds that germinated from the first to 29^{th} day after sowing (DAS). There were differences in the germination rate due to differences between the plant species (Figure 1). Although *Parkia* was the first to germinate after 7 DAS, Tamarind had higher germination rate of 100% with hot water treatment at 100^0C while the untreated seeds recorded the longest DAS to germinate. This agrees with the findings of Abubakar and Muhammad (2013) who reported that immersing *Parkia* in 100^0C hot water gave 100% germination in 10 DAS. The acid treatment also had Tamarind recording higher germination percentage compared to *Parkia* and these were higher than the control (Figure 1).

Plant Height: *Parkia* seeds under 100^0C hot water treatment recorded the tallest plants compared to Tamarind under the same treatment and both were taller than the control. The dilute acid treatment had Tamarind been taller than Parkia which in turn is taller than the control. Similar findings were reported by Ajiboye (2013) who observed taller plants of Tamarind treated with dilute HCl compared to untreated plants (Figure 2).

Number of Leaves: The result in Figure 3 shows that Tamarind had higher number of leaves than *Parkia* as at 29 DAS under 100^0C hot water treatment compared to 50^0C. Tamarind also produced higher number of leaves than Parkia under the dilute acid treatment and both were higher than the control. This corroborates the earlier findings of Abubakar and Muhammad (2013) and that of Ajiboye (2013) who observed similar trends in their studies.

Conclusion

The findings of this study showed that hot water treatment at 100^0C proved to be more effective in breaking seed dormancy of the plants under study compared 50^0C and the dilute acid treatment. *Tamarindus indica* seeds responds better than *Parkia biglobosa* in most of parameters measured.

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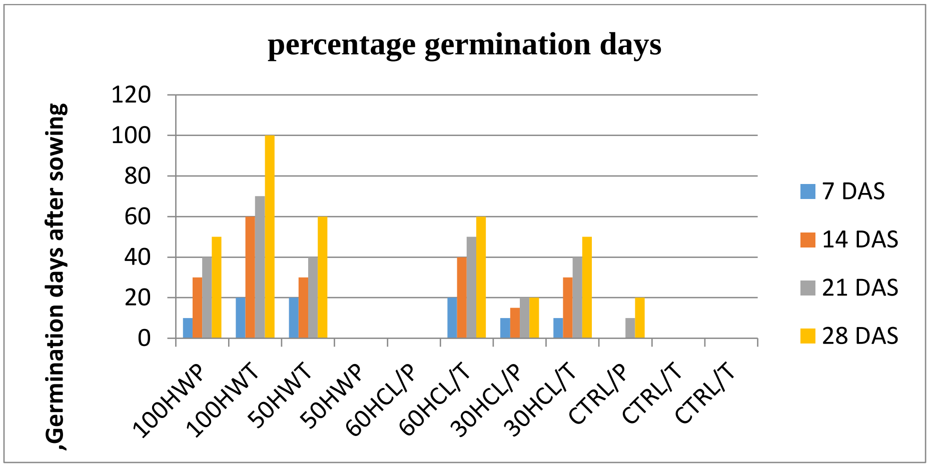

Figure 1. Effect of Hot Water and Dilute Acid treatment on Seed Germination of *Parkia* and Tamarind.

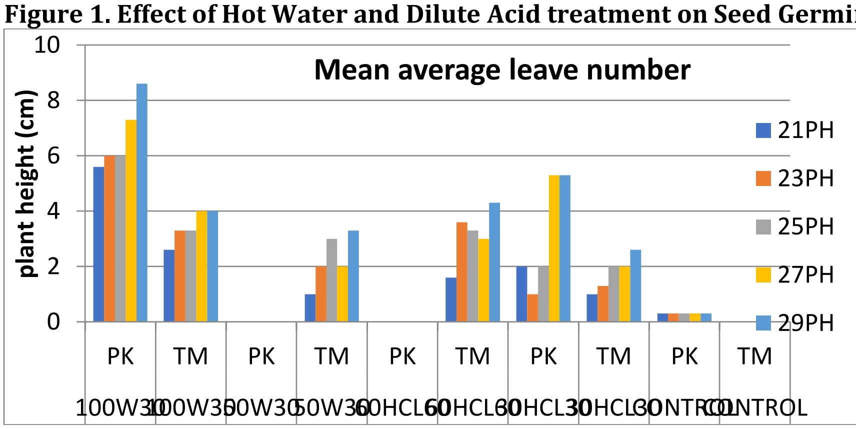

Figure 2. Effect of Hot Water and Dilute Acid treatment on Plant Height of *Parkia* and Tamarind

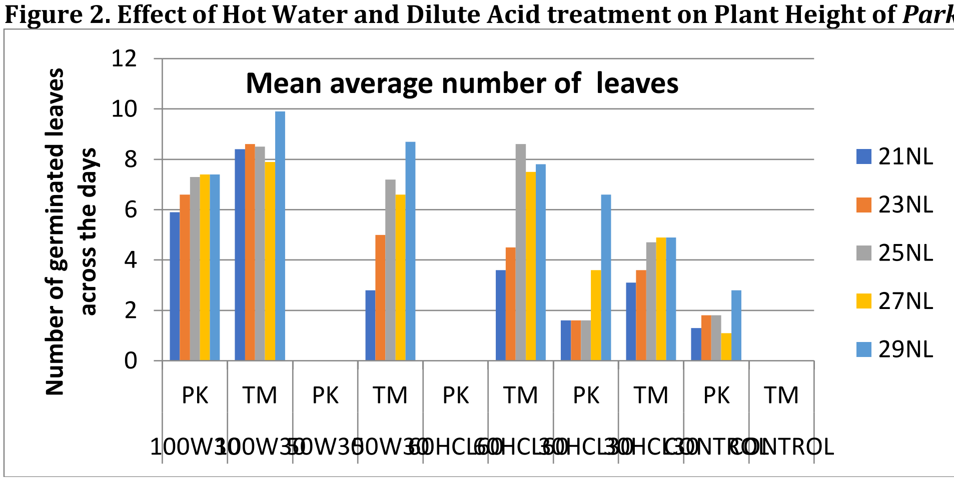

Figure 2. Effect of Hot Water and Dilute Acid treatment on Plant Height of *Parkia* and Tamarind

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Lime and Poultry Manure on Vegetative Growth of Maize (*Zea Mays* L.) in Selected Agro Ecological Zones Of Nigeria

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Abstract

The effect of poultry manure and hydrated lime on vegetative growth of maize was evaluated in the field during 2014 wet season. The treatment consisted of Hydrated lime, NPK (15:15:15) and poultry manure at 0.5 t/h, 0.25 t/ha and 2.0 t/ha respectively and unamended (control). The treatments were arranged in a pair plot design replicated in three locations, Imota (Lagos state), Ipa Orogbo (Ogun state) and Anyingba (Kogi state). The soil reaction showed pH of 6.0 (moderately acidic) at Imota, 7.2 (slightly alkaline) at Anyingba and 7.6 (slightly alkaline) at Ipa Orogbo. The statistical analysis using one-way ANOVA revealed no significant difference (5% level of significancy) between control and treatment on stand count in all the locations. A significant difference was observed 4 weeks after sowing (WAS) in plant height. The soil responded positively to ameliorative materials at 4 and 6 WAS on leaf area in all the states. Therefore, hydrated lime and poultry manure can be applied to the soils as ameliorative materials to increase vegetative growth in maize.

Key words: Hydrated lime, Poultry manure, NPK (15:15:15), Maize

Introduction

Maize (*Zea mays* L.) is one of the most popular and widely grown cereal crop in the world with a great significance as human and animal feed and raw materials for industries (FAO, 1992). Maize is being grown across a range of agro-ecological zones in Nigeria, with a total demand of about 800,000 tonnes / annum and an estimated supply of 350,000 tonnes per annum. The crop thrives well at pH of 5.5- 5.7, while strongly acidic soils (pH< 5.0) is unsuitable for better yield (Benedict, 2012). Soil pH, electrical conductivity and organic matter content influenced grain yield of maize when optimally utilized (Katerji, 1996). Acid soil; Oxisols and ultisols represent over 25% of the south eastern, western and central part of Nigeria (FDLAR, 2013). These are soils characterized by low organic matter and total nitrogen content, low capacity to hold nutrients against leaching, therefore, deprived of basic cations and nitrogen (Adetunji and Bamiro, 1994). In most acid soils with pH levels less than 5.5, the major plant growth limitations are due to elemental toxicity mainly arising from Aluminium and Manganese. This may ultimately lead to a decrease in crop yield, seedling emergence and survival, legumes nodulation and root growth (Athanase *et al*, 2014). Lime is the cheapest substance available to correct the effect of soil acidity. It is affected by the soil pH and its buffering capacity which is related to the cation exchange capacity of the soils (Benedict, 2012). The use of lime has been found to enhance the health condition of the soil by improving soil pH, base saturation, calcium and Magnesium. Other notable impacts include; reduction of Aluminium and Manganese toxicities and increasing both uptake in high Phosporuos fixing soils and plant rooting system (Buni, 2014). Through enhancing the cycling of three important nutrients (N, P and S) in increasing their activity to plants, liming stimulates biological activity in the soil (Athanase *et al,* 2014).

Application of organic manure to the soil increases the pH from acidic to near neutral after 90 days over one season (Evelyn *et al*; 2004). Ayodele *et al* (2014) has affirmed organic manure enhancement of maize response to lime and fertilizer application by improving soil pH, available p, exchangeable Ca and Mg, and helps in the reduction of toxic levels of Al, Fe and Mn. Follet *et al.*, (1995), Hsich and Hsu (1993) has confirmed the superiority of poultry manure over other organic manures. Ano and Agwu (2005) and Bulluck *et al,* (2002) had reported an increase in soil organic carbon through the use of poultry manure. The use of poultry manure also apart from neutralizing soil acidity by raising the buffering capacity of the soils, it also serves as a source of some micro-nutrients like Zn, B, and Cu in the soils for crop production (Hassan *et al*, 2007). Lime and inorganic fertilizer were considered to be an extra or additional cost for the farmers being ingredients that have positive impact on crop yield and soil properties. But farmers do often use them at recommended rates and appropriate times due to high cost, poor distribution and delivery system. In view of this, the use of poultry manure was considered as a complementary with lime in managing soils associated with acidity problems in order to increase maize production and provide food security in the country. The objective of this study was therefore to investigate the effects of hydrated lime and poultry manure on vegetative growth of maize in Kogi, Lagos and Ogun states.

Materials and methods

Experimental sites: Three locations were selected for the study; these were Lagos state; Ipa/Orogbo (Ajegunle settlement scheme), N07^{0}14.46" E03^{0}42.95" Ogun state; Imota Farm settlement scheme N06^{0}67.70" E03^{0}66.85" and Kogi state; Anyingba (ADP demonstration Farm) N07^{0}49.41" E07^0.18.14" during 2014 wet season. Composite soil samples (0-20cm) were taken for the determination of particle sizes, organic C, pH, total N, available P, exchangeable acidity, exchangeable bases (Ca, Mg, Na and K) and cation exchange capacity according to standard procedures.

Treatments and experimental design: The treatments consisted of Hydrated lime and poultry manure applied as follows:

T1= Control

T2= 0.5 tonnes/ha hydrated lime + 0.25 tonnes/ha NPK + 2 tonnes/ha poultry manure

The experiment was laid out in a pair plot design replicated in three states (Ogun, Lagos and Kogi). Extra early maize (Oba, 98) was used as test crop. Hydrated lime and poultry manure were evenly broadcasted on each plot one week before planting. Each plot measured 10m x 10m = 100m^2 with a 1m alley between plots. Three seeds of maize were sown per hole at a spacing of 75cmx25cm and later maintained to 1 plant per stand after thinning. Measurements of plant count, leaf area and plant height were done beginning from 10th day of emergence as described by Hassan *et al*; (2007). Data collected were analyzed using analysis of variance (ANOVA) as described by Adikuru (2016) and differences between means were separated using the least significance difference (LSD) at 5% level of significance.

Results and Discussion

Previous soil data with regards to management in the study areas indicates the need for liming in these areas. This was supplemented with organic amendments and inorganic fertilizer for proper performance of crops. Poultry manure as an organic amendment serve as one of the major sources of soil organic matter that supplies essential micro-nutrients and nutrients such as NPK and S (Hassan *et al.*, 2007). This helps in soil aggregation, water holding capacity and nutrient retention characteristics of the soil.

Effect of lime+ poultry manure on stand count: Table 2 shows the effect of treatments on stand count. There was no significant difference between the farmers practice (control) and the treatment (lime+ poultry manure) on stand count in all the states. This demonstrates that application of lime and poultry manure did not impose variability on plant population density.

Effect of lime+ poultry manure on plant height: In the second week after sowing (2WAS), there was no significant difference, which means the amendment did not result in any variability. But in the fourth week (4WAS), the crop responded positively to the amendment which may be due to soil N transformation and fluxes affected by the soil pH (Table 3). Increasing the pH of the acid soils by application of soil amendments (lime) may result in an increased N mineralization (Windsor, 1958; Nyborg and Hoyt,1978), which may consequently lead to an increased in growth parameters.

Effect of lime+ poultry manure on leaf area: There was a significant difference between the control and the treatment especially in the 4 and 6 WAS in all the states. The soil ameliorative material resulted in greater variability between the treatments (Table 4). With the rainfall fully established (adequate moisture) and favourable temperature, a clear relationship was established between nitrification rate and soil pH. The flow of N through the processes of mineralization, nitrification and microbial immobilization influences N availability, and thus, when acid soils are limed, crop uptake of N can increase through enhancement of soil N turnover and root and shoot growth. This will invariably leads to an increase in leaf area.

Conclusion

The result from this study shows a significant difference between control and treatment (4WAS) in plant height. The soil responded positively to ameliorative materials at 4 and 6 WAS on leaf area in all the states. However, there was no significant difference (5% Los) between control and treatment on stand count in all the locations therefore hydrated lime and poultry manure can be recommended to be applied to the soils as ameliorative materials to increase vegetative growth in maize.

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Table 1: Physical and chemical properties of composite surface soils in acid affected sites of Ogun, Lagos and Kogi states

	Sand	Silt	Clay	TC	pH		OC	TN	AP	Ca	Mg	K	Na	H+A	CEC
		gkg-1			H20	Cacl		gkg-1	mgkg-1			Cmol(+)kg-1			
AB	74	10	16	SL	7.2	6.2	0.63	0.007	20.48	1.46	0.51	0.16	0.51	0	3.7
I O	68	08	24	SCL	7.6	6.3	2.78	o.19	100.5	9,59	3.27	0.87	0.56	0	21.8
I M	66	08	26	SCL	6.0	4.8	1.25	0.01	26.6	1.08	0.65	0.18	0.59	0.8	9.0

AB= Anyingba (Kogi state)
IO= Ipa Orogbo (Ogun state)
IM= Imota (Lagos state)
SL = Sandy loam
SCL = Silty clay loam

Table 2: Effect of treatment on stand count

Treatment	2 WAS	4WAS	6WAS
Control	242.33	230.67	172.67
Treatment	317.00	349.00	250.67
LSD	80.36	213.81	221.37

Table 3 : Effect of lime+ poultry manure on plant height

Treatment	2 WAS	4 WAS	6 WAS
Control	22.84	50.29b	122.19
Treatment	26.59	79.86a	244.09
LSD	7.53	22.18	391.72

Table 4: **Effect of Lime+ poultry manure on leaf area**

Treatment	2 WAS	4WAS	6WAS
Control	62.37	377.06b	597.71b
Treatment	66.31	614.34a	786.86a
LSD	34.21	109.08	104.02

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Nitrogen and Sulphur on Wheat (*Triticum aestivum* l.) and Soybean (*glycine max)* (l.)Merr) in Sudan Savanna Ecological Zone of Nigeria

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Abstract
A field study was conducted during the 2015 dry season at Dambatta (12° 27' N, 8° 30' E, 418m above sea level) to study the effect of Nitrogen and sulphur on wheat (*Triticum aestivum* L.) with soybean (*Glycine max* L. (merr) in Sudan Savanna Ecological Zone of Nigeria. The experiment was designed in RCBD arranged in a factorial combination of two nitrogen (N) levels at 0 and 150kg N/ha and and elemental sulphur applied at 40kgSO_{-3}ha^{-1} and replicated four times. Results from the study showed that there was significant interaction between application of N on mean yield parameters studied such as thousand and hundred seed weight, grain yield (kg)/plot and yield /hectare (kg) among the treatments. Based from the result of this study, it could be recommended that there is a beneficial effect and interaction of legume and cereal mixture which can maximize productivity in terms of grain yield in the Sudan Savannah ecological zone of Nigeria.

Keywords: RCBD, Factorial, Nitrogen, Sulphur

Introduction
The uptake of N and S are closely related (Zhao *et al.,* 1999) and the interaction of N and S has been studied principally in sole-crop situations (Zhao *et al.,* 1999; Eriksen *et al.,* 2001). Very few studies have been undertaken to clarify N and S interactions. Akber et al., (2013), results show that plant height increased with increasing levels of sulphur up to maximum level of S application. The increase in plant height as observed in the experiment may be due to the favourable effects of sulphur on N-metabolism and consequently on the vegetative growth of soybean plant. Soybean plants showed significant variation in respect of plant height when different doses of sulphur fertilizer were applied. Arable intercropping often mixes cereals and legumes as components, within which various studies have demonstrated complementary use of resources. Combinations include pea + barley (Hauggaard-Nielsen *et al*., 2006; Andersen *et al*., 2007) and wheat + faba bean intercrops (Bulson *et al*., 1997; Gooding *et al*., 2007). The legume is then forced to rely on symbiotic N-fixation with Rhizobia. The intercrop components are thus able to use different N sources and therefore minimize interspecies competition. The degree of this complementarily for N accumulation is a function of both inter- and intra-specific competition which is also influenced by the available resources and the density of intercrop components (Vandermeer, 1989).
In sub Saharan Africa, growing crops as an intercrop cereals and grain legumes is because they are particularly important human food as they are rich in protein and are sometimes sold for cash income (Ogutu *et al.,* 2002). In addition, cereal-legume intercrops ensure stability of the yields over several seasons (Ofori and Stern, 1987); when one crop fails, the other might still give a reasonable yield. Furthermore, grain legumes help maintain and improve soil fertility due to their ability to biologically fix atmospheric nitrogen (BFN). Reported grain legume–cereal intercropping performance indicates some principal advantage worth considering while directing present agricultural practices in more sustainable directions like yield advantages and greater yield stability over years compared to grain legume sole cropping. Furthermore, pea (*Pisum*

sativum L.) and barley (*Hordeum vulgare* L.) dual intercropping compared to the corresponding sole croppings has shown a more efficient use of environmental sources for plant growth due to inter-specific complementarities (Aziz *et al.*, 2015). Of the major nutrients, nitrogen (N) has received the most attention, this is both because N is most often limiting in areas where intercropping is practiced, and because combinations of legumes and non-legumes most often dominate intercropping systems (Ofori and Stern 1987). In these combinations, popular wisdom says that the key role of the legume component is its contribution to the N-economy of the system. The principal source of N for cereal grains is N remobilized from senescing plant vegetative tissues (Simpson *et al.,* 1983) and many authors have reported that the contribution of remobilized N to grain N is about 60-92% (e.g. Cox *et al.,* 1985a; Papakosta and Gagianas, 1991). The present study investigates the effect of nitrogen on wheat (*Triticum aestivum* L.) and soybean (*Glycine max* (L.) Merr) intercropping in Sudan Savannah Ecological Zone of Nigeria

Materials and Methods

Field experiments was conducted at the Research Farm, Audu Bako College of Agriculture, Tomas Dambatta, (12° 27' N, 8° 30' E), Kano State, in the Sudan Savanna Ecological Zone of Nigeria during the dry season of 2015/2016. After land preparation, five composite soil samples were randomly taken at a depth of 0-30cm using soil auger from the fields. The soil sample was air dried and ground to pass through a 2mm mesh before subjecting it to laboratory analysis. Physical and chemical properties of the soil samples were determined using standard procedures as described by Black (1965). The experimental design was split plot design replicated four times. The treatment is factorial combination of nitrogen at 0 and 150 kg N/ha and elemental sulphur treatments applied at 40kg$SO_{-3}$$ha^{-1}$ arranged in RCBD. All treatments were replicated four times. The size of the main plot was 4m x 5m with a discard of 2m between the plots. The experimental sites were ploughed, harrowed and ridges constructed, the plots were then demarcated into sunken beds. Wheat (var. Norman Borlaugh) was dibbled at 20cm x 25cm on 14th December, 2015 while the soybean was drilled two weeks after sowing wheat. The fields were irrigated at one week intervals through surface flooding of water from the main canal in both sites but the schedule was reduced to three days when they became matured. Two split application of N Fertilizer at 150Kg N/ha and elemental sulphur was applied two weeks after sowing (WAS) and incorporated according to the level of treatment to the plots and five (5WAS) for Nitrogen. Pests were controlled with Cypermethrin dimethoate at the rate of 1.5 l/ ha at 9WAS. The wheat spike and soybean pods of the intercrops were harvested when they were fully matured and the grains were threshed, weighed and recorded. Data collected were subjected to analysis of variance as described by Snedecor and Cochran (1967) using SAS version 9.3 (2010) software and the means were separated using LSD all-pair wise comparison. Also growth and yield parameters were determined as described by Steel and Torrie (1984).

Results and Discussion

The mean effects of nitrogen and sulphur on one thousand grain weight of wheat and one hundred grain weight of soybean at Dambatta was presented in table 1. Application of N at 150kg N/ha and S at 40kg $SO_{3/}$ha significantly increases the one thousand seeds weight of wheat in N1S1 and the control at ($p \leq 0.05$). This was in contrast with the work reported by Ogutu *et al*., (2012) that there was significant effect ($p \leq 0.05$) on thousand grain weight on bean – maize intercrop which could be due to differences in altitude, soil type and temperature. Seed filling process in beans was most probably affected by temperatures as happens in most crops. My finding agree with the work of Songin (1993) who reported that thousand grain weight did not depend on N fertilizer application in pea as shown at Dambatta experimental field when N was applied at 150KgNha^{-1}. Those differences may be attributed to environmental conditions experienced by the crops. Table 2 shows the mean effect of nitrogen and sulphur on grain weight (kg) of wheat and soybean at Dambatta was presented. Application of nitrogen at the rate of at 150kg N/ha showed a significant interaction on grain weight of wheat and soybean at ($p \leq 0.05$) when applied. An interaction was observed on the effect of nitrogen and intercropping system on grain weight of wheat at Kadawa. Result from table 3 shows that application of nitrogen and sulphur at 150kg N/ha and 40kg $SO_{3/}$ha significantly affect yield/hectare of wheat and soybean ($p \leq 0.05$). Thus, the reduction in yield of soybean may be attributed to shading effect as reported by Olufajo (1992) that shading by the taller plants in mixture could reduce the photosynthetic rate of the lower growing plants and thereby reduce their yields. It can also be as the result of interspecific competition between the intercrop components for water, light, air and nutrients or aggressive effects of C3 species like soybean (Mateus *et al*., 2014). Also this can be attributed due to low temperature at the early stage of growth.

Conclusion

In the conclusion, results obtained from this study showed that application of nitrogen at the rate of 150kg N/ha and 40kg SO_3/ha did significantly results in the increasing some yield parameters at the experimental site. However, planting wheat and soybean in the Sudan Savannah ecological zone can results in more biological yield and surety against unpredictable phenomenon as may be experienced by the farmers in relation to climate change in the tropics.

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Table1: Physico-Chemical properties of soil of at the experimental field during 2015/2016 dry season at Dambatta

Soil characteristics	Value
Particle size distribution (%)	
Sand	86.4

Silt	9.6
Clay	4.0
Textural class	Loamy Sand
Exchangeable bases (cmo/kg^{-1})	
P	10.69
K	0.13mg/100
Ca	3.81mg/100
Mg	2.03mg/100
Exchangeable acidity	
CEC	7.31
Chemical properties	
Total N	0.32
Organic Carbon (%)	0.549
P^{H} in H_2O (1:2:5)	6.64
P^{H} in $CaCl_2$ (1:2:5)	6.16

Table 2: Effect of Nitrogen and Sulphur on Wheat and Soybean on one thousand grain weight of wheat and one hundred grain weight of Soybean at Dambatta in 2015/2016 dry season

Treatment	Wheat	Soybean
N1S1	40.144	12.979
N1S2	40.794	14.169
N2S1	39.656	13.438
N2S2	38.806	12.588
SE±	0.634	0.571
	NS	NS

Means followed by the same letter(s) in the vertical column are not statistically different at 5% level of probability
SE –Standard Error
NS – Not Significant

Table 3: Effect of Nitrogen and Sulphur on Wheat and Soybean on grain weight at Dambatta in 2015/2016 dry season

Treatment	Wheat	Soybean
N1S1	396.29^{ab}	180.48
N1S2	378.39^{b}	175.76
N2S1	519.43^{ab}	177.08
N2S2	534.56^{a}	160.84
SE±	44.879	12.328
	*	NS

Means followed by the same letter(s) in the vertical column are not statistically different at 5% level of probability
SE –Standard Error
NS-Not Significant

Table 4: Effect of Nitrogen and Sulphur on Wheat and Soybean on yield/hectare at Dambatta in 2015/2016 dry season

Treatment	Wheat	Soybean
N1S1	990.7[ab]	451.20
N1S2	946.0[b]	439.39
N2S1	1298.6[ab]	442.69
N2S2	1336.4[a]	402.11
SE±	112.199	30.819
	*	NS

Means followed by the same letter(s) in the vertical column are not statistically different at 5% level of probability
SE –Standard Error
NS – Not Significant

ASN 53rd Annual Conference Proceedings (*Sub-Theme: Agronomy*)

Effects of Plant Spacing on the Growth and Yield of African Egg Plant (*Solanium macrocarpon*) in the Northern Guinea Savannah of Nigeria

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Abstract
Field experiments were conducted to determine the effect of planting spacing on the growth and yield of African eggplant (*Solanum macrocarpon*) in Institute of Agricultural Research, Ahmadu Bello university (IAR/ABU) Teaching and Research farm Zaria, Kaduna State in 2017 and 2018 cropping seasons. The experiment consists of five treatments (Planting spacing 80 × 20cm, 80 × 50cm, 100 × 50cm, 100 × 60cm and 120×70cm inter and intra row spacing respectively, replicated four times laid out in randomized complete block design. Data were collected on both growth and yield parameters. The data were analyzed using analysis of variance (ANOVA) procedure. Results showed that close row spacing of 80cm × 20cm significantly reduced number of {leaves and branches per plant and gave taller plant. Plant spacing of 100cm × 60cm gave higher growth parameters (leaves, branches, dry matter biomass and their growth rate and fruit yield per plant) fruit yield per hectare was however, higher in narrow inter and intra rows of 80cm × 50cm. Based on the findings of this study, eggplant should be cultivated at a spacing of 100cm × 80cm (inter and intra row spacing for optimum growth and fruits yield in Zaria location of Northern Nigeria.

Keywords: Eggplant, Spacing, Growth and Yield

Introduction

African eggplant (Solanum marcrocarpon belongs to solanaceae Family. It is a tropical fruits and leafy vegetable crop depending on the prevailing environmental conditions. When cultivated in humid tropics it will survive for many seasons thus described as perennial plant but in semi-arid or dry weather conditions, it behaves as annual plant due to moisture deficit that accelerate its senescence (Abdullahi et al 2013

In Nigeria, the Hausa called it “Yalo”, “Anara” in Igbos; ‘Igbagba’ in Yoruba (Schippers 2000). The leaves and fruits have high economic importance. They are used as food (eaten raw or cooked) as vegetables. In North western part of Nigeria especially Katsina, Gusau, Kebbi, Zanfara and Sokoto states, both the young green leaves and fruits are used for soup, stew, sauce or in making African salad (Abubakar 2017).

Emma Okafor (2017) reported that in many traditional cultures, garden egg including African eggplant fruits represent fruitfulness and blessings and are offered in ceremonies, marriage, child naming /dedication and social events as a symbol of goodwill and acceptance of visitors. African eggplant leaves root and fruit have high variety of medicinal values. The roots are used in traditional medium to treat bronchitis, asthma, wounds, abdominal worms and stomach disorders (Guiama, 2010). Abdullahi *et.al.,* 2013 observed that leaves of eggplant are used to cure boils, stomach and throat pains. The unripe young green fruits are used as laxative for cardiac diseases and to relieve toothache. Despite the high economic importance of African eggplant, there are a lot of literature on the cultural techniques such as data of planting, soil nutrient requirement and other requirement needed for optimum growth and yield. Therefore, this study was carried out to determine the ideal planting distance (inter and intra-row spacing) for optimum growth and fruit yield of African eggplant (*Solanum marcrocarpon*)

Materials and Methods

Field experiments were conducted in the Institute of Agricultural Research farm Ahmadu Bellow University Zaria in 2017 and 2018 cropping seasons. Zaria is located at latitude 11°11ʹN and longitude 7°38ʹE and altitude of 650m above sea Level. The experimental site was cleared and ploughed on 3rd April, 2017 and 2018. The experiment design was a randomized complete block design {RCBD}in four replications. Treatments were five planting spacing 80cm × 20cm, 80cm × 50cm, 100cm × 50cm, 100cm × 60cm and 120cm×70cm inter and intra row spacing respectively. There were sixteen (16) plots and each plot measured 6m ×6m given an area of $36m^2$. Eggplant (*Solanum marcrocarpon*) seeds were collected from IAR/ABU Zaria. The variety eggplant seed is called Samaru ESM 31) the seeds were sown in the nursery to raise seeding for three weeks before transplanted to the experimental plots. Transplanting of eggplant (*Solanum marcrocarpon*) was done at the rate of one seeding per stand according to the schedules spaces (80× 20cm, 80 × 50cm 100 ×50cm, 100 × 60cm, and 120 ×70cm inter and intra row spacing respectively for both 2017 and 2018 cropping seasons. Data were collected on number of leaves, branches per plant, leaf area index (LAI) at 6, 8, and 12 weeks after planting (WAP). The number of fruits per plant, fresh fruit yield per hectare (t/ha) fruit, dry weight (g) were collected and analysis

Data collected were analyzed using analysis of variance (ANOVA) procedure for randomized complete block design experiments as described by Gomez and Gomez (1984). Fishers least Significant Difference (F-LSD) at 5% probability level was used to separate treatment means for statistical significance as described by Snedecor and Cochran (1967).

Results and Discussion

Plant spacing significantly ($P \leq 0.05$) influenced the growth and yield of African eggplant (*Solanum marcrocarpon*). Number of leaves and branches per plant increased significantly ($P \leq 0.05$) with increase in plant spacing 80-20cm intra and 100-50cm inter –row spacing respectively (Table 1). There were more number of leaves and branches per plant in the wider inter and intra-row spacing than the narrow spacing. The highest number of leaves (74.3) in 2017 and (74.4) in 2018 and branches 15,4 in 2017 and 15.0 in 2018 at 12 WAP respectively were recorded in wider row spacing of120cm ×70cm in the two cropping seasons of 2017 and 2018. This could be due to positive effect of wider intra-row spacing where there is minimum competition for growth resources between plants Mani *et al.,* 2000. Plant height and leaf area index decreased significantly in wider row spacing than in closer spacing (Table 1). Closer spacing with narrow intra-row spacing resulted in taller plants with high leaf area index. This could be due to the high plant population which resulted in high competition for growth resources. The views agree with that of Mani 2017 who reported significant increase in plant height and LAI in narrow intra-row spacing of the eggplant. The effect of plant row spacing significantly influenced yield and components of African eggplants. (Table 2) Fruit yield per plant were higher in wider intra-row spacing than in narrow row spacing. Fresh fruit per plant increased with increasing inter and intra row spacing from 20-80cm and from 50-100cm inter row spacing. But did not show significant difference beyond 100 and 120cm respectively in the two seasons. Similar results by Idoko *et al.,* (2017) also recorded significant increase in yield and yield component of eggplant.

Results showed that on hectare basis, fruit yield was significantly ($p \leq 0.05$) higher in narrow inter and intra-row spacing than in wider row spacing. The highest eggplant yield per hectare of 16.16 t/ha in 2017 and 15.16 t/ha in 2018 were obtained in a narrow row spacing of 80 ×20cm in 2017 and 2018 cropping seasons respectively.

The higher fruit yield per hectare recorded in narrow row spacing in this study could be due to the fact that narrow rows has closer spacing with more plants per plot each contributing to the total yield per plot; thus resulting in higher yield per hectare than wider rows plots. This result agrees with Idoko et al (2017) who reported higher yield per hectare in narrow intra row than wider row spacing.

It has been observed from this study that plant spacing significantly affected the growth and yield of African eggplant (*Solanum marcrocarpon*). Plant spacing 100 ×60cm gave higher growth parameters (leaves, number of branches, dry matter biomass and their growth rates and fruit yield per plant in Zaria, Northern Guinea Savannah Agro-ecological region.

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Table 1: Effects of spacing on the number of leaves, branches per plant, leaf area index and vine length 6, 8 and 12 weeks after planting on African eggplant (*Solanum macrocarpon)* in 2017 and 2018 cropping seasons.

Plant Spacing (cm)	No. of Leaves per Plant			Leaf Area (cm^2) per Plant			No. of branches per Plant			Plant Height (cm)		
	WAP			**WAP**			**WAP**			**WAP**		
	6	8	12	6	8	12	6	8	12	6	8	12
2017 Cropping Season												
80 × 30cm	8.21	14.32	18.13	13.43	23.67	35.27	1.1	2.2	3.1	17.6	34.2	84.2
80 × 50cm	9.33	17.12	21.4	19.23	34.52	42.16	1.3	3.1	4.2	15.4	31.3	63.4
100 × 50cm	19.1	25.3	46.2	32.16	49.85	69.67	3.0	4.5	11.1	14.3	25.2	32.7
100 × 60cm	23.4	28.1	51.3	63.54	79.32	89.58	3.5	5.1	13.1	12.2	23.5	35.7
120 × 70cm	24.1	31.3	63.1	74.3	96.4	78.4	3.6	5.3	15.4	10.3	20.7	31.3
LSD ($P < 0.05$)	1.2	1.6	3.2	1.4	4.5	12.6	0.10	0.3	1.2	0.5	1.4	8.3
2018 Cropping Season												
80 × 30cm	7.15	15.41	22.21	15.24	25.17	36.8	1.1	2.1	3.2	18.4	36.1	86.3
80 × 50cm	8.41	17.22	28.54	18.43	47.52	46.4	1.3	3.1	4.1	16.3	33.2	58.7
100 × 50cm	18.3	24.5	46.5	35.4	47.3	70.4	3.1	4.6	12.1	187.5	287.4	57.4
100 × 60cm	21.2	29.3	52.1	70.1	82.1	86.4	3.4	5.2	13.4	170.1	265.1	49.2
120 × 70cm	23.5	32.4	62.5	73.4	91.9	79.7	3.7	5.4	15.3	155.3	241.1	47.4
LSD ($P < 0.05$)	1.1	1.4	3.2	1.3	3.3	10.4	0.01	0.3	1.1	4.2	5.4	7.3

Table 2: Effect of spacing on leaf and stem dry weight (g) per plant and their growth rates at 6, 8 and 12 weeks after planting on African egg plant (*Solanum macrocarpon)* in 2017 and 2018 cropping seasons.

Plant Spacing (cm)	Leaf dry weight per plant			Stem dry per plant			Leaf Rate (g/m^2/day)			Stem Growth Rate g/m^2/day)		
	WAP			**WAP**			**WAP**			**WAP**		
	6	8	12	6	8	12	6	8	12	6	8	12
2017 Cropping												

Season												
80 × 20cm	4.23	7.38	12.47	2.16	10.57	17.45	1.05	2.43	3.25	0.04	1.04	2.07
80 × 50cm	5.37	7.71	16.32	2.75	14.35	18.31	1.08	2.78	3.91	0.09	1.09	2.39
100 × 50cm	5.68	8.15	49.87	2.95	18.14	39.85	1.10	4.75	6.3	0.14	1.13	2.84
100 × 60cm	6.11	26.73	53.33	3.16	22.35	43.47	1.21	5.24	7.3	0.19	1.46	3.45
120 × 70cm	6.46	29.95	61.25	3.55	26.11	49.63	1.36	6.11	9.4	0.23	2.25	4.65
LSD $(P < 0.05)$	0.2	2.3	4.2	0.42	1.3	1.51	0.01	0.22	0.53	0.01	0.01	0.02
2018 Cropping Season												
80 × 20cm	3.41	7.14	13.13	2.08	12.46	16.68	1.04	2.37	3.28	0.03	1.03	2.5
80 × 50cm	4.76	7.84	15.89	2.69	16.22	21.24	1.08	4.25	14.21	0.12	1.16	2.27
100 × 50cm	5.32	8.14	50.10	2.87	19.34	40.95	1.13	4.81	17.11	0.31	1.31	2.91
100 × 60cm	15.85	27.01	53.41	3.21	23.14	44.11	1.42	5.14	19.31	0.62	1.54	3.27
120 × 70cm	19.47	29.81	60.59	3.62	26.24	50.32	1.41	6.13	23.58	0.93	2.28	4.36
LSD $(P < 0.05)$	0.6	2.3	4.3	0.4	1.3	1.62	0.01	0.21	0.54	0.01	0.01	0.02

Table 3. Effect of spacing on the yield and yield components of African eggplant (*Solanum macrocarpon*) in 2017 and 2018 cropping seasons

Plant Spacing (cm)	No. of Fruits per Plant	Fresh Fruit weight per Plant (g)	Fruit Dry weight per Plant (g)	Fresh Fruit yield per Hectare (t/ha)
2017 Cropping Season				
80 × 20cm	13.3	78.72	34.83	16.142
80 × 50cm	15.8	121.31	42.15	12.563
100 × 50cm	19.4	137.3	63.45	10.531
100 × 60cm	24.3	162.2	72.13	8.461
120 × 70cm	32.4	212.4	89.78	6.387
LSD $(P < 0.05)$	3.1	7.3	6.2	0.51
2018 Cropping Season				
80 × 20cm	12.2	69.48	29.78	15.163
80 × 50cm	16.1	129.26	46.31	11.211
100 × 50cm	21.3	141.35	67.77	10.311
100 × 60cm	27.2	172.25	75.43	8.243
120 × 70cm	35.33	247	85.64	5.434
LSD $(P < 0.05)$	3.2	6.4	6.4	0.52

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Sequential Planting of Vegetable Cowpea on Growth and Yield of Some Cassava Varieties in Cassava-Vegetable Cowpea Intercrop

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Abstract
The field trial was conducted at the research farm, National Root Crops Research Institute, Umudike (NRCRI) in 2018 cropping season to determine the effect of sequential planting of vegetable cowpea (*Vigna unguiculata* L. Walp.) on growth and yield of the component crops in cassava (*Manihot esculenta* Crantz)/vegetable cowpea intercrop. Two high branching and two low branching cassava varieties were used. Cassava (10,000 plants/ha) was intercropped with cowpea (40,000 plants/ha) while sole cowpea was sown at 53,333 plants/ha. The sole cassava varieties were also planted at 10,000 plants/ha. The treatments were NR8082/vegetable cowpea, TMS30572/vegetable cowpea, TME419/vegetable cowpea, TMS 98/0505/vegetable cowpea, sole NR 8082, sole TMS 30572, sole TME 419 sole TMS 98/0505 and sole vegetable cowpea. The experiment was arranged in a randomized complete block design (RCBD) with three replicates. The first cowpea was harvested at 3 months after planting (MAP). New cowpea was then introduced in the same plots where the first cowpea was planted and also harvested at 3 MAP when the cassava is 6 months in the field. The cassava component was harvested at 12 months after planting. The results showed that it is more beneficial to intercrop cassava with vegetable cowpea. The cassava variety TMS 98/0505 gave the highest root yield compared to the others, hence was adjoined to be more compatible with vegetable cowpea. Sequential planting of vegetable cowpea in established cassava plots may be encouraged, especially in degraded soils of south eastern Nigeria. The investigation needs further studies at the farmers' level as to ascertain their acceptability over wider environmental variables.

Keywords: Cassava, Intercrop, Vegetable cowpea, Productivity

Introduction
In the humid tropical zone of west and central Africa cassava is a major food crop, often inter cropped with annuals which mature earlier. The annual crops may be cereals (Ezumah and Okigbo, 1980), grain legumes (Mba, 1985; Lutaladio, 1986) or vegetables (Ikeorgu *et al*, 1989). Among the grain Legumes commonly intercropped with cassava are peanuts (*Arachis hypogeal*) (Lukaladio 1986), Pigeon peas (*Cajanuscajan*) (Okigbo, 1977), and Cowpeas (*Vignaunguiculata*) (Mba, 1985; Juo and Ezumah, 1991).
Cassava is a popular energy food in most of the tropics and has replaced yam and cocoyam as the number one carbohydrate staple. According to Udo *et al*. (2005) cassava is said to provide up to 40 % of all the calories consumed in Africa. Currently, Nigeria is the largest world producer of cassava with about 34 million metric tonnes. Generally, per hectare crop yield obtained by the small holder farmers in Nigeria is still Low (10 – 18 t/ha), compared to those from researcher managed fields (30 - 40 t/ha), according to Alimi and Manyong (2003). In this research work, four varieties of cassava were used, (two high cyanide and two low cyanide cassava varieties). The two high cyanide cassava varieties were NR 8082 and TMS 30572 while the two low cyanide cassava varieties were TME 419 and TMS 98/0505. Cowpea (*Vigna unguiculate* L. Walp) is a nutritious annual leguminous crop whose role in the tropics in human and livestock nutrition and soil fertility has been established properly (Onwerenmadu *et al.*, 2003). Grain type cowpea varieties produce short pods with mature early whereas vegetable type varieties produce long pods with less number of seeds and mature late and the pods remain tender and soft for long period.

Cowpea is a cheap source of protein from plant as compared to egg, milk and meat which are costly protein sources from animal. It is also an important source of vitamin B and constitutes a significant proportion of the total dietary protein intake of Nigerians. Cowpea is also characterized as a soil regenerative crop because it provides its own nitrogen to other succeeding crops through effective nitrogen fixation to the tune of 60 – 70 t/ha (Singh Rachie, 1985). The fresh vegetable cowpea pods are snapped into small pieces and boiled with the young shoot to a soft consistency and served with yam or any other carbohydrate food and palm oil. ((Bubenhein *et al.,* 1990; Uguru, 1996). Low intake of vegetable protein is one of the most serious defects of dietary protein in the Southern States of Nigeria (Mba, 1985) reported that about 5 per person per day is take in the east is less than 2g per person, far below the daily requirement of protein which is over 100g.
Two genotypes of vegetable cowpea exist in the farming system of South Eastern Nigeria namely those with climbing habit referred as *Vigna unguiculata* sub-species S*esquipedalis,* which is *akidienu* and those prostrate habit referred to as *Vigna unguiculata* sub-species *Dekintiana* and *Mensensis* known as *Akidiani* (Steele and Mehra, 1980). However, there is scarce information, especially on its agronomy when intercropped with a root crop such as cassava (Udealor, 2002; Ano. 2006). Therefore, this study was conceived to determine the effect of sequential planting of vegetable cowpea in cassava-based cropping system on the yield and productivity of the component crops.

Materials and Methods

The experiment was carried out at the Research farm of National Root Crops Research Institute, Umudike (NRCRI) Eastern farm in 2018 cropping season. Umudike is located at 05° 29' N latitude. 07° 33' E longitude and 122 m latitude. The total rainfall and rainfall days recorded in 2018 were 2,069 mm and 123 days, respectively while mean maximum temperature was 31.7 °C (Table 2). The analysis of the pre-planting soil sample indicated that the soil is a sandy loam with pH value of 4.8, available phosphorus (17.50 mg/kg) and exchangeable potassium (0.117 cmol/kg). Four improved cassava varieties sourced from National Root Crops Research Institute, Umudike, Abia State were used for the study (Table 1).

NR 8082: Unexpanded leaf colour is green purple. The first fully expanded leaf colour show green. The pubescence of the young leaf is absent. The central leaf lobeshape shows lanceolate. The petiole colour is green purple. The growth habit of the stem is straight. The stem colour is brown. There is no presence to flowers in Umudike. The outer root skin colour is light brown while inner root stem colour is white or green. Root flesh colour is white while the root neck length is short.

TMS 30572: The unexpanded leaf colour is green purple. The first fully expanded leaf colour is green purple. Pubescence of young leaf is absent. The central leaf lobe shape is lanceolate. The petiole colour is dark green. The growth habit of stem is straight. The stem colour is dark brown. There is presence of flowers in Ibadan. The outer root skin colour is dark brown. The inner root skin colour is cream/white. The root neck length is absent.

TME 419: The unexpanded leaf colour is green purple. The first fully expanded leaf colour is bright, green pubescence of young leaf is absent. The petiole colour is green. The growth habit of stem is straight. The stem colour is light brown, presence of flower in Umudike is absent. The centre root stem colour is light brown. Inner root stem colour is white/cream. The root flesh colour is white or cream while root neck length is short.

TMS 98/0505: The unexpanded leaf colour is green purple. The first fully expanded leaf colour is green purple pubescence of young leaf is little pubescence. Central leaf lobe shape is elliptic. The petiole colour is green purple. The growth habit of stem is straight. The stem colour is silver green. Presence of flower in Umudike is present. Outer root skin colour is light browning inner root skin colour is white/cream. Root flesh colour is white while root neck length is absent

The cassava varieties were sourced from National Root Crops Research Institute, Umudike. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The plot size of 5 m x 5 m (25 m^2). The treatments were as follows: NR8082/vegetable cowpea, TMS 30572/ vegetable cowpea, TME 419/ vegetable cowpea, TMS 98/0505/ vegetable cowpea, Sole NR 8082, Sole TMS 30572, Sole TME 419, Sole TMS 98/0505, Sole vegetable cowpea.

One variety of vegetable cowpea was used *Akidiani* (Local best) characterized by its black seeds and spreading growth habit. The seed was sourced from local farmers in Enugu-Ukwu, Anambra State, Nigeria. The cassava cuttings were planted 100 cm x 100 cm, which gave a plant population of 10,000 plants/ha while the vegetable cowpea seeds were planted on the crest of the ridges at 25 cm x 100 cm apart which gave a plant population of 40,000 plants/ha. Two seeds were sowed per stand and later thinned to one plant per stand. The cowpea was planted again in the same portion after three months when the first one has completed its cycle. Weeding was done manually with hoe, at 8 and 12 weeks after planting (WAP). Fertilizer (N:P:K 15:15:15) was applied two months after planting to the cassava at the recommended rate of 600 kg/ha. Data were collected at 3, 6, 9 and 12 WAP. The growth and yield parameters collected from cassava include the following: plant height (cm), number of leaves per plant, root Length, root diameter, weight of marketable roots/plant, weight un-marketable roots/plant and fresh root yield (t/ha). The cowpea parameters were as follows: vine length (cm), number of pods/plant, weight of pods/plant and fresh pod yield. The growth parameters were collected at 3, 6, 9, and 12 WAP. Statistical analysis was performed on the data according to the procedures for randomized complete block design (RCBD) as outlined by Gomez and Gomez (1984). Mean comparison of treatment for significance was done using least significance difference (LSD) at 5 % probability level (Obi, 2001).

Results and Discussion

Plant height of cassava across the sampled dates indicated significant difference among the cassava genotypes except at 3 and 6 weeks after planting (Table 3). Among the cassava genotypes, sole cropped cassava genotypes significantly exhibited lower plant heights compared to intercropped cassava genotypes. TME 419 gave the highest plant height in both sole and in the intercropped situations while TMS 30572 had the shortest plant height in both cropping systems. The trend was relatively the same across the sampled ages. Similar observations were reported by Mulualem and Ayenew (2012) in their studies on some varieties of cassava. Significantly highest number of leaves per plant was obtained in both sole and intercropped. TMS 98/0505 at 3 weeks after planting (WAP) (Table 4) while at 6, 9, 12 and 24 WAP, NR 8082 significantly gave the highest number of leaves per plant compared to the other cassava varieties. The trend was the same at 48 WAP. Highest number of leaves per plant was obtained under sole vegetable cowpea while in the intercropped treatments, TMS 98/0505/vegetable cowpea intercrop significantly produced the highest number of leaves per plant, which was sustained at the sampled dates of 6, 9 and 12 weeks after sowing.

Among the intercropped treatments, NR 8082/vegetable cowpea crop combination produced the longest vine length at the sampled dates of 6, 9 and 12 weeks after sowing (WAS) while sole vegetable cowpea had the shortest vine length at the sampled dates. Table 5 showed that number of leaves per plant was significantly influenced by sequential planting of vegetable cowpea at all the sampled dates.

However, TMS 98/0505 gave the highest weight of marketable tubers per plant and fresh root tuber yield (18.51 t/ha) relative to the other cassava genotypes in both sole and intercrop. Vine length of vegetable cowpea indicated significant difference among the treatments at the sampled dates (Table 6).

Number of pods per plant, weight of fresh pods per plant and fresh pod yield (t/ha) in both first and second harvests indicated significant difference amongst the assigned treatments in the study (Table 7). Sole vegetable cowpea produced more number of pods per plant, weight of fresh pods per plant and fresh pod yield per hectare compared with the intercrop.

Sequential planting of vegetable cowpea in cassava-based cropping system significantly induced highest weight of fresh pods per plant and fresh pod yield in TMS 98/0505/vegetable cowpea intercropping system compared with the other treatment combinations in the first vegetable cowpea harvest. In contrast, the second vegetable cowpea harvest from TMS 98/0505 was nil compared to TME 419, which gave the highest significant yield and yield characters compared to the other intercropped combinations. Our findings corroborate similar studies by Ayoola and Makinde (2008) on cassava and maize intercrop relayed with cowpea as well as Nyasasi and Kisetu (2014) in maize/cowpea intercropping system.

Conclusion

The results showed that it is more beneficial to intercrop cassava with vegetable cowpea. TMS 98/0505 gave the highest root yield, an indication that it was more in growth consonance relative to sole cropping of the component crops. Sequential planting of vegetable cowpea in established cassava plots may be encouraged, especially in degraded soils. The investigation needs further studies at the farmers' level as to ascertain their acceptability over wider environmental variables.

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Table 1: Brief characteristics of the cassava varieties used in the study

Variety	Growth habit	Cyanide content
NR 8082	High branching	High
TMS 30572	Low branching	High
TME 419	Erect	Low
TMS 98/0505	High branching	Low

Table 2: Agro-meteorological data of the experimental site (2018)

Month	Rainfall		Temperature (°C)	
	Amount (mm)	Days	Max	Min
January	0	0	33.4	21.5
February	43.7	2	33.9	23.2
March	138.8	8	33.2	23.4
April	78.7	6	32.2	23.5
May	249.2	16	31.9	23.4
June	281.8	12	30.5	24.2
July	114.9	14	30.0	24.0
August	444.2	20	29.6	23.3
September	405.3	22	29.8	22.9
October	165.1	12	31.0	23.6
November	147.4	11	31.6	23.5
December	0.0	0	32.7	21.8
Total	2069	123	-	-
Mean	-	-	31.7	23.2

Source: Meteorological Unit, National Root Crops Research Institute, Umudike, Abia State.

Table 3: Effect of sequential planting of vegetable cowpea on plant height of cassava at different ages in cassava/vegetable cowpea intercrop.

Treatment	**Plant height (cm)**					
	Weeks after planting					
	3	**6**	**9**	**12**	**24**	**48**
NR 8082/vegetable cowpea	10.33	25.50	37.0	67.4	196.3	288.3
TMS30572/vegetable cowpea	11.57	18.57	46.4	64.5	88.7	162.0
TME 419/vegetable cowpea	10.10	23.33	65.90	104.9	210.0	343.7
TMS 98/0505/vegetable cowpea	10.43	21.50	44.4	86.6	205.3	242.7
Sole NR 8082	10.47	21.30	35.9	82	158.0	246.3
Sole TMS 30572	10.43	21.50	30.2	59.7	128.7	206.3
Sole TME 419	8.47	20.40	40.3	59.5	145.0	263.7
Sole TMS 98/0505	9.70	17.73	25.4	44.0	134.7	237.0
$LSD_{(0.05)}$	Ns	Ns	20.26	38.57	48.62	66.17

Table 4: Effect of sequential planting of vegetable cowpea on number of leaves per plant at different ages in cassava/vegetable

Treatment	**Number of leaves per plant**					
	Weeks after planting (WAP)					
	3	**6**	**9**	**12**	**24**	**48**
NR 08082/vegetable cowpea	42.3	72.7	98.3	133.3	419	511
TMS30572/ vegetable cowpea	38.7	21.3	47.3	105.7	300	398
TME 419/ vegetable cowpea	29.0	57.7	76.3	89.7	162	125
TMS 98/0505/ vegetable cowpea	49.7	58.7	84.3	118.0	289	457
Sole NR 8082	53.3	74.3	115.0	222.7	547	254
Sole TMS 30572	51.0	21.0	51.3	95.7	228	431
Sole TME 419	38.7	63.7	93.7	127.3	445	569
Sole TMS 98/0505	60.3	65.7	152.3	286.0	724	1003
$LSD_{(0.05)}$	14.82	12.7	24.80	37.85		

Table 5: Effect of sequential planting of vegetable cowpea on vine length of vegetable cowpea in cassava/vegetable cowpea intercrop

Treatments	Weeks after planting			
	3	6	9	12
NR 8082/vegetable cowpea	77.7	439	785	954
TMS 30572/vegetable cowpea	64.6	426	776	833
TME 419/vegetable cowpea	68.7	363	730	811
TMS98/0505/vegetable cowpea	72.8	355	623	736
Sole vegetable cowpea	66.7	311	510	733
$LSD_{(0.05)}$	Ns	102.4	192.7	Ns

Table 6: Effect of sequential planting of vegetable cowpea on yield and yield components of cassava in cassava/vegetable

Treatment	Root Length (cm)	Root diameter (cm)	Wt. of marketable roots/ plant (kg)	Wt. of unmarketable roots/ Plant (kg)	Fresh root yield (t/ha)
NR 08082/vegetable cowpea	6.3	15.33	15.23	1.67	17.45
TMS30572/vegetable cowpea	5.33	16.0	6.93	1.87	12.32
TME 419/vegetable cowpea	6.90	11.67	8.60	1.80	15.73
TMS 98/0505/vegetable cowpea	6.30	14.67	19.07	1.93	26.82
Sole NR 8082	6.03	20.0	11.63	2.67	17.23
Sole TMS 30572	5.27	15.0	7.60	1.80	9.60
Sole TME 419	6.37	19.33	10.00	1.57	17.23
Sole TMS 98/0505	5.47	18.67	9.57	1.80	18.51
$LSD_{(0.05)}$	Ns	7.039	5.599	Ns	7.388

Table 7: Effect of sequential planting of vegetable cowpea on first and second crop yield and yield components of vegetable cowpea in cassava/vegetable cowpea intercrop

		First harvest		Second harvest		
Treatment	No. of pods/ Plant	Weight of pods/plant (g)	Fresh pod yield (kg/ha)	No.of pods/plant	Weight of pods/plant(g)	Fresh podyield (kg/ha)
NR 8082/vegetable cowpea	93	237	9.47	0	0	0
TMS 30572/ vegetable cowpea	116	163	6.53	0	0	0
TME 419/ vegetable cowpea	290	207	8.27	53.0	47.3	1.89
TMS 98/0505/ vegetable cowpea	212	270	10.81	0	0	0
Sole vegetable cowpea	231	406	11.24	66.5	0	0
$LSD_{(0.05)}$	120.9	112.9	4.516	27.40	93.0	3.719

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Effects of Spacing and Muriate of Potash on Leaf Nutrient Composition, Growth and Yield of Sweetpotato in Kabba, Kogi State, Nigeria

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Abstract
The experiment was conducted at the Research Site of Agronomy Section, Kabba College of Agriculture, Kabba, Kogi State, Nigeria to evaluate the effect of spacing and muriate of potash on growth and yield of sweet potato. The spacing used were 75, 60, 45 and 30 cm and muriate of potash at the rates of 30, 60 kg/ha were applied as treatment to sweet potato with a control. The experiment was a factorial laid out in a randomized complete block design (RCBD) with three replications. Data on growth and tuber yield taken were length of vines, number of branches, number of leaves, the internodes length, leaf area, number of tuber per plant and tuber weight. Data obtained were analyzed using (ANOVA) and means were separated using Least Significant Difference (LSD). The results showed that leaf area and internodes length were not significant in all the treatments. Application of muriate of potash at 30 kg/ha produced the maximum yield of tubers, also maximum yield of potato was recorded at the spacing of 60 cm. it was concluded that application of muriate of potash and appropriate spacing enhanced the growth and yield of sweet potato.

Keywords: Sweetpotato; Spacing; Muriate of potash

Introduction

Sweet potato (*Ipomoea batatas (L) Lam*) is a warm season, viny, storage root that requires a long frost-free growing season to mature (Magagula et al. 2010, pp. 36). It is native to central and south America. Sweet potato is one of the world's most important food crop in terms of human consumption, particularly in sub-Sahara Africa, part of Asia and the pacific islands. It is grown in developing countries than any other tuber crop. Sweet potato is a tuber, not a root and belonging to a morning glory family. Many parts of the plants are edible, including leaves, tubers and vines and varieties exist with a wide range of skin and flesh colour, from white to yellow to orange and deep purple (CIP 1999). Sweet potato currently ranks as the world's seventh most important food crop and fifth most important food crop on a fresh weight basis in developing countries after rice, wheat, maize and sorghum (FAO 2004).

Nigeria is the third largest producer of sweet potatoes in the world in terms of quantity after China and Uganda. In 2010, Nigeria produced 2.5 % of the world's production of sweet potatoes. However, sweet potatoes are still considered a minor crop in the country. In 2010, sweet potatoes had the tenth highest production level of any single food crop in Nigeria (after cassava, yam, oil palm fruit, maize, sorghum, millet, paddy rice, and plantain). The crop is grown almost in all agro ecological zones in marginal soils. It also gives high yield per unit area, best maturity period and double advantage to be a food security crop. The fact that sweet potato matures during the time when there is a food shortage, and its short life circle to mature enables it to deserve appreciation by farmers (Solomon, 1985).

Several improved sweet potato varieties have been developed, which gain their importance through the production of carbohydrate, protein and vitamins (Gibson 2006, p. 33).

Recently, the crop has gained its potential through commercialization both in rural and urban markets. The crop plays an important role in household food security and income generation among farmers and supplies

nutritional diets that can greatly reduce the risk of heart diseases, stroke and even cancer (Carey et al. 1999, p. 97; Helen Keller international, Tanzania, 2012, p. 37).
Plant density in potato affect some of the important plants traits such as total yield, marketable tuber number, unmarketable tuber and quality. Increase in mean tuber weight, increase in the number of tuber and yield per unit area due to plant density could be due to competition caused among the plants (Marguerite et al*.* 2006, p. 567), (Geogggakil et al. 1999, p.) concluded that by increasing plant density, the tuber yield was increased. Application of inorganic fertilizer significantly increase the different trait of potato production (Harnet et al. 2012, p. 1250. Zealem, 2008). The production of sweet potato is low in Kabba due to lack of proper spacing and other factors such as inadequate soil fertility and incidence of pests. Not much has been done on spacing and fertilizer application to increase production of sweet potato in Southern Guinea Savanna, especially in Kabba. Thus, this study aims at providing information on the best spacing method and fertilizer application rate that will give maximum yield of sweet potato in the study area.

Materials and Methods
The experiment was carried out during the raining seasons at the Research Site of Agronomy Section, College of Agriculture, Kabba. The site is located on latitude 07° 35' N and longitude of 06° 08' E and is 435m above sea level. It is in the Southern Guinea Savanna Agro Ecological Zone of Nigeria. The raining season commences in April and end in November with the peak in July. The dry season extends from December to March. The mean annual rainfall is 1570mm per annum with an annual temperature range of 18°C - 32°C. The mean relative humidity (RH) is 60% (Higgins, 1999). The major soil order within the experimental site is Ultisol (Babalola 2010).
Sweet potato vines (local variety) used for the experiment was collected from Iyamoye in Ijumu Local Government Area of Kogi State. The experiment was a randomized complete block design (RCBD) with three replications in factorial arrangement was employed for this study. The experiment consists of two factors, factor A (S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm) and factor B muriate of potash (MOP) levels (M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha). The land was slashed, ploughed, and flat beds were made. Pegging was carried out to identify each planting space before planting. Planting was done on 15th May, 2018. Weeding was done regularly by using hoe at the primary stage but hand picking after establishment of sweet potato vines was employed, the tuber was harvested with hoe and cutlass when maturity stage was reached.
The proximate analyses of sample for total carbohydrate, dietary fibre, total fat, protein, calcium magnesium and iron. Crude fibre and total ash were carried out in triplicate according to the methods of Association of Official Analytical Chemists (AOAC, 2000).
Data were taken on vine length, number of branches, internodes length, number of leaves and leaf area and yield characters taken were number of tubers, weight of tubers. Other parameters taken were soil and leaf nutrient composition. The analysis of variance (ANOVA) was used, sing statistical packages and procedures outlined by Gomez & Gomez 1984) appropriate to randomized complete block design. Mean separation was determined using least significant difference (LSD) at 5 % probability level.

Results and Discussion
Table 1 shows the result of the soil properties used for the experiment which indicated that the soil predominantly sandy, sandy loam in texture, slightly acidic and high in soil bulk density. The organic matter, total nitrogen, available phosphorus and exchangeable potassium and calcium were low. The soil of the experimental site is an Ultisol (Babalola, 2010).
The effect of different spacing and levels of muriate of potash on vine length of sweet potato is shown in Table 2. Significant difference was observed in vine length of sweet potato due to different spacing employed. The effect of spacing at 2, 4, 6, 8 and 10 weeks after planting was not consistent. However, at 10 weeks after planting, plot with 75 cm (S4) produced the longest vine. The least vine length was recorded with spacing of 60 cm apart (S3). The longest vine recorded with spacing at 75 cm may be attributed to the well displayed leaves leading to better interception of solar radiation and enhanced photosynthesis that favours sweet potato vines to trail.
Significant difference was observed in vine length due to different rates of muriate of potash applied. Plot that received muriate of potash of 30 kg/ha (M2) had the longest vine. However, this was not significantly better than plot with 60 kg/ha of muriate of potash (M3). The least vine length was observed in plot with no muriate of potash application (control). Better performance of plants in plots treated with muriate of potash is in agreement with the

findings of (Bao et al 1985, p 323), in an analysis of 392 experiments, came to the conclusion that potassium fertilizer was very effective on sweet potato.
The effect of spacing on the number of leaves of sweet potato at 2, 4, 6, 8 and 10 weeks after planting is presented in Table 3. The result revealed that plot spaced between 45 cm (S2) and 75 cm (S4) were similar in number of leaves produced. All these were better than sweet potato spaced at 30 cm. The highest number of leaves was observed in plot spaced at 45 cm (S2). In the present study, low plant density influenced the number of leaves produced, this is contrary to the work of Law-Ogbomo & Osaigbovo (2014, p 2204), they reported an increase in number of leaves per m^2 and LAI with increasing plant density indicates an increase in leaf photosynthetic activity due to closer plant spacing
Significant difference was observed in number of leaves produced at sample period of 8 and 10 weeks after planting due to different rates of muriate of potash applied. No significant difference observed at 2, 4, and 8 weeks after planting. Number of leaves was highest in plots that was treated with 30 kg/ha (M2) muriate of potash, although the effect was similar with plot that received 60 kg/ha (M3) of MOP. Control plot had the least number of leaves (M1). It is assumed that sweet potato responded to the application of K.
Effect of spacing and muriate of potash on leaf area of potato is presented in Table 4. Table revealed that no significant difference observed in potato leaf area at all the sampling periods. Adubasim et al. (2017, p. 46) reported a country result, they found significant difference in the leaf area index of sweet potato with 30 cm x 90 cm giving the highest leaf index. Significant difference was observed in leaf area of potato due to different rates of muriate of potash applied. Plot with 30 kg/ha (M2) and 60 kg/ha (M3) MOP produced similar effect and significantly better than plot without muriate of potash. Plot with 60 kg/ha of MOP gave the least leaf area at 10 weeks of planting. The significant difference observed in leaf area suggests that potassium increases the leaf area (LA) and the effect may be through its indirect influence in enhancing the availability of nitrogen to plants. Table 5 shows the effect of both spacing and levels of MOP on internodes length of sweet potato. No significant difference observed in the length of internodes due to spacing and levels of MOP applied. The number of branches in potato as influenced by spacing and muriate of potash are presented in Table 6. Significant difference was observed in number of branches potato at 4, 6 and 10 weeks after planting. Spacing at 75 cm (S4) produced the highest branches. The least branches occurred in spacing 45 cm (S2).
Muriate of potash significantly affect number of branches produced. Plot amended with MOP were better than the control and similar in their effect. Control plot recorded the least branches in this experiment
Effect of different spacing and different rates of muriate of potash on number of tubers per plant, average tuber weight per plant and tuber yield per hectare are presented in Table 7. Significant difference was observed in all the yield attributes observed due to different spacing used during planting. Yield character increases as the spacing increase up to 60 cm (S3), after the spacing of 60 cm, the yield characters drop. Average tuber weight was highest at the highest spacing S4 (75 cm). The highest number of tuber per plant, tuber weight per plant and tuber yield per hectare were highest at the spacing of 60 cm (S3). Least value of numbers of tuber per plant, average tuber weight, tuber weight per plant and tuber yield per hectare were significantly lower in plots with 30 cm (S1) interval (Table 7). Number of tuber per plant, tuber weight per plant and tuber yield per hectare were significantly affected with muriate of potash applied. Plots with muriate of potash were better than the control in numbers of tuber per plant, tuber weight per plant and tuber yield per hectare. Plants fertilized with muriate of potash at the rate of 30 kg/ha gave the highest number of tuber and tuber yield per hectare, though this was not better than plots fertilized with muriate of potash at 60 kg/ha. The least value of number of tuber per plant, average tuber weight, tuber weight per plant and tuber yield per hectare were lowest in the control plots.
Growth and yield was better when planted at the spacing of 60 cm (S3) intra-row. This agreed with the findings of Hamet et al, (2013, pp. 1250). The highest tuber weight was recorded at 60 cm intra-row spacing used. Muriate of potash significantly increases growth and yield of potato, this correlate with the findings of Mangel & Kirkby (1987). There was no significant different in the effect of MOP applied at 30 kg/ha (M2) and 60 kg/ha (M3). This indicated that muriate of potash applied at 30 kg/ha (M2) releases enough potassium that is needed for optimum growth and yield of sweet potato. Any additional MOP applied above 30 kg/ha (M2) seem to be in excess. Table 8 revealed the effect of spacing and muriate of potash on leaf composition of sweet potato. The result shows no significant difference in all the nutrient considered.

Conclusion

From the experiment, the following conclusions were drawn. Growth and yield of potato were affected by different spacing. Optimum yield of potato was achieved with 60 cm (S3) intra-row spacing. Application of 30 kg/ha (M2) of muriate of potash gave the highest yield of sweet potato in the study area. For optimum production of potato, farmers should plant their potato field at 60 cm (S3) intra-row and amend the soil with muriate of potash at 30 kg/ha (M2)..International Potash Institute, Bern, Switzerland.

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Table 1: Soil physical and chemical properties of the experimental site

Soil properties	Values
(a) Physical properties	
Sand	66.6
Silt	15
Clay	18.4
Soil texture	sandy loam
(b) Chemical properties	
Soil Ph	5.7
Bulk density g (cm)	1.36
Total porosity	41.8
Organic matter	2.56
Total N	0.16
Available P (mg/kg)	2.46
Exchangeable Ca (cmol/kg)	3.62
Exchangeable mg (cmol/kg)	3.41

Analysis was carried out at the Soil Science Laboratory of the Federal University of Technology, Akure (FUTA)

Table 2: Effect of spacing and muriate of potash on vine length of sweet potato

Treatment	2nd week	4th week	6th week	8th week	10th week
Spacing					
S1	162^{a}	197^{a}	203^{a}	213^{a}	218^{ab}
S2	110^{c}	188^{ab}	200^{ab}	213^{a}	221^{a}
S3	133^{b}	173^{b}	1833^{b}	194^{b}	203^{b}
S4	143^{ab}	202^{a}	204^{a}	218^{a}	225^{a}
Lsd (0.05)	20.63	24.61	17.51	6.78	16.43
M.O.P Level					
M1	114^{b}	184^{b}	194^{b}	214^{b}	214^{b}
M2	158^{a}	197^{a}	203^{a}	212^{a}	219^{a}
M3	136^{a}	190^{b}	198^{ab}	211^{a}	218^{a}
Lsd (0.05)	27	6.43	5.63	4.31	3.64

S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm. M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha

Table 3: Effect of spacing and muriate of potash on number of leaves of sweet potato

Treatment	2nd week	4th week	6th week	8th week	10th week
Spacing					
S1	27[a]	38[a]	41[b]	47[b]	53[b]
S2	26[a]	39[a]	45[a]	53[a]	59[a]
S3	28 [a]	40[a]	46[a]	52[a]	61[a]
S4	27[a]	39[a]	45[a]	51[a]	58[a]
Lsd (0.05)	NS	NS	2.63	2.41	3.04
M.O.P Level					
M1	26[a]	38	44	49[b]	56[b]
M2	27[a]	38	44	51[a]	60[a]
M3	27[a]	39	45	52[a]	57[ab]
Lsd (0.05)	NS	NS	NS	1.64	3.76

S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm. M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha

Table 4: Effect of spacing and muriate of potash on leaf area of sweet potato

Treatment	2nd week	4th week	6th week	8th week	10th week
Spacing					
S1	3.3	3.3	3.3	3.3[b]	3.3
S2	3.0	3.1	3.2	3.2[a]	3.2
S3	3.3	3.4	3.5	3.5[a]	3.5
S4	3.2	3.6	3.6	3.6[a]	3.6
Lsd (0.05)	NS	NS	NS	NS	NS
M.O.P Level					
M1	20[b]	24[b]	24[b]	24[b]	24[b]
M2	31[a]	34[a]	34[a]	34[a]	34[a]
M3	36[a]	37[a]	37 [a]	37.1[a]	37.1[a]
Lsd (0.05)	8.4	5.6	5.4	5.8	4.6

S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm. M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha

Table 5: Effect of spacing and muriate of potash on internodes length of sweet potato

Treatment	2nd week	4th week	6th week	8th week	10th week
Spacing					
S1	4.5	5.0	5.3	5.4	5.5
S2	4.0	4.5	4.7	4.9	4.9
S3	4.7	5.0	5.1	5.2	6.2
S4	3.9	4.3	4.4	4.5	4.5
Lsd (0.05)	NS	NS	NS	NS	NS
M.O.P Level					
M1	4.0	4.6	4.6	4.8	4.8

M2	5.0	5.2	5.2	5.2	5.24
M3	4.2	4.8	4.8	4.9	4.9
Lsd (0.05)	NS	NS	NS	NS	NS

S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm. M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha

Table 6: Effect of spacing and muriate of potash on number of branches of sweet potato

Treatment	2nd week	4th week	6th week	8th week	10th week
Spacing					
S1	2	4[ab]	4[ab]	5	6[bc]
S2	2	3[b]	4[ab]	5	5[c]
S3	3	5[ab]	6[a]	6	7[ab]
S4	3	6[a]	7[a]	7	8[a]
Lsd (0.05)	NS	2.41	2.06	NS	1.68
M.O.P Level					
M1	2	3[b]	4[b]	5[b]	6[b]
M2	3	6[a]	6[a]	7[a]	8[a]
M3	3	5[a]	5[ab]	6[a]	8[a]
Lsd (0.05)	NS	1.31	1.06	1.26	1.21

S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm. M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha

Table 7: Effect of spacing and muriate of potash on yield of sweet potato

Treatment	Number of tuber per plant	Average tuber	Tuber weight per plant (kg/plant)	Tuber yield (t/ha)
Spacing				
S1	3.14[c]	0.31[c]	0.98[B]	5.43[c]
S2	5.26[b]	0.45[b]	2.37[ab]	9.85[b]
S3	800[a]	0.51[ab]	4.11[a]	12.86[a]
S4	6.93[ab]	0.55[a]	3.79[a]	8.43[b]
Lsd (0.05)	2.10	0.09	2.11	2.7
M.O.P Level				
M1	4.6[b]	0.54	2.47[b]	7.22[b]
M2	6.0[a]	0.52	3.25[a]	10.14[a]
M3	5.91[a]	0.52	3.06[a]	9.57[a]
Lsd (0.05)	1.02	NS	0.43	1.84

S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm. M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha

Table 8: Effect of spacing and muriate of potash on leave nutrients composition of sweet potato

Treatment	Cho	Df	Tf	Pro	Ca	Mg	Fe
Spacing							
S1	2.2[a]	0.71[a]	0.10[a]	1.41[a]	12.61[a]	20.0[a]	0.41[a]
S2	2.1[a]	0.68[a]	0.17[a]	1.38[a]	12.84[a]	20.6[a]	0.38[a]
S3	2.2[a]	0.64[a]	0.14[a]	1.32[a]	12.73[a]	21.0[a]	0.38[a]
S4	2.2[a]	0.72[a]	0.10[a]	1.38[a]	12.66[a]	19.6[a]	0.42[a]
Lsd (0.05)	NS	NS	NS	NS	SN	NS	NS
M.O.P Level							
M1	2.3[a]	0.68[a]	0.11[a]	1.40[a]	13.0[a]	19.8[a]	0.39[a]
M2	2.0[a]	0.68[a]	0.10[a]	1.40[a]	12.8[a]	20.3[a]	0.41[a]
M3	2.1[a]	0.70	0.13[a]	1.40[a]	12.8[a]	20.1[a]	0.38[a]
Lsd (0.05)	NS	NS	NS	NS	NS	NS	NS

S1 = 30 cm, S2 = 45 cm, S3 = 60 cm and S4 = 75 cm. M1 = 0 kg/ha, M2 = 30kg/ha and M3 = 60kg/ha
Key: Cho= Total Carbohydrate (g), Df = Dietary Fibre (g), Tf = Total Fat (g), Pro = Protein (g), Ca = Calcium (mg), Mg = Magnesium (mg), Fe = Iron (mg).

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effect of Tillage and Seed Coating with Rhizobium Inoculants on N Uptake and Harvest Index of Soybean in the Northern Guinea Savanna Alfisols of Nigeria

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Abstract
A field experiment was conducted in continuity of our previous study to assess the effect of Tillage practices and Rhizobium *inoculation (RI) on nitrogen uptake and harvest index of soybean in the Northern Guinea Savanna Alfisol of Nigeria. Different treatments were i) tillage practices (conventional tillage (CT) and Reduced tillage (RT) and ii)* Rhizobium *inoculation (inoculated and uninoculated). Soybean variety TGX 1448-2E was as used as a testing crop.* Conventional tillage system gave statistically higher N uptake of soybean (84.48; 2011 and 175.57 kg ha^{-1}; 2012) when compared with that of reduced tillage system (77.49; 2011 and 167.17 kg ha^{-1}; 2012). Rhizobium inoculation soybean gave significantly higher N uptake and HI in both years. The percent difference was 51.10 % in 2011 and 85.91 % in 2012 for N uptake. These values were consistently lower in 2011 than 2012 in both treatments. *The results generally indicated a significant enhancement of N uptake and HI potential of soybean by Rhizobium inoculation with minimum tillage operations.*

Keywords: Tillage, Rhizobium, Inoculation, N uptake, harvest index

Introduction

Tillage enhances the mineralization of soil organic C and nitrogen (N) by incorporating crop residues, disrupting soil aggregates, and increasing aeration (Tangyuan *et al*., 2009) subsequently facilitates early emergence and root development of crop. But conservation tillage is a complex, fairly flexible agricultural system that can be widely adapted to local conditions and slow released of soil nutrient (Omeke, 2016a). However, frequent conventional tillage and excessive nitrogen fertilizer application not only reduces the crop productivity but also exacerbates soil erosion, air and water pollution (Godfray *et al*., 2010), thereby lowering soil productivity.

Rhizobium-inoculated soybean in cropping systems under minimum soil disturbances can meet most of the crop's N needs and contribute to soil N through a symbiotic nitrogen fixation (Omeke, 2016b). Legumes have been shown to reduce N fertilizer application in maize production by 18-68 kg N ha^{-1}, when compared to fallow system (Petrickova, 1992). Studies have indicated that legumes can fix up to 450 kg N ha^{-1} year^{-1} under optimal field conditions (Giller, 2001). Also, legume fixed between 16 to 50 kg N ha^{-1} of their total N and had an estimated N contribution to soil ranging from -22 to 3 kg N ha^{-1} depending on the ratio of N derived from atmosphere and N harvest index (Yusuf *et al*., 2009). However, optimum legume N-benefits can only be achieved in the presence of efficient rhizobial strains, which can be native to the soil or introduced in the form of commercial inoculants. Symbiotic nitrogen fixation is definitely beneficial to agriculture and is a major source of fixed nitrogen in agricultural soils. Inoculation of soybean seeds with proper bacterial strains increased grain production by 33-83 % over uninoculated soybean seeds (Omeke *et al.*, 2017). Reduced soil disturbance, for example, improves soil physical parameters; such as structure, and chemical and biological parameters that affect nitrogen fixation. weights (6.9 g/plant), number of nodules (96 number/plant) weight of nodules (0.318 g/plant) and root nitrogen Soil moisture and temperature, are known to be influenced by tillage, all of which affect biological nitrogen fixation (Salvagiotti *et al*., 2008). According to Kemal *et al.,* (2011), No-Tillage with Direct Seeding (NTDS) plots gave root content (% 0.71), which were statistically higher than with the other tillage methods. In reduced tillage with rotary tiller (RTR) plots, values of root dry weight (51.3 g/plant), mean nodule weight (3.91 mg/nodule), root N content (2.38 %) were higher than in NTDS plots. Studies in the northern Guinea savanna of Nigeria with respect to soil fertility problems included responses to inoculation with rhizobium (Sanginga, 2003; Vanlauwe *et al*., 2003; Okogun *et al*., 2005), nitrogen fertilizer and legume-rotation effect on maize performance (Yusuf *et al*., 2009) and soil nitrogen and soybean nodulation (Omeke, 2016a). But there is little information on the incorporation of coating of soybean seeds with rhizobia in the dominant cropping systems under different tillage practices. The current research, therefore, sought to investigate the effect of tillage and soybean coated with rhizobium inoculant on n uptake and harvest index of soybean in the Northern Guinea Savanna Alfisol.of Nigerian.

Materials and Methods

A field study was conducted at Research Farm of the 'Institute for Agricultural Research, Ahmadu Bello University (IAR/ABU)', Samaru, Zaria, during year 2011 and 2012 cropping seasons. The research field was located within latitude 11°11'19.3"N and Longitude 7°37'02"E. Samaru has an altitude of 686 m above sea level and is located in Northern Guinea savanna ecological zone of Nigeria. Samaru received a total rainfall amount of 1207 mm in year 2011 and 1333 mm in year 2012. Also, in both years, the third decadal of June witnessed reduced rainfall events, suggesting dry spell occurrence at this period. The rainfall data for 2011 and 2012 were obtained from the Meteorological Unit of the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria. The weather station is located about 100 m away from the experimental field. Rainfall and temperature data obtained for both seasons fell within the long-term range, with temperature of 21.05oC (minimum) and 33.47Oc (maximum) and annual rainfall of 1011 ± 161 mm. The main soil sub-group is Typic Haplustalf or Chromic Cambisols according to the FAO system of soil classification (FAO, 2001).

The experiment was laid in a randomized complete block design with split plot arrangement and three replicates. The treatments were tillage practice as main plot (reduced and conventional tillage) and rhizobium inoculation as sub plot (inoculated and uninoculated). The conventional tillage (CT) was manual ridging at 0.75 m apart using hoe and was remoulded at 8 weeks after sowing. For reduced tillage (RT) treatment seeds were sown directly without ridging at 0.75 m interval between the ridges and was not remoulded. Soybean (TGX 1448-2E) was used as a test crop. Phosphorus and potassium fertilizers were applied to all plots at the rate of 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} respectively at planting, without nitrogen fertilizer application. Weeds were controlled by the application of glyphosate at two weeks before land preparation at 4 l ha^{-1}. Subsequently, manual weeding was employed two times before harvesting. Each plot size measured 8 m by 5 m and soybean was sown on 1st July, 2011 and 6th July, 2012. The seeds were surface sterilized and inoculated with a Legume Fix bradyrhizobia strain using the method of IITA (2014). Soybean seeds were drilled in open grooves on the ridges and covered lightly with soil. The uninoculated soybean treatment rows were planted first in order to avoid cross contamination between rows. The seedlings were thinned to three plants per hill at 5 cm within row spacing at two weeks after planting. Subsequent field operations such as weeding were cautiously done manually to avoid transfer of rhizobia from inoculated rows to uninoculated rows. At maturity, four disturbed surface soil samples (0-15 cm depth) were taken at alternate points from four inner ridges per plot using a soil auger and used for determination of total nitrogen by micro-kjeldahl digestion method (Bremner and Mulvaney, 1982). All plants within the net ridges of each plot at crop physiological maturity (when 95 % of plants were brown) were cut at ground level, bagged, air-dried and manually threshed. The following measurements were obtained: weight of dry haulms and grain yield. The grains and haulms were ground in a hammer mill, passed through a 0.5 mm sieve and stored at -5 0C in bags for analysis of nitrogen content by micro-kjeldahl digestion method (Bremner and Mulvaney, 1982).

Harvest index and Total N uptake

$$HI = Gy/By \quad (1)$$

Where,

HI= Harvest index

Gy= Grain yield (kgha^{-1})

By= Total biomass yield (kgha^{-1}) at harvest.

$$By = Gy + Hy \quad (2)$$

Where;

By= Total biomass yield (kgha^{-1}) at harvest.
Gy= Grain yield (kgha^{-1})
Hy = Haulm yield (kgha^{-1})
Nt = Total plant N (kg N ha^{-1}) at harvest (grain + haulm) (kg ha^{-1})

All data were subjected to analysis of variance (ANOVA) using mixed linear model procedure of SAS, (Institute Inc., 2009). The effects of main factors and their interactions were compared by computing least square means and standard errors of difference (SED) at 5 % level of probability.

Results and Discussion

Conventional tillage system gave statistically higher N uptake of soybean (84.48; 2011 and 175.57 kg ha^{-1}; 2012) when compared with that of reduced tillage system (77.49; 2011 and 167.17 kg ha^{-1}; 2012) (Table 1). The same trends were observed for harvest index (HI) which was significantly higher under conventional tillage over reduced tillage with 49 % difference in 2012 only. Similarly, a significant difference was found between the tillage practices and rhizobium inoculation combined effects on HI (Figure 2) which was significantly higher under inoculated soybean plots in all the tillage practices. This shows a trend of increase over the years. This was supported by the greater N accumulation at harvest under CT which could be attributed to more readily availability of N and better rooting system as a result of pulverization of the soil than RT. Every effect that soil is subjected to has positive and negative reaction; in this case it was beneficial effect because it strongly reflected on grain yield.
The total plant N uptake in soybean and HI shows significant differences among the Rhizobium inoculation applications (Table 1). Rhizobium inoculation soybean gave significantly higher N uptake and HI in both years. The percent difference was 51.10 % in 2011 and 85.91 % in 2012 for N uptake. These values were consistently lower in 2011 than 2012 in both treatments. The data of HI recorded in 2011 are in line with 29 % reported by Wenting *et al*., (2019) while 2012 season are in conformity with the range of 45 to 55 % obtained by Dunigan *et al.,* (1984), 45 to 52% reported by singh *et al.,* (2002) and higher than mean value of 31 % established by Yusuf (2007) for the same variety. The positive response of the soybean as a result of Rhizobium inoculation could probably be due to the effectiveness of the Rhizobium strain (RACAL 6) as a result of low population densities of the indigenous Rhizobia, which in turn might be as a result of low rainfall and high temperature in this zone Sanginga *et al*., (1996); Yakubu *et al*., (2010) observed a similar relationship between the Rhizobial population and inoculation for soybean and cowpea in the Savanna zone of Nigeria respectively. Significant interaction between tillage practices and rhizobium inoculation was found on HI which indicated higher value under CT with inoculated soybean combination as compared to other treatment combinations (Figure 4). Harvest Index is very variable in grain legumes (McKenzie and Hill, 1990; Ayaz, 2001). Variability in HI among the legume was attributed to variability in yield components (Ayaz, 2001). The slight difference observed in this study between inoculated and uninoculated treatments was due to similar results obtained for DMY and symbiosis relationship between soybean and Rhizobium strain as well as favourable biotic and abiotic factors observed during the study.

Conclusions

No effect of tillage practices on N uptake, and HI were detected in 2011 but a favorable significant difference obtained in 2012 (second year) justified N improvement by soil tillage. Soybean seed coating with rhizobium inoculants is a viable option for enhancing N uptake and harvest index in soybean productivity. 3. The treatment combination appears to offer some N enhancement in the growth period after germination especially inoculated plots with reduced tillage.

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Table 1. Effect of tillage and Rhizobium inoculation on N uptake of soybean

	Total N uptake (kg ha^{-1})		Harvest index (%)	
Treatment	**2011**	**2012**	**2011**	**2012**
Tillage system (TS)				
CT	84.48	175.57	27.95	49.17
RT	77.49	167.17	27.82	40.53
± SE	1.94	5.77	0.62	0.02
Rhizobium Inoculation (RI)				
Inoculated (IN)	97.46	222.87	29.54	48.59
Uninoculated (UN)	37.01	66.75	29.54	41.11
± SE	0.79*	4.77**	0.62*	1.16*
Interaction				
TS x RI	NS	NS	**	**

***= Significant at P < 0.05, **= Significant at P < 0.01 and NS= Not significant**

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Figure 1: Tillage practices and Rhizobium inoculation interaction on harvest index in both years.

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ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Different Levels of Poultry Manure on The Growth and Yield of Sweet Pepper (*Capsicum annum* L.)

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Abstract
A pot experiment was carried out towards the end of the raining season in 2016 at the Centre for Dry-land Agriculture (CDA) screen house, Bayero University Kano ($11^0$58N, 8^0 and 475 m above sea level) within the Sudan savannah zone of northern Nigeria to evaluate the effects of different levels of poultry manure (PM) at the rates of 0, 1, 2, 3, 4 and 5 t/ha on the growth and yield of sweet pepper (capsicum annum). The results revealed that application of PM at the rate of 5t/ha produce the tallest plant (21.33, 25.53cm), higher leaf area (5.05, 6.70cm^2) and higher number of leaves (12.67, 16.33) and are significantly different from other application rates at 3 and 4 WAT respectively while the control treatment recorded the least values for all parameters measured. Treatments with the highest levels of PM (5t/ha) produced the highest yield of pepper and the number of fruits (14.48g, 3.67) while the control treatment had the least (7.29g, 1.33). From the findings of this study, it is thus recommended that growth and yield of pepper fruits could significantly ($P<0.05$) be improved by the application of PM at 5 tons/ha.

Introduction

Pepper (*capsicum species)* is one of the most widely grown fruit vegetables worldwide. It was believed to have originated from Tropical America before spreading to Europe, Africa and others parts of the world (Andrew, 1995; Ashilenje, 2013). Pepper is a very important fruit vegetable in the world and in the second most important vegetable after tomatoes (Olaniyi and Ojetayo, 2010). It has increased in popularity, value and importance over a long period, thus making it an indispensable part of the daily diet of millions of Nigerians. Pepper is normally used as in spice in the preparation of soup and stew when cooked with tomatoes and onions. It can also be used extensively in flavouring of processed meat, colouring certain food preparation and for medicinal purpose (Alabi, 2006). Nigerian soils have a high potential for crop production but yield levels obtained under farmer's practices are usually low due to poor soil management and conservation methods. This type of problem is solved through the use of fertilizer are applied to vegetables in order to achieve a higher yield (Stewart *et al., 2005)* and maximum value of growth (Dauda *et al.,* 2008). However, the use of inorganic fertilizers alone may cause problems for human health and environment (Arisha *et al* 2003). The use of inorganic fertilizer by resources poor farmers is limited by its scarcity and cost (Akanbi *et al*., 2001) and untimely availability (Adedoyin, 1995). The cultivation with persistent application of organic fertilizer increase soil acidity and soil physical degradation which may reduce crop yield (Ojeniyi *et al.* 2007).

Materials and Methods

Pot experiment during the rainy season of 2016 at the screen house of Centre for Dry-land Agriculture (CDA), Bayero University Kano (11^0 58N^0, 8^0 25E^0 and 475 m above sea level) within the Sudan savannah zone of northern Nigeria. The treatments consisted of 6 different rates of poultry manure 0, 1, 2, 3, 4 and 5 tonnes per hectare. The treatments were applied to the pots at about 3 days to transplanting. The experiment was then laid out in a completely randomized design (CRD) with three repetitions. Sweet pepper (*Capsicum annum*) was used for the study. The seeds were soured locally and were raised for 6 weeks in the nursery before transplanting into pots. A wooden box was used to raise the seedlings before transplanting. The soil was prepared by mixing sand and top soil at the ratio of 1:2:1. Seeds of sweet pepper were sown by drilling at 5 cm interval between rows. The seedlings were watered continuously every morning to keep the soil moist. The pots were filled with 6kg of river sand and were placed in the screen house after which the treatments were applied (0g, 3g, 6g, 9g, 12g and 15g for 0, 1, 2, 3, 4 and 5 tonnes per hectare respectively). The data collected were subjected to analysis of variance (ANOVA) using Genstat Version 17TH (2015). Treatment means found to be significantly different from each other were separated by Fisher's LSD at $p<0.05$.

Results and Discussion

Plant height (cm): The result obtained from the study shows that plant heights were significantly affected by the different rates of poultry manure (PM) applied. (Table 1) shows that pepper height increased with increase in poultry manures rates. The comparison of treatments' means at 2 WAT that the maximum plant height (16.63cm) was recorded from plots where 5 t/ha (PM) was applied, followed by 4 t/ha (14.97cm) and the lowest value 11.03cm recorded for control treatment 0 t/ha, while at 4 WAT, 5 t/ha recorded the highest value (25.53cm) and the lowest (14.87cm) was recorded for control treatment, plant height as influenced by poultry manure rates significantly different at 2, 3,and 4 WAT. The increase in poultry manure rate increased the number of leaves, plant height, leaf area and number of branches. These results are in accordance with the findings of Alabi (2006), Adewale, *et al.,* (2011), Ewolu *et al.,* (2008) that the plant height of pepper, garlic and tomato increased significantly as the fertilizer rates increases. This could be attributed to improved soil conditions (moisture retention, soil structure and aeration and increased nitrogen availability) following the poultry manure application. Nitrogen is known to enhance physiological activities in crops thereby improving the synthesis of photo-assimilation (Aliyu, 2000).

Leaf area (cm^2): The result in table 2 shows that leaf area was significantly affected by the different rates of PM applied. At 2,3 and 4 WAT, the application of 5 t/ha recorded the highest value 3.85 cm^2, 5.05 cm^2 and 6.70 cm^2 respectively and the lowest values (2.96 cm^2, 3.33 cm^2 and 3.94cm^2 respectively) was recorded for control treatment (Table 1). At 4 WAT, the treatment with 5 t/ha was significantly different from all other treatments. The observed increase in the size of leaf area implies that there is effective utilization of nutrients from the soil. This result is in consonances with Aliyu (2002, 2003) and this confirm the ability of poultry droppings to supply the required N content needed by pepper plants to enhance their growth and general performance (Alabi, 2006)

Number of leaves per plant: Number of leaves at 3 and 4 WAT was significantly influenced by the different dosages of PM, the highest value was recorded for PM at 5 t/ha 12.67 and 16.33 respectively and the least in control treatment 8.00 and 11.00. Application of 5 t/ha produced significantly higher number of leaves than the other treatment rates. However, application of 4 t/ha shows no significant difference at 3 and 4 WAT (Table 2). The observed increase in the size of leaf area implies that there is effective utilization of nutrients from the soil. This result is in consonances with Aliyu (2002, 2003) and this confirm the ability of poultry droppings to supply the required N content needed by pepper plants to enhance their growth and general performance (Alabi, 2006).

Number of fruits and fruit yield: Table 2 also reveals that the treatment with 5t/ha produced the highest number of fruits and fruit yield 3.67 and 17.25g respectively ant the least number of fruits was recorded in the control pot with 1.33 and also the yield of 7.29g. The increase in number of fruits and average weight could be attributed to the ability of PM to promote vigorous growth, increase meristematic and physiological activities in the plant due to supply of plant nutrient and improvement in the soil properties, thereby, resulting in the synthesis of more photo-assimilates, which is used in producing fruits (Dauda *et al.,* 2008). This result tallies with that of Dileep (2005) and Ajayi (2009) who reported significant response in yield to different levels of manure applications.

Conclusion

From the results generally, it is sufficing to suggest that application of poultry manure albeit at higher application rates improve pepper yield. The major reason being that poultry manure contains essential nutrient elements associated with high photosynthetic activities and thus promoted roots and vegetative growths and the increase in poultry manure rate increased the number of leaves, plant height, leaf area, number of branches, as well as the yield of pepper. Increasing yield and production of pepper can thus translate in an increase in the standard of living of farmers who engaged in pepper cultivation.

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Table 1. Effects of rates of Poultry Manure on the Plant Height (cm), Leaf Area (cm²), Number of Fruits and Fruit Yield (g) per Pot

Treatments (t/ha)	Plant Height (cm)			Leaf Area (cm²)			Numbers of fruits	Fruit yield in (g)/Pot
	2WAT	3WAT	4WAT	2WAT	3WAT	4WAT		
0	11.03	12.33	14.87	2.92	3.33	3.94	1.33	7.29
1	12.57	14.53	17.33	3.36	3.95	4.71	2.00	10.68
2	13.70	16.40	18.53	3.28	3.98	4.86	2.33	11.68
3	13.73	17.03	20.70	3.84	4.66	5.85	2.67	12.56
4	14.97	18.67	22.63	3.77	4.76	6.16	3.00	14.48
5	16.63	21.33	25.53	3.85	5.05	6.70	3.67	17.25
S.E ±	0.26	0.32	0.69	0.22	0.19	0.2	0.39	0.35

Mean followed by the same letter in each row for each parameter are not significantly different from each other by Fisher's LSD at 5% level of probability WAT- Weeks After Transplanting

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Lime Rates and Varieties on Yield and Yield attribute of Groundnut (*Arachis hypogaea* L) in Northern Guinea Savanna of Nigeria

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Abstract
This current investigation was undertaken to assess the effects of lime rates and varieties on yield and yield attributes of groundnut (Arachis hypogaea L) in the Northern guinea savanna of Nigeria. The experiment was conducted during the 2013/2014 wet and dry season at the Teaching and Research farm of the Institute for Agricultural Research, Samaru Zaria. The treatment consists of four (4) rates of lime ($CaC0_3$) viz: 0,400,800 and 1200 kg ha-) and four varieties of groundnut (SAMNUT-10, SAMNUT 21, SAMNUT 22, and SAMNUT 24). Results showed that both varieties and lime rates had significant effects on the selected yield and yield attributes. Pod weight, kernel weight and kernel numbers were significantly higher in dry season than wet season. Among varieties, SAMNUT 22 and SAMNUT 21 outperformed other genotypes in yield attributes in both seasons. For instance, the highest average kernel weight of 50.29 g plant^{-1} was obtained in SAMNUT 21 with the application of 400 kg ha^{-1} of lime. Generally, the average pod yield was 18% higher in dry season (1827 kg ha^{-1}) than wet season (1460 kg ha^{-1}). Application of 400 kg ha^{-1} lime to SAMNUT 21 and SAMNUT 22 resulted to higher kernel weight in dry season. Therefore, based on the findings, the influence of lime rates on the productivity of groundnut can be grouped into two: SAMNUT 21 and SAMNUT 22 yield were enhanced with the application of 400 kg ha^{-1} of lime, whereas, application of lime at the rate of 800 kg ha^{-1} and above translated to an increase in harvest index (HI), nodule number and proportion (percentage) of matured pods.

Key words: Lime, Rates, SAMNUT, Growth, Yield

Introduction

Groundnut (*Arachis hypogaea* L.), also known as peanut, earthnut, monkey-nut or goober, is a self-pollinating, indeterminate, and annual herbaceous legume crop (Adinya *et al.,* 2010) ranked as the thirteenth most important food crop of the world; fourth most important source of edible oil and the third most important source of vegetable protein (Taru *et al.* 2010). According to Yakubu *et al*. (2010), groundnut has the potential to fix atmospheric nitrogen at the rate of 21 to 206 kg/ha annually in soils through root nodule bacterium belonging to the genus *Rhizobium*, thus improves soil fertility. In Nigeria, groundnut is cultivated as an excellent food crop, containing about 60% highly digestible protein, 22% carbohydrate, 4% minerals and about 8% fat (John, 2010). Traditional commercial groundnut producing areas in Nigeria encompass the Sahel, Sudan and derived savanna, Northern Guinea and most parts of the Southern Guinea vegetation zone. The major groundnut producing states are Kano, Katsina, Kaduna, Jigawa, Sokoto, Zamfara and Kebbi in the Northwest; Adamawa, Bauchi, Yobe and Borno in the Northeast; and Benue, Plateau, Taraba, Nasarawa, FCT Abuja, Kogi, Niger and Kwara in the Central Zone (Ajeigbe *et al.,* 2015). However, there is high prospect of commercial production of groundnut in the transition zone between the southern guinea savannah and the derived savanna zone of Nigeria in the southern part of the country, particularly Cross River and Ebonyi State. Like most annuals, optimum yield of groundnut is often realizable with balance supply of both organic and inorganic fertilizer, with particularly high proportion of phosphorus and calcium fertilizer. However, this optimum condition is rarely achievable with the current degraded state of soils in the northern guinea savanna zone of Nigeria. Among factors affecting groundnut yield, soil fertility constraints are among major

limitations for optimum groundnut production among small holder farmers in Africa due to little or no external input to replenish nutrients lost at harvest. Moreso, groundnut (*Arachis hypogaea L*) plants are sensitive to extreme salinity and acidity. Acidity is believed to rank among the top hindrances to good yields (CIMMYT, 1998; Donovan *et al*. 2002). Approximately 30% of the world's total land area consists of acidic soils, and as much as 50% of the world's potentially arable lands are acidic (von Uexkull and Mutert, 1995). The production of staple food crops, and in particular grain crops, is negatively impacted by acid soils, and high soil acidity (pH<5) could induce magnesium or aluminum availability and toxicity (Ntare *et al.,* 2008).
Under acidic conditions, calcium and magnesium supply is reduced and plant growth suffers. In addition to these, other beneficial nutrients such as nitrogen, phosphorus, sulphur are also in deficient concentration (Mulungu *et al*., 2013). The low yields of groundnut in acid soils are due to poor pod filling, which is because of poor calcium supplying power of soils. Thus, it becomes evident that all efforts have to be made to improve the yields of this crop. To meet the calcium demand as well as to create favorable conditions for better uptake of other essential nutrients particularly phosphorus, liming is an important management practice in acid soils. Improvement of these acid soils should also aim at eliminating the toxic effects of Al and Mn (Rajkishore, 2005). Liming helps in raising the base saturation of the soil and inactivation of iron, aluminum and manganese in the soil solution (Ntare *et al.,* 2008). Liming also helps to minimize phosphate fixation by iron and aluminum. Mulungu *et al*. (2013) reported the need for raising soil pH beyond the point of neutralizing exchangeable aluminum particularly for legumes and this can be achieved by raising soil pH by adding suitable quantity of lime (Rajkishore, 2005). In the light of the above considerations, the present investigation was undertaken with the aim of determining the response of groundnut genotypes to rates of lime application in Northern Guinea savanna of Nigeria.

Materials and Methods

One field trial was conducted during the wet season of 2013 and repeated during the 2013/2014 dry season under irrigation. Both trials were conducted at the Teaching and Research farm of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, Zaria. (11^0 11′N, 07^0 38′ E, 686m above sea level) located in the Northern Guinea Savannah of Nigeria. The soils of the experimental sites were well-drained loamy and silty-loam in wet and dry season respectively with low values of N (0.42%), P (8.8 mg kg-), K (0.18 Cmol kg^{-1})
Prior to the commencement of the field trials in both seasons, the experimental area was marked out from the whole field, cleared, ploughed, harrowed twice and ridged at an inter row spacing of 0.75m apart. The treatments consist of four varieties of groundnut (SAMNUT-10, SAMNUT-21, SAMNUT-22 and SAMNUT-24) and four rates of lime ($CaCO_3$) (0, 400, 800 and 1200 kg ha^{-1}) laid out in a split-plot design with three replications. The various groundnut genotypes represent the main plots while the lime rates were assigned to the sub plots.
Soil samples were randomly collected from 10 within the two experimental sites with dimensions of 0.24 ha each at the depth of 0-30cm using an auger before seed sowing. Samples from each field were bulked, air-dried and a composite was analyzed for physico-chemical properties using standard procedures as described by IITA, (1993).
At harvest, observation was carried out on yield parameters such as pod and kernel yield, kernel number per plant, 100 seed weight, Harvest index (HI), and percentage of matured pod. Data collected were subjected to analysis of variance (ANOVA) using SAS software (SAS. Institute Inc. 2000).

Results and Discussion

Results of the effects of varieties and lime rates on yield and yield attributes of groundnut in wet and dry season is shown in Table 5. Results showed a significant difference (p<0.05) among varieties in both seasons. In wet season, the highest pod yield was reported in SAMNUT 21 (46.69 g $plant^{-1}$) which was at par with SAMNUT 22 (47.61 g $plant^{-1}$). However, in dry season the trend was not maintained, whence, the highest pod yield was reported in SAMNUT-21 with an average of 63.76 g $plant^{-1}$ which was statistically similar with SAMNUT-10 which had an average yield of 61.81 g $plant^{-1}$ in both years, the least pod yield was consistently reported in SAMNUT-24. Generally, the average pod yield was 18% higher in dry season (55.04 g $plant^{-1}$) than wet season (39.98 g $plant^{-1}$).
Application of lime also had significant effects on pod yield of groundnut in both wet and dry seasons. In the wet season, application of 1200 kg ha^{-1} of lime had similar effects on the pod yield as those reported for the

control and 400 kg ha^{-1} application rates. During the dry season on the other hand, there was a progressive increase in pod yield of groundnut with increase rate of lime up to 800 kg ha^{-1}. With further increased above 800 to 1200 kg ha^{-1}, reduction in pod yield of groundnut varieties was reported. Results further revealed that interaction between varieties and lime rates was not significant.

Number of pods per plant significantly ($P<0.05$) differed among varieties and lime rates in both seasons. In wet season, the highest number of pods was recorded in SAMNUT-21 (41.48) and SAMNUT 22 (41.61) while in dry season SAMNUT 21, SAMNUT-22 and SAMNUT 10 had statistically similar number of pods. Generally, average number of pods per plant was higher in dry season (48.79) than wet season (36.69). Four hundred kilogram per hectare (400 kg ha^{-1}) rate of lime application gave the highest pod number in both wet and dry season. Average kernel weight and number was higher in dry season than wet season. Whereas, among varieties, SAMNUT 21 and SAMNUT 22 were the best in both seasons, and outperformed other varieties. Result further showed significant interaction between varieties and lime rates on kernel weight in dry season (Figure 1), whence, the highest (50.29 g plant $^{-1}$) kernel weight per plant was obtained with the combination of SAMNUT-21 and 400 kg ha^{-1} of lime.

Nevertheless, other yield results further showed that higher pod, kernel and seeds yield were reported in SAMNUT 22 in both seasons. Harvest index (HI) and percentage of matured pods were significantly ($P<0.05$) improved by lime rates up to 800 kg ha^{-1}. Like other yield parameters earlier discussed, 100 seed varied significantly among genotypes in both seasons. The highest (49.92) and lowest (36.48) values were reported in SAMNUT 22 and SAMNUT 24 respectively. Similarly, lime application had no significant effects on 100 seed weight. Average 100 seed were generally higher in dry season (49.9) than wet season (45.11). Harvest index (HI) significantly differed among genotypes in both season. In wet season, SAMNUT 22 (48.92) and SAMNUT 24 (47.49) were significantly similar and returned the highest values. In the same season, varying the rate of lime had significant effects on HI of the various groundnut genotypes. Hence, the application of 400 kg $ha^{-1}$of lime gave the highest HI value of 38.23. On the other hand, in dry season, the highest (43.28) and lowest (17.57) values were reported in SAMNUT 24 and SAMNUT 22. Similarly, the control and 400 rate of application had the same effects on the HI of groundnut.

The variation in yield and yield attributes among groundnut genotypes confirmed the earlier observation reported by Agah *et al*. (2016) who found significant variation in growth and yield attributes among ten selected groundnut genotypes in Samaru, Zaria, Nigeria. The researchers however attributed the differences to inherent genotypic variability existing among species. Similarly better growth conditions such as bright light, high temperature and low relative humidity in dry season could be responsible for the higher yield and yield attributes advantage observed during the dry season relative to wet season. Under such favorable environmental conditions, assimilate production and translocation via photosynthesis is enhanced. Generally, increase in pod yield with the application of lime corroborates the findings of Hosseinzabeh *et al*. (2013) who reported positive influence of Ca on pod, kernel and biological yield of groundnut.

Conclusion

Vast areas of arable land in the humid and dry tropics are strongly acidic thereby negatively influencing the overall output of grain crop per unit area. Results showed that variety and lime rate was significant on most of the yield and yield attributes. This implies that lime rates significantly improved the selected yield and yield attributes of groundnut varieties. Therefore, based on the findings, the effects of lime rates on the productivity of the selected groundnut varieties can be grouped into two viz: SAMNUT 21 and SAMNUT 22 yield were enhanced with the application of 400 kg/ha of lime, whereas, applying lime at 800 kg/ha and above translated to an increased in harvest index (HI), nodule number (not included due to page restriction) and proportion (percentage) of matured pod.

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Table 1: Effects groundnut varieties and lime rates on pod yield, kernel yield, 100 seed count and harvest index of groundnut at harvest during wet and dry season

	Wet Season					Dry Season				
Treatment	Pod yield (kg/ha)	Proportion of Matured Pod	Kernel yield (kg/ha)	100 Seed (g)	Harvest Index (HI)	Pod yield (kg/ha)	Proportion of Matured Pod	Kernel yield (kg/ha)	100 Seed (g)	Harvest Index (HI)
Variety (V)										
SAMNUT-10	1415c	63.83c	737c	46.80 b	28.94 b	1775 b	65.08c	948c	56.08 a	22.05 b
SAMNUT-21	1523b	65.42b	857c	47.25 b	19.17 c	1987 a	65.46c	1151b	56.94 a	21.31 b
SAMNUT-22	1612a	65.58b	1130a	49.92 a	48.93 a	2019 a	66.33b	1507a	46.45 b	17.57 c
SAMNUT-24	1289d	68.71a	861b	36.48 c	47.49 a	1453 c	70.13a	863c	38.11 c	43.28 a
Mean	1460	65.89	896	45.11	36.13	1827	66.75	1117	49.39	26.05
SE±	29.01	0.22	40.68	0.52	1.44	38.85	0.20	51.92	0.50	1.27
Lime rates (L)										
0	1482	62.58d	924	44.75	35.65 b	1828	63.00c	1126	49.63	27.28 ab
400	1467	67.25b	931	45.78	38.23 a	1812	68.96a	1180	49.11	24.68 ab
800	1425	68.29a	834	45.51	33.82 c	1813	69.04a	1030	50.02	28.16 a
1200	1465	65.42c	887	44.71	36.84 b	1855	66.00b	1133	48.83	24.09 b
SE±	40.00	0.22	40.68	0.58	2.54	38.85	0.20	51.92	0.50	1.27
Interaction										
V x L	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

Means within the same column and treatment group followed by the same letter(s) are not significantly different at 5% probability level, S.E = Standard Error

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Organic Manure and Npk Fertilizer on the Yield And Performance of Sweet Potato Varieties (*Ipomoea Batat*as (L) Lam in Nyanya, Fct, Abuja

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Abstract

In Nigeria, one of the major problems confronting agriculture is poor soil fertility replenishment strategy that could allow sustainable crop production. A field trial was conducted at National Root Crops Research Institute Nyanya out-station with the aim of studying the effects of organic manure and NPK fertilizer on the yield and performance of sweet potato varieties. The trial was conducted during the 2018 farming season. Treatments comprised of seven treatment combinations of 50% cow dung (3tons/ha), Poultry manure (3tons/ha), NPK (2.59kg/ha), 25% cow dung (1.5tons/ha), poultry manure (1.5tons/ha), NPK (1.295kg /ha), and (0kg/ha control) and 2 varieties of sweet potato (butter milk and umuspo 1). These treatments were factorially combined and laid out in a randomized complete block design, with three replications. Results obtained showed that Vine length were significantly different at 4, 6 and 10 WAP at ($P<0.05$). Treatment combination of (25% NPK+25% PM) gave the highest value for vine length. Treatment of 50 % poultry manure gave the highest number of tubers (15) with NPK giving the lowest number of tubers (8). It is recommended that application of poultry manure (3tons/ha) should be adopted for the cultivation of sweet potato in the study area.

Keywords: Variety, Organic manure, Potato

Introduction

Sweet potato (*Ipomoea batatas)* is a warm season root crop widely grown in the Tropics. According to udo *et al*. *(*2005), the largest producer of sweet potato outside the Tropics is Japan. However, China and United States of America produce substantial quantities. It is ranked the third most important root crops after cassava and yam. The root tubers are used as food for man and livestock in many countries of the world, it also serves as raw materials for the manufacture of starch, glucose and alcohol. The leaves are used as vegetables in some communities in Nigeria. Plant nutrients are essential for the production of quality crop. Plant nutrients are vital components of sustainable Agriculture; increase in crop relies on the type of fertilizer and manure used to supplement essential nutrients for plant growth. Intensive use of chemical fertilizers was advocated for crop production in the tropics in order to alleviate these nutrient deficiencies (Anonymous, 2000). The yield of sweet potato like other crop is influenced by climatic, biological and soil factors (Udo *et al*., 2005; NRCRI, 2008). Among the soil factors, fertility is the most important for its production. Use of organic manure is a traditional method of boosting soil fertility although the use of inorganic fertilizer like NPK is becoming increasingly important.

Materials and Methods

The study was carried out at National Root Crops Research Institute Nyanya-Out Station, Abuja (Latitude 9.06°733°E and Longitude 7.62°318°N) during the 2018 cropping season. The experiment was laid out in a

Randomized Complete Block Design with three replications, the plot size was 2x2 (4 m^2) having 14 plots in each replication with a distance of 1m between the replicates and 1m between the treatments. Treatment comprises seven treatment combinations of 50 % cow-dung (3 tons/ha), poultry manure (3 tons/ha), NPK (2.59 kg/ha), 25 % of cow-dung (1.5 tons/ha), poultry manure (1.5 tons/ha), NPK (1.295kg/ha) and control (0kg/ha).

Data were collected on vine length, number of leaves, number of tubers and weight of tubers and were subjected to analysis of variance using SAS (2008). Means were separated using Student-Newman Keuls Test at p<0.05.

Results and Discussion

Table 1 shows the result of physical and chemical properties of the experimental site. Results showed that the pH is 6.8 which is at neutral level. The result also showed that textural class of the soil is sandy loam. The available phosphorus of the soil analyzed has a value of 7.31 $mgkg^{-1}$. The organic carbon is low with a value of 8.13 gkg^{-1}; this may be as a result of poor vegetation, continuous cropping and subsequent bush burning which are characteristics of savanna soil. The total nitrogen was 0.78 which is low this may be due to continuous use of land over the years.

The result in Table 2 shows the effect of treatment combination and cultivars on the performance of sweet potato vine length. Vine length was significantly different (p<0.05) at 4, 6 and 10 weeks after planting (WAP). However, at 8 WAP, there was no significant different (p> 0.05). The longest vines were observed in treatments combination of 25% NPK+25% PM of 91.58 cm and 393.47cm at 4 and 8 WAP respectively. The application of 25 % NPK + 25 % CD + 25 % PM resulted in longest vine length (138.39 cm) at 6 WAP, while application of 50 % PM at 10 WAP resulted in highest vine length (914.17 cm) which could be due to high nitrogen uptake (Owudike, 2010), while the shortest vine lengths were observed in the control at 4, 6, 8, and 10 WAP. This result is in line with the findings of Ebregt *et al*., 2004;Nodolo *et al.,*2007) who reported that survival of sweet potato vine is more related to the conditions of the Agro-ecological zones and that the most common cause of planting material failing to take off is drought. A significant difference was also observed in vine length between both cultivars at 4, 6, 8, and 10 WAP. Butter milk consistently recorded longer vine lengths compared to Umuspo1.

Table 3 shows the effects of treatment combination on the number of leaves. Number of leaves was not significantly different (p<0.05) at 6, 8 and 10 WAP. However, number of leaves was significantly different at 4wap with control having the lowest number of leaves (37) which could be due to high nitrogen uptake (Owudike, 2010). This also conforms to the findings of Tesfaye *et al.,* (2003) who reported that application of maximum manure helps in foliage development. Number of leaves was not significantly different among cultivars

The effect of treatment on the yield and weight of potato in Table 4 revealed that the application of 50% Poultry manure (3ton/ha) gave the highest numbers of tubers. The influence of poultry manure application in improving soil physical conditions has been widely reported (Weil and Kroontse, 1997; Khaleel *et al.,* 1981), Paglial *et al*., 1987;Akanni, 2005). Plots treated with poultry manure produced more tuber than those to which NPK was applied. This confirms results of other field trials that showed that sweet potato were higher and consistent where organic manure rather than inorganic inputs were applied (Hartemink, 2003) while NPK (2.59kg/ha), gave the lowest number of tubers, this is in line with the findings of FAO (2005) who reported that inorganic fertilizer can decrease the number of harvested tuber.

Conclusion

From this study it is recommended that application of poultry manure (3tons/ha) should be adopted for the cultivation of sweet potato in the study area.

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Table 1: Physical and chemical properties of soil of the experimental site

Parameters	Value
Particle size distribution (g kg^{-1})	
Sandy	662
Silt	225
Clay	113
Textural class	Sandy loam
Chemical properties	
pH (1:2.5) soil water ratio	6.8
$CaCl_2$	6
Organic Carbon (g kg^{-1})	8.13
Total N (g kg^{-1})	0.78
Available P (mg kg^{-1})	7.31
Exchangeable bases	
Ca^{2+} (cmol kg^{-1}))	9.2
Mg^{2+} (cmol kg^{-1})	9.2
K^{+} (cmolkg^{-1})	0.58
Na^{+}	1.55
Exchangeable acid (cmol kg^{-1})	0.14

Table 2: Effect of treatment combination and cultivars on the growth of vine length

Treatment(T)	Weeks After Planting(cm) 4	6	8	10
Control(0kg/ha)	51.53b	89.22 b	278.17 a	631.33 c
NPK (400kg/ha)	60.07 b	96.55 b	342.65 a	800.33 ab
50 % CD(3tons/ha)	51.77 b	105.32 ab	292.63 a	700.17 bc
50 % PM (3tons/ha)	67.80 ab	125.92 ab	362.73 a	913.17 a
25 % NPK + 25 % CD + 25 % PM (1.295kg/ha+1.5tons/ha+1.5ton/ha)	75.53 ab	138.39 a	361.2 a	872.67 a
25 % NPK + 25 %PM (1.295kg/ha+1.5tons/ha)	91.58 a	129.77 a	393.47 a	879.33 a
25 % NPK + 25 % CD (1.295kg/ha+1.5tons/ha)	74.07 ab	132.1 a	358.17 a	819 ab
SE±	10.71	13.74	41.42	60.94
Cultivar (C)				
Butter milk	92.45 a	153.23 a	502.6 a	1009.24 a
Umuspo1	42.51 b	80.27 b	179.98 b	595.33 b
Interaction				
TxC	NS	NS	NS	NS

Means followed by the same letter(s) within the rows and columns are not significantly different (p<0.50) by Student-Newman-keuls Test. NS=Not Significant, CD=Cow-Dung, PM=Poultry Manure

Table 3: Effect of treatment combination and cultivars on the growth of sweet potato leaves

Treatment(T)	Weeks After Planting 4	6	8	10
Control(0kg/ha)	36.6ab	265.33a	397.33a	707.8a
NPK (400kg/ha)	40.53ab	270a	397.33a	793a
50 % CD(3tons/ha)	39.1ab	317.67a	406.56a	852.8a
50 % PM(3ton/ha)	52.16a	306.83a	392.67a	937a
25 % NPK + 25 % CD + 25 % PM (1.295kg/ha+1.5tons/ha+1.5tons/ha)	58.93a	364.5a	487.17a	956.3a
25 % NPK + 25 % PM (1.295kg/ha+1.5tons/ha)	56.37a	312.5a	413.83a	949a
25 % NPK + 25 % CD (1.5tons/ha+1.5tons/ha)	55.93a	390.5a	523.33a	1024.3a
SE±	6.87	44.79	57.64	104.27
Cultivar (C)				
Butter milk	48.05a	318.81a	442.67a	955.76a
Umuspo 1	47.49a	317.57a	419.67a	821.48a
Interaction				
TxC	NS	NS	NS	NS

Means followed by the same letter(s) within the rows and columns are not significantly different (p<0.50) by Student-Newman-keuls Test

NS=Not Significant, CD=Cow-Dung, PM=Poultry Manure

Table 4: Effect of treatment combination on yield and weight of tagged plants

Treatment(T)	Number of tubers	Weight of Tubers(kg)
Control(0kg/ha)	10ab	1.6a
NPK (400kg/ha)	8b	1.1a
50 % CD(3tons/ha)	13ab	2.02a
50 % PM)3tons/ha)	15a	2.4a
25 % NPK + 25 % CD + 25 % PM (1.295kg+1.5tons/ha+1.5tons/ha)	9ab	2.22a
25 % NPK + 25 % PM (1.295kg/ha+1.5tons/ha)	10ab	1.52a
25 % NPK + 25 % CD (1.295kg/ha+1.5tons/ha)	12ab	2.52a
SE±	2.07	0.55
Cultivar (C)		
Butter milk	12a	1.65a
Umuspo 1	10a	2.19a
Interaction		
TxC	NS	NS

NS=Not Significant, CD=Cow-Dung, PM=Poultry Manure

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Mulching Materials on the Growth and Yield of Watermelon (*citrullus lanatus*) in Southeastern, Nigeria.

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Abstract

The research was carried out in 2018 and 2019 dry season to evaluate the effects of different mulching materials on the growth and yield of watermelon in Abakaliki, Nigeria. The experiment was laid out in a randomized complete block design (RCBD) in a 2 x 5 factorial experiment in three replications. The treatments consisted of two varieties of watermelon (Kaolack and Sugar baby) and five different mulching materials (black plastic mulch, transparent plastic mulch, saw dust mulch, dry grass mulch and a control). The plots were irrigated twice daily (morning and evening) enough to make moisture available for the plants. Sugar baby variety performed better than Kaolack in all the agronomic characteristics measured. All the mulching materials differed significantly ($p<0.05$) from the control on all the agronomic characteristics measured. However, saw dust mulch was better in enhancing watermelon performance, followed by transparent plastic mulch, then black plastic mulch, while the least came from the control. On the other hand, the treatments generally increased moisture content which also increased the crop yield over the control.

Keywords: **Watermelon, watermelon production, mulch, mulching, mulching materials, growth and yield parameters.**

Introduction

Watermelon (*Citrullus lanatus*) is one of the most widely cultivated crops in the world and the global production in 2002 reached 89.9 million grams (Huh *et al*., 2008). China was reported to be a leading country in the production of watermelon (70.3%) followed by Turkey (4.7%), Iran (2.3%), United States of America (2.2%), Egypt (1.7%) and the Republic of Korea (1.2%) (Huh *et al*., 2008 and Wehner and Maynard, 2003). There are over 1,200 varieties of watermelon worldwide and quite a number of these varieties are also cultivated in Africa (Zohary and Hopf, 2000). Watermelon is one of the most popular and widely grown cucurbitaceous fruit vegetables in tropical and subtropical countries of the world. Its global consumption is greater than that of any other cucurbits and account for 6.8 percent of the world area devoted to vegetable production (Goreta *et al*., 2005). Different mulching materials have different effectiveness for enhancing performance because of their different capacities in absorbing moisture due to their aggregate nature in allowing air circulation (Carlson and Wilson, 1997; Mozunder *et al.,* 2005), while others have detrimental effects including higher occurrence of pests and reduced agronomic performance of the crops (Khan *et al.,* 2005). Rweyemamu *et al*., (1998) reported that mulching was effective in controlling weeds and emphasized that rice hull mulch was more effective than dry grass mulch. According to studies by Carlson and Wilson (1997), baggase and chopped palm fronds were the best in controlling weeds, while juniper and blue spruce had adverse effects on Bermuda weed without affecting production of tomato and radish. On the other hand, pine mulch was not recommended for use in tomato due to its adverse effects on soil pH, tomato health and production. It is therefore, important to investigate the relative effectiveness of mulch types on environmental and micro-climate conditions, vegetable production, net revenue generation and production costs reduction for possible recommendation and use by the farmers. Soil mulching with plastic films is very beneficial because cucurbits, watermelon being one of them, are very shallow rooting and do not like being hoed (Messiaen, 1992). Against this backdrop therefore, the objective of this research was to test the effects of available, affordable mulching materials in this zone on the growth and yield of watermelon.

Materials and Methods

Researches were conducted at the research farm of the Department of Crop Production and Landscape Management, Faculty of Agriculture, Ebonyi State University, Abakaliki, during the dry season of 2018 and 2019. The treatments were five mulching materials (transparent plastic mulch (TPM), black plastic mulch (BPM), dry grass mulch (DGM), rice hull mulch (RHM) and a control) and two watermelon varieties (Kaolack and Sugar baby) grown in Nigeria, which were laid out in a factorial experiment arranged in a randomized complete block design (RCBD) in four replications. Each replication contained ten (10) plots giving a total of 40 plots in the experiment, each plot measured 4 x 4m (8m) allowing 1.0m between adjacent plots, while 1.0m separated each replicate or block. Flat beds were manually prepared while seeds were sown at 2-3cm depth, 4 x 4m apart starting at the end of January each year. Weeds were removed as at when required by hand picking especially on the control plots and dry grass mulched plots during the crop growing periods. The agronomic characteristics were measured and recorded. The data collected were subjected to analysis using the General linear Model in SAS and the treatment means were compared using Turkey´s test while the residual effects of treatments were also tested using Anderson Darling´s test.

Results

The number of fruits obtained from Sugarbaby variety was significantly ($P<0.05$) higher than Kaolack in 2018, whereas Kaolack was statistically higher than Sugarbaby in 2019 as seen in Table 1. Sugarbaby produced 7.43 fruits in 2018, where Kaolack produced 6.45 fruits, whereas in 2019, Kaolack produced 5.33 fruits which differ significantly from 3.84 fruits produced by Sugarbaby. Black plastic mulch produced the highest number of fruits (15.45), followed by rice husk mulch (9.33) and Black plastic mulch (9.33) in 2018, whereas in 2019 rice husk produced the highest number of fruits (9.67 and 5.33). The lowest number of fruits (approximately 2) was recorded from the control mulch in 2018. Variety x mulch interaction was significant with the highest number of fruits (15.45) and the lowest number (2.20) obtained from Sugar baby under black plastic mulch and the control respectively in 2018, whereas Kaolack under rice husk produced the highest fruit number (9.67) among other treatment combinations in 2019, followed by 5.33 fruits obtained from Sugarbaby under rice husk mulch. On the other hand, Sugar baby under control mulch produced the lowest number of fruits with 2.67 fruits in the second planting.

Discussion

The significant varietal differences on yield components of watermelon suggest the potentials and the inherent superiority of watermelon varieties for exploiting its production. Thus sugar baby has an inherent potential for production of more fruits despite the fact that Kaolack have more vegetative growth. Varieties of watermelon can be selected for the superiority in resisting cracking, sun scotch and blossom end rot disease of fruits. A variety can be selected for cultivation in order to meet the fruit quality market demands. In general, mulching seemed to promote better performance of watermelon varieties in most of the yield parameters. Khan (2005) reported that organic mulch has been found to have multiple advantages in culture, resulting to enhanced physiological efficiency of the plants. These advantages include soil moisture conservation, suppression of weeds, maintaining soil structure, optimizing soil temperature and enriching the soil with organic matter. Watermelon like any other horticultural crops needs intensive application of nutrient and moisture. Utilization of nutrients in the soil depends on efficient mobilization which in turn is a function of moisture availability. Thus mulch has a direct impact on plant performance by supplying moisture and indirect impact on nutrient availability through enhanced mobilization of the nutrients from the soil. Number of branches and number of fruits were influenced by mulches. These parameters were found to differ significantly from other mulch applications and watermelon varieties in all the cropping seasons. The highest number of branch and number of fruits were obtained under rice husk application in this study. There were significant differences among the watermelon varieties in terms of these parameters in all this study. Sugarbaby produced the highest number of branch and number of fruits. This is in agreement with Farios–

Larios and Orozco-Stantos (1997) who reported that marketable fruits from the mulch treatments were higher than those produced on bare soil. Similarly, Bonanno and Lamont (1987), Brinen and Locascio (1979), Carter and Johnson (1988) all of them reported that total and early yields increased with polyethylene mulches.

Conclusion

Farmers should therefore be encouraged to apply mulch as a crop husbandry practice for moisture availability during the off season. In their effects on yield parameters, rice husk and black plastic mulches were more effective followed by white plastic mulch. It is therefore, recommended that rice husk mulch should be used as mulch by farmers especially in rice growing areas like ours where this by-product is generated in large amounts. It was evidently observed in this work that rice husk mulch greatly influenced the growth and yield parameters and sometimes compared favourably with other mulch types, such that if any of this becomes scarce, this by-product can be effectively utilized. Using this product as mulch can help cleanse the environment, prevent pollution, save and reclaim threatened lands and increase soil fertility.

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Table 1: Effect of mulching materials on the number of fruits of two watermelon varieties during 2018 and 2019 dry season plantings.

		Varieties		
Year	Treatments	Sugar baby	Koalack Mean	
2018	Mulching Materials			
Control (zero)	2.20b	4.00ab	3.10B	
Black plastic	15.45a	9.33a	12.39A	
Grasses	3.67b	4.67ab	4.17B	
Rice husk	9.33a	7.80a	8.57A	
	Transparent plastic	6.50ab	6.47a	6.49AB
	Mean	7.43a	6.45a	
	SE±	SEv=1.67	SEm=1.06	SEmv=2.36
2019	Control (zero)	2.67c	3.67bc	3.17C
Black plastic	4.87b	5.00b	4.95B	
Grasses	3.00bc	4.00b	3.50C	
Rice husk	5.33b	9.67a	7.70A	
	Transparent plastic	3.33bc	4.33b	3.83C
	Mean	3.84a	5.33a	
	SE±	SEv=0.61	SEm=0.39	SEmv=0.87

Treatments are significantly different if they do not share a letter (s) in common at adjusted P value <0.05

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Effects of Phosphorus Fertilizer on Agronomic and Yield Performance of Cowpea (*Vignaunguiculata* (L)) walp) in Jalingo, Nigeria

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Abstract
One major constraint to high productivity of cowpea in sub-sahara African soil is inherent low phosphorus fertility. However, most subsistence farmer has no access to phosphorus fertilizer. Therefore, evaluation of some cowpea genotypes at different phosphorus levels can be a good option to this problem. Three improved cowpea varieties and one local cultivar were evaluated at the Teaching and Research Farm of Taraba State University, Jalingo at 0kgha^{-1}, 40kgha^{-1} and 60kgha^{-1} of phosphorus fertilizer rates. Phosphorus significantly enhance the vegetative and yield growth of cowpea genotypes. Sampea 15 at the rate of 40kgha^{-1} of phosphorus gave the highest yield and therefore recommended to farmers who wants to embark on commercial cowpea production in that agro-zone.

Keywords: Cowpea, Phosphorus, Fertilizer, Yield

Introduction
Cowpea (*Vignaunguiculata* (L.)Walp) is one of the most important grain legumes grown and consumed by over 200 million people in the dry Savanna of tropical Africa with an annual production of 3 million tons (FAO, 2005). Nigeria is one of the World's largest producer of cowpea with an average production of 2.92 million tons closely followed by the republic of Niger with 1.1 million tons (FAO, 2012). Cowpea grains are a major source of plant proteins and vitamins for human, the haulms are valuable source of feed for livestock (Fatokun, 2002) and also a source of income for smallholder farmers in sub-saharan Africa (TJAI, 2010). However, despite it great importance, grain yield of cowpea is still low especially in Nigeria due to several constraints including low soil fertility and use of seeds of low yielding varieties as planting materials (Ecocrop, 2009). Although cowpea does not require too much nitrogen fertilizer because it fixes its own nitrogen from the atmosphere, phosphorus is critical to its yield as it is reported to stimulate growth, initiate nodulation as well as influence the efficiency of rhizobium-legume symbiosis (Haruna, 2011). In Nigeria under farmers practice, legumes usually receive little mineral phosphorus fertilizer, they rather rely parthy on the natural available soil phosphorus and other nutrients for nitrogen fixation and growth, and their results in low yields (Nkaa*et al*., 2014). Application of phosphorus is therefore recommended for cowpea production on soils low in phosphorus. There are many improved varieties of cowpea with higher yield potentials that are bred for diverse agro-ecological zones and they vary greatly in growth habit where necessitated a review of the fertilizer recommendations based on soil fertility classes (FFD, 2002). All efforts should be made to prevent P deficiency from limiting cowpea yields through adequate fertilizer management practices as farmers may not be applying P fertilizer at all or applying amounts that vary from just enough to excess. Therefore this study was initiated and carried out at Jalingo in northern Guinea Savanna agro-ecological zone to determine the optimum level of phosphorus fertilizer: as single super phosphate (SSP) on some cowpea genotypes so as to advice farmers appropriately.

Materials and methods
The materials for the comprised of three improved varieties of cowpea obtained from the Institute of Agricultural Research (IAR), savanna, Zaria and a local cultivar obtained from a farmer in Jalingo. The experiment was carried out during the rainy season (Augurt to November) of 2017 at the Teaching and

Research Farm, Department of Agronomy, Taraba State University Jalingo. Top soil was collected at a depth of 0.20cm randomly from the field using soil auger and taken to the laboratory for physiochemical analysis (Table 1). Quantity of single superphosphate (SSP) fertilizer was purchased from an agrodealer at Jalingo main market.

Experimental design: A plot of land measuring 17m by 14m (799m^2) was ploughed, harrowed and marked out into plots of 15m^2 separated by 1m pathway. The experiment was a factorial combination of 4 cowpea genotypes and 3p application rates in a Randomized Complete Block Design (RCBD) and replicated three times. Three seeds of cowpea genotype were sown per hole at the spacing of 50cm x 75cm. two weeks after planting, seedlings were thinned to one plant per stand. Weeding was carried out manually using hand hoe at 2 weeks after planting and repeated at 5 weeks. Cypermethrine was sprayed at the onset of flowering and subsequently 10 days after the first application until pod maturing to protect the plants against leaf, flower and pod insect pests. Phosphorus fertilizer as single superphosphate (SSP) was applied at three different rates (0kg/ha, 40kg/ha and 60kg/ha) by side placement 2 weeks after planting. The right amount of fertilizer was worked out for the different rates by taking into account the plot size.

Data collection: Five plants were randomly selected from central rows for collection of vegetative and yield data fortnightly on plant height vine, number of pods, pod weight, pod length and seed yield. Plant height was measured with a meter rule from ground level to the topmost leaf of the terminal branch. Total height values of the five plants were divided by five. The same process was done for number of leaves, number of branches, pod weight, pod length and seed physiological maturity. Harvesting was done by handpicking of pods twice weekly. The pods were threshed by beating with stick, grains winnowed, further sun dried and weighed and expressed in kgha^{-1}.

Data Analysis: Data collected were subjected to statistical analysis using the general linear model (GLM) procedure of statistical Analysis system (SAS, 1999) package.

Results and Discussion

Results of the physical and chemical properties of the soil at the experimental site before planting are presented in Table 2. The soil was predominantly sandy loam and slightly acidic with a pH value of 6.1 and low total nitrogen and exchangeable cations. Available p was 0.7895 which is far below the established 7.0mgkg^{-1} (Kang and Nangju, 1983) as the critical soil available p level for cowpea.

Results of the effect of phosphorus fertilizer on the height of cowpea genotypes are presented in Table 3. The results showed that at 2 WAS and NWAS, sampea 15 at 40kgha- of phosphorus produced the tallest plants which differed significantly ($p<0.05$) from sampea 8 at 0kgha^{-1} of phosphorus and at 60kgha- of phosphorus at 4 WAS. At 6 WAS, the local cultivar at 60kgha^{-1} of phosphorus produced the tallest plants which differed significantly ($P<0.05$) from sampea 8 and sampea 11 across the fertilizer rates but was comparable in height with sampea 15 across the fertilizer rates. As the rate of fertilizer increased from 0kgha^{-1} to 40kgha^{-1}, there was notiveable increase in plant height but as the rate was increased to 60kgha^{-1}, a dramatic decline in height was observed in the three improved varieties. For the local cultivar (Iron bean), increase in phosphorus rate from 0kgha^{-1} resulted in proportional increase in plant height. Table 4 showed the results of the effect of phosphours fertilizer on the number of leaves of cowpea genotypes. The results revealed that at 2 WAS samepea 8 at 0kgha^{-1} of phosphorus recorded the least number of leaves which was comparable with those of sampea 8 at 60kgha^{-1} of phosphorus and samp 15 at 0kgha^{-1} of phosphorus which were statistically ($P<0.05$) different from the rest of the other combinations. At 4 WAS the local cultivars at 60kgha^{-1} of phosphorus produced the highest number of leaves and was significantly ($p<0.05$) different from the other combinations. However, sampea 8 at 0kgha^{-1} of phosphorus maintained the least number of leaves. At 6WAS AND 8 WAS the local cultivar at 60kgha^{-1} of phosphorus still maintained the highest number of leaves that differed significantly ($p<0.05$) from the other genotypes and fertilizer rates whereas sampea 15 at 0kgha^{-1} of phosphorus had the least number of leaves that was not comparable with the rest of the genotypes and fertilizer rates. It was also observed in sampea 8 and sampea 15 that as the rate of phosphorus increased from 0kgha^{-1} to 40kgha^{-1}, there was appreciable increase in the number of leaves but as the rate was raised to 60kgha^{-1}, there was a noticeable decrease in number of leaves. In the local cultivar, increased in fertilizer rates resulted in proportional increase in number of leaves. Table 5 showed effect of fertilizer rates on the number of branches of cowpea genotypes. At 4 WAS sampea 15 at 40kgha^{-1} of phosphorus and the local cultivar at 60kgha^{-1}of phosphorus produced comparable number of branches that differed significantly ($p<0.05$) from the rest of the genotypes and fertilizer rates. However, the local cultivar at 60kgha^{-1} recorded the highest number of branches. At 8 WAS, sampea 11 at 40kgha^{-1} and the local cultivar at 60kgha^{-1} of phosphorus produced statistically ($p<0.05$) the highest number of branches. As phosphorus rate was increased from 0kgha^{-1} to 40kgha^{-1}, there was significant increase in the number of branches in sampea 11 and sampea 15 but as the amount of fertilizer was increased from 40kg to

60kgha^{-1}, the was a drop in the number of branches per plant. Results of the yield and yield related traits for the cowpea genotypes are shown in Table 6. The results revealed that genotypes varied in their yield and yield related traits with the genotype sampea 15 producing the highest number of pods, pod weight and seed yield of 0.068kg at 40kgha^{-1} of phosphorus which differed significantly ($p<0.05$) from the rest of the other genotypes and fertilizer rates. Similarly, sampea 11 recorded the least number of pods, podweight and seed yield of 0.021kg at 0kgha^{-1} of phosphorus fertilizer. In a related development, all the genotypes varied in the 100 seed weight which ranged from 0.012kg in sampea 8 at 0kgha- of ssp fertilizer to 0.19kg in local cultivar at 60kgha^{-1} of SSP fertilizer.
The experimental site have been under arable crop production for long where constant tillage and regular use of inorganic fertilizers had degraded the soil through rapid organic matter depletion (Lal, 1999). Soil organic matter influences physical properties that relate to water absorption, available water content and nutrient retention such that soil management practices must emphasize raising the level and preventing it rapid depletion. Vegetative characters such as plant height, number of leaves and number of branches were significantly increased by the application of phosphorus fertilizer. This could be attributed to the role phosphorus play in cell division especially at the meristematic regions where metabolism is high. This result is in agreement with the finding of Ayodele and Oso (2014) who reported that application of 20kgha^{-1} of phosphorus significantly increased plant height and leaf area index. Similarly, Sanginga*et al*. (2013) and Nyoki*et al*. (2013) also reported that plant height and number of leaves were significantly enhanced by phosphorus application. In this present study, it was observed that 40kgha^{-1} of phosphorus significantly increased number of branches in cowpea. This is in conformity with the report of Nkaa*et al*. (2014) who observed that the application of phosphorus fertilizer to cowpea varieties encouraged more leaves and branches Muhammede*t al.* (2013) also reported that the number of reproductive branches per plant (Flower bud-bearing) was positively affected by phosphorus application up to 40kgha^{-1}. Another contributing factor that might have enhanced number of branches could be the soil texture of the experimental site which is sandy loam which facilitated soil moisture holding capacity that reserved adequate water for the crop usage especially in photosynthesis, translocation of assimilate and other physiological processes (Namakka*et al*., 2017). Sampea 15 produced the highest number of pods, pod weight and seed yield at 40kg of phosphorus per hectare which is in agreement with the findings of Nkaa*et al*. (2014) who reported that the highest yield characters obtained by TT99K-573-2-1 cowpea variety was at phosphorus rate of 40kgha^{-1}. Similarly, Namakka*et al*. (2017) recorded the highest growth and yield of sampe 17 cowpea variety at phosphorus rate of 39kgha^{-1} which is not too far with the current result being reported. However, this is in variance with the findings of Haruna and Usman (2013) who reported highest yield at 30kgha^{-1} and Singh *et al.* (2011) who reported highest yield at 60kgha^{-1} and suggested that may be the optimum as further application of phosphorus may or may not increase cowpea yield.

Conclusion

Sampea 15 is an improved variety of cowpea and at phosphorus rate of 40kgha^{-1} may be deemed ideal for farmers in Jalingo and its environs where soils are highly depleted of its nutrient status as a result of bad agricultural practices. Further fertilizer trials should be conducted to enable farmers adopt the best rate that will enhance their productivity.

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Table 1: Physic-chemical properties of soil inthe study site parameter

Parameters	Amount
Clay %	14.9
Silt %	12.6
Fine sand %	46.3
Coarse sand %	26.3
Textural class	Sandy loam
pH (H20)	6.1
Organic carbon%	0.266
Organic matter %	0.459
Available P mg/kg	0.7895
Total nitrogen %	0.126
Exchangeable cations	
Na + me/100g	0.74
K+ me/100g	4.742
Ca me/100g	3.2
Mg+ me/100g	0.8
Exchangeable acidity	1.6
CEC	9.936
Base saturation %	99.041

CEC = cation exchange capacity

Table 2: Effect of SSP fertilizer on plant height of cowpea genotypes

Treatment	**2WAS**	**4WAS**	**6WAS**	**8WAS**
V_1F_0	17.77c	32.21b	62.57cde	81.87abcd
V_1F_1	20.12abc	34.35ab	75.47bcde	98.53abcd
VF_2	19.69abc	32.29b	55.27e	62.33cd
V_2F_0	19.70abc	35.23ab	77.67bcde	70.20bcd
V_2F_1	18.75abc	34.03ab	59.60de	57.80d
V_2F_2	18.90abc	33.67ab	72.60bcde	81.60bcd
V_3F_0	17.81bc	34.17ab	113.47ab	108.40abc
V_3F_1	21.66a	36.40a	103.30abcd	107.33abc
V_3F_2	21.28abc	34.90ab	82.13abcde	67.87bcd
V_4F_0	19.47abc	34.29ab	104.67abcd	112.53ab
V_4F_1	20.27abc	35.18ab	108.27abc	95.40abcd
V_4F_2	21.33ab	36.13ab	127.87a	125.07a

Means in the same column with the same superscript are not significantly different at 5% level of probability
WAS = weeks after sowing

Table 3: Effect of SSP fertilizer on number of leaves of cowpea genotypes

Treatment	2WAS	4WAS	6WAS	8WAS
V_1F_0	7.13b	33.27c	100.33c	106.07cd
V_1F_1	10.13ab	53.67abc	127.87bc	102.67cd
V_1F_2	8.07b	40.93bc	122.27bc	150.53abc
V_2F_0	10.13ab	49.67abc	140.53abc	166.67ab
V_2F_1	9.27ab	49.67abc	129.73bc	132.53abcd
V_2F_2	10.07ab	54.73ab	145.47abc	138.13abcd
V_3F_0	7.80b	45.67abc	99.53c	78.80d
V_3F_1	9.80ab	55.93ab	139.07abc	112.00bcd
V_3F_2	9.40ab	45.67abc	151.93abc	84.93d
V_4F_0	9.60ab	60.20ab	158.40abc	178.00a
V_4F_1	9.73ab	55.07ab	184.27ab	160.53abc
V_4F_2	11.20ab	66.67a	202.27a	178.80a

Means in the same column with the same superscript are not significantly different at 5% level of probability
WAS = weeks after sowing

Table 4: Effect of SSP fertilizer on number of branches of cowpea genotypes

Treatment	2WAS	4WAS	6WAS	8WAS
V_1F_0	0.00a	3.08bc	4.07abc	4.20ab
V_1F_1	0.00a	3.65abc	3.73abc	3.87ab
V_1F_2	0.00a	3.20abc	3.67abc	4.00ab
V_2F_0	0.00a	3.60abc	3.80abc	4.27ab
V_2F_1	0.00a	3.47abc	4.93a	4.67a
V_2F_2	0.00a	3.27abc	4.00abc	4.60a
V_3F_0	0.00a	2.87c	3.07c	3.20b
V_3F_1	0.00a	3.93a	4.47ab	4.20ab
V_3F_2	0.00a	3.60abc	3.67bc	3.47ab
V_4F_0	0.00a	3.67abc	4.20abc	4.60a
V_4F_1	0.00a	3.73abc	4.07abc	4.53a
V_4F_2	0.00a	4.07a	4.27abc	4.67a

Means in the same column with the same superscript are not significantly different at 5% level of probability
WAS = weeks after sowing

Table 5: Effect of SSP fertilizer on yield and related traits

Treatment	NP	PW(g)	SY(g)	100SW(g)
V_1F_0	77.00cd	93.33abc	64.67ab	17.50f
V_2F_0	67.83d	47.33c	32.00b	18.40ef
V_3F_0	84.87abc	116.33abc	62.33ab	20.80cdef
V_4F_0	78.43cd	67.33c	49.33ab	23.03bcd
V_1F_1	85.87abc	78.67c	51.67ab	19.80def
V_2F_1	78.30cd	63.67c	46.00ab	22.73bcde
V_3F_1	97.17a	158.00a	101.67ab	24.73abc
V_4F_1	92.43ab	91.67abc	66.67ab	25.53ab
V_1F_2	94.13ab	105.33abc	73.33ab	21.03cdef
V_2F_2	82.23bc	64.33c	44.33ab	20.87cdef
V_3F_2	89.17abc	146.33c	89.67ab	22.43bcde
V_4F_2	85.53abc	75.00c	53.67ab	28.13a

Means in the same column with the same superscript are not significantly different at 5% level of probability
NP = number of pods, PW = pod weight, SY = seed yield, SW = seed weight

Evaluation of the Performance of Some Beta Carotene Cassava Varieties in Relation to Different Fertilizer Sources and Rates in South Eastern Nigeria

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Abstract
Field experiment was conducted at National Root Crops Research Institute Umudike Abia State of Nigeria in 2013 and 2014 cropping seasons to evaluate the performance of some beta-carotene cassava genotypes in relation to different fertilizer source and rates. The treatments consisted of two varieties of yellow cassava (TMS1412 and TMS1368) two fertilizer sources (N.P.K 20:10:10 and N.P.K 15:15:15) with four rates of 0,200,400 and 600 tonnes per hectare. It was laid out in a split plot fitted to Randomized complete block design. The data collected were subjected to analysis using ANOVA and means were separated with least significant difference. The results of this experiment revealed that higher weight in tonnes per hectare was achieved in cassava yellow variety of TMS1412 (45.5kg/h) than TMS1368.(30.5t/h) The two fertilizer sources used (N.P.K. 20:10:10 and 15:15:15) did not record any significant difference in tonnes per hectare. The highest harvest index (0.82) was achieved in fertilizer source of N.P.K 15:15:15 . Dry matter was highest at (44.1%) 600kg/h while TMS1412 gave a higher dry matter content (42.3%) thanTMS1368 (33.1%) . Carotene content was highest at zero fertilizer rate (7.23µg) and the least (5.2µg) at 600kg/ha . It was concluded that the two varieties can be cultivated by using the two fertilizer sources at 400 kg/ha . TMS1412 performed better in terms of productivity than TMS 1368 herefor, TMS1412 is recommended for higher yield and dry matter contents than TMS1368. For more beta carotene content and to enhance vitamin A intake the two varieties are there for recommended for zero fertilization.

Key Word: Yellow Cassava, Beta Carotene, N.P.K fertilization, Tuber yield

Introduction

Cassava is one of the root tuber crops that provides a major staple food in most part of Africa. It plays an important role in income generation, employment and food security. (Olaiya and Salami, 2017) It derives its importance from the fact that it produces more calories/unit area from its starchy tuberous root which is a valuable source of cheap calories especially in developing countries (Som, 2007). One of the most limiting factors in agricultural production is low soil fertility. The low fertility of soil has made it possible for food production to be at pace with the population growth in sub-saharan Africa. Although cassava adapts to low fertility of soil has made it possible for food production in humid tropics.(Okigbo,1989) Fertilizers nourish the soil by returning essential mineral nutrients, Eke Okoro *et al* (1998) mentioned the over ridding performance of N.P.K 20:10:10 12 in cassava yield over other formulation due to its micronutrient content and stressed the need for the inclusion of micronutrients in fertilizer formulation for cassava. Carotene based cassava is a new genotype; much work has not been done on its nutrient requirements. There is need to assess the nutritional supplement of (N.P.K 20:10:10, 15:15:15) and their contribution to the yield of carotene based cassava. The aim is to determine the effects of N.P.K (20:10:10 and 15:15:15) on the productivity and Beta carotene content of two yellow cassava varieties using different rates.

Materials and Method

The experiment was conducted in the research farm of N.R.C.R.I. in the cropping season of 2013 and 2014.The existing vegetation was cleared, harrowed, ridged and marked out into various plots. Plot size was 5m×4m treatments comprises of two varieties of beta carotene cassava (Umucass1368 and Umucass1412). Two sources of N.P.K fertilizer (20:10:10 and 15:15:15) at different rates of 0, 200, 400 and 600 kg/ha. The crop spacing was maintained at 1m×1m. The treatment combination was laid out in a split plot design. All the agronomic practices were carried out as at when due. Appropriate data were collected and subjected to statistics analysis using R Programming statistical tool.

Results and Discussion

Harvest index did not record any significant difference due to variety but was significantly affected (0.71%) by fertilizer sources and rates on N.P.K 15: 15:15 and at the rate of 600kg/ha.(Table 1) The percentage dry matter in both years were significantly affected by variety and rate. In this case, the higher dry matter content was achieved in TMS1412 (42.5%) and at fertilizer rate of 600kg/ha. The beta carotene was not affected significantly due to variety and fertilizer sources although recorded higher in TMS 1412 on N.P.K 15: 15: 15 (5.3 µg) than TMS1368 on N.P.K 20: 10: 10 (4.8 µg) . The highest beta carotene was obtained in zero fertilizer (7.2µg) while the lowest was obtained in N.P.K 600kg/ha (5.2 µg). In order words, there is an indication that fertilizer sources could affect the b carotene level; this supports the hypothesis that total carotene value of cassava is affected by fertilizer application, Furthermore, TMS1412 recorded the highest fresh tuber yield in tonnes per hectare (42t/ha) due to varietal effect of the cassava used in this experiment. (Table 1) This occurred due to genetic inherent qualities of the tubers.(Udealor and Asiegbu ,2006) The fertilizer source (N.P.K 20: 10: 10 and 15: 15:15) did not influence the yield, but the rate were significant and recorded an astronomic increase as the rate of fertilizer increases (Obasi and Muoneke 2008). The highest mean value was obtained in 600kg/ha (48t/ha) although not significantly difference from the rate of 400kg/ha fertilizer application. Interaction was significant, consequently the lowest yield was recorded in zero fertilization of TMS 1368 at 20: 10: 10 (17.3t/ha) and 15: 15: 15 (19.16t/ha).(Table 2) Also, zero fertilizer on TMS 1412 recorded 23.3 and 22.7t/ha for 20: 10: 10 and 15: 15:15 respectively. This showed that TMS 1412 can perform better in the absence of fertilizer sources than TMS 1368 variety.

Conclusion

The result of this experiment revealed that higher weight in tonnes per hectare was achieved in cassava yellow variety of TMS 1412 than 1368. The two fertilizer sources used (N.P.K, 20: 10: 10 and 15: 15: 15) did not record any significant difference in terms of fresh root weight in ton/ha. There was an astronomical increase in yield as rate increases. The highest harvest index was achieved in fertilizer source of N.P.K 15: 15: 15(0.83) this predominantly occurred at the fertilizer rate of 600kg/ha (0.71). Beta carotene content was significantly affected by rates where the highest was obtained in zero fertilizer (7.23ug) and gave the least at 600kg/h (5.2ug). This significance revealed that there is evidence that rate of fertilizer sources can influence the beta carotene content. The difference between the yield dry matter and carotene content did not differ between 400 and 600kg/ha for economic reason 400kg/ha remain the recommended rate but in terms of carotene and dry matter content ,TMS 1412 performed better and can be recommended. Therefore this experiment is subject for more research.

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Table 1 Effect of different fertilizer sources on dry matter (%) harvest index, beta carotene content and yield of yellow cassava varieties

Treatments	Harvest index 2013/2014	Dry matter 2013/2014	Beta-carotene I(ug/g) 2013/2014	Yield/tonne/ yield/ha2013/2014 Hectare
Variety				

TMS 1368	0.58	33.1	5.8	38.3
TMS 1412	0.67	42.3	6.1	42.2
LSD 0.05	NS	1.20	NS	1.34
Fertilizer				
20: 10: 10	0.51	38.1	4.8	38.0
15: 15: 15	0.83	33.0	5.3	40.0
LSD 0.05	0.01	NS	NS	NS
Rates				
0	0.31	28.5	7.3	20.5
200	0.36	32.0	6.1	30.0
400	0.53	43.1	6.3	47.0
600	0.71	44.1	5.2	48.0
LSD 0.05	0.08	1.01	0.41	1.30

Table 2 Interaction effect of different fertilizer sources and rates on the yield t/ha of beta carotene cassava varieties in 2013 and 2014.

Treatment	2013	2014	Mean
TMS 1368×20:10:10×0	18.67	16.00	17.33
TMS 1368×20:10:10 200	44.00	31.43	37.71
TMS 1368×20:10:10×400	47.33	48.36	47.84
TMS 1368×20:10:10×600	49.33	41.33	45.33
TMS 136815:15:15×0	22.66	15.66	19.16
TMS 1368×15:15:15×200	45.66	39.70	42.68
TMS 1368×15:15:15×400	47.66	39.70	42.68
TMS 1368×15:15:15×600	49.00	49.76	49.38
TMS 1412×20:10:10×0	26.33	20.33	23.33
TMS 1412×20:10:10×200	42.00	39.58	40.79
TMS 1412×20:10:10×400	46.66	46.35	46.45
TMS 1412×20:10:10×600	49.66	47.60	48.63
TMS 1412×15:15:15×0	26.33	19.16	22.74
TMS 1412×15:15:15×200	42.00	43.86	42.93
TMS 1412×15:15:15×400	46.66	46.43	46.54
TMS 1412×15:15:15×600	49.33	48.68	49.00
LSD	1.22	2.12	

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Growth and Development of Habanero Pepper (*Capsicum chinense* L.) Varieties as influenced by Farmyard Manure, Weed control And intra Row spacing

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Abstract

The effect of farmyard manure at 0, 10 and 15 t/ha six weed control treatments which included application of pendimethalin at 1.5 and 2.0 Kg a.i/ha each at pre-transplanting and also post-transplanting and three hoe weeding at 3, 6 and 9 week after transplanting (WAT) and weedy check and two spacings 20 and 40 cm on growth and yield of habanero pepper were evaluated under field condition in 2015 and 2016 at the experimental site of Kaduna Agricultural Development Project (KADP) located at Maigana, Soba Local Area ($11^{0}39$; 08^{0} 02'E, 500 m above the sea level) and the research farm of the Institute for Agricultural Research (IAR) Ahmadu Bello University Zaria (located at Samaru 11^{0} 11'N long 07^{0} 38'E, 686 m) above sea level in the Northern Guinea savanna ecological zone of Nigeria. Farmyard manure application significantly increase plant height, number of fruit per plant, fresh fruit weight per plant and fresh fruit yield per hectare, however hoe weeding at 3, 6 and 9 weeks after transplanting (WAT) significantly produced taller plant with higher number of fruit, fruit weight per plant and fresh fruit yield per hectare except at 6 WAT were application of 1.5 and 2.0 Kg a.i/ha of pendimethalin at post-transplanting recorded more taller plant follow by application of 1.5 and 2.0 Kg a.i/ha of pendimethalin at pre-transplanting and weedy check recorded the least plant height, number of fruit, fruit weight per plant and fresh fruit yield per hectare while the number of fruit, fruit weight per plant and fresh fruit yield per hectare increase with increase in intra row spacing. Significant interaction between farmyard manure and weed control was recorded on plant height at 12 weeks after transplanting. Application of 15 t/ha of farmyard manure and hoe weeding in 40 cm intra row spacing resulted in higher yield of habanero pepper..

Keywords: Farmyard, Manure, Weed, Intra-row, Growth, Yield, Habanero pepper

Introduction

Habanero pepper (*Capsicum chinense* L.) in one of the most important vegetables grown in Nigeria and other sub-humid and semi-arid tropics. After tomato and onion Habanero pepper is the third most important vegetable in Nigeria. Nigeria being the largest producer of crops in Africa account for 50% of the African production (Aliyu, 2001). Nutritionally, according to (Marin *et al.* 2004, and Gil-guerrero, 2006), habanero peppers are an excellent source of natural colours and antioxidant compounds, ascorbic acid, carotenoids, and phenolic compounds. It also contains vitamins A and C and it was reported that as hot pepper matures, the pro-vitamin A (B Carotene) and ascorbic acid increase. The intake of these compounds in foods is an important health protecting factor. Mediated intake of these compounds have been recognize to prevent some human diseases, including cancer and cardiovascular diseases, (Kaur and Kapoor, 2001; Sardas, 2003). This led to extensive production of habanero pepper varieties in some countries for export markets. However, inspite of the important of pepper in Nigeria. Low yield were often obtained by farmers due to use of low yielding varieties, inadequate application of nutrients on soil that are already of low nutrients status, poor agronomic practices, improper row or planting arrangement, low soil fertility and other environmental factors such as the prevalence of fungal (blight) and bacterial as well as viral diseases (Fekudu and Dandena, 2006). The use of organic fertilizers and herbicide has attracted attention in recent years in vegetables as a result of sustainable high yield and due to the fact that inorganic fertilizers alone cannot sustain the productivity of the soil under highly intensive cropping systems (Singh and Jain, 2004). Weed competition is one of the most important factors limiting habanero pepper yield particularly at early stages of the crop life cycle. The study is aimed at determining the effect of farmyard manure, the best weed control treatment and intra row spacing on the growth, yield and yield components of Habanero pepper.

Materials and Methods

Field trial was conducted during the rainy seasons of 2015 and 2016 at the experimental site of Kaduna Agricultural Development Project (KADP) located at Maigana, Soba Local Government Area ($11^{0}39$; 08^{0} 02'E, 500 m above the sea level) and the research farm of the Institute for Agricultural Research (IAR) Ahmadu

Bello University Zaria (located at Samaru 11^0 11'N 07^0 38'E, 686 meter above sea level in the Northern Guinea savanna ecological zone of Nigeria. The material used for the study is an improved variety of " pepper Safi" which has compact growth habit, fruit position is pendent and colour from light green to deep red and very pungent and aromatic. The experimental site was ploughed and harrow, ridges were then made 75 cm apart with plants. Transplanted at a spacing of 20 and 40 cm within the row, seedlings were maintained for six weeks in the nursery before transplanting. The experiment consisted of 36 treatments made up of factorial combinations of three farm yard manure (FYM) rates at (0, 10, and 15 tha^{-1}), six weed control treatment which included application of Pendimethalin at 1.5 and 2.0 Kg a.i/ha each at pre-transplanting and also at post-transplanting, three hoe weeding at 3, 6 and 9 week after transplanting (WAT) and a weedy check. Two intra row spacing 20 and 40 cm. The experiment was laid in a Split Plot Design. The weed control and spacing treatments were allocated to the main plots while FYM was allocated to the sub plot. The treatments were replicated three times, the gross plot size was 4 m x 3 m (12 m^2) and the net plot was 1.5 x 4 m (6 m^2). While the inter row spacing was 75 cm. soil and manure analysis were done in accordance with Black (1965). Plant height, number of fruit, fruit weight and fruit yield were recorded on plot basis. The data collected were analysed statistically in accordance with Snedecor and Cochran (1967). Significant different means were compared using Duncan Multiple Range Test (DMRT) (Duncan, 1965).

Results and Discussion

The effect of manure rates, weed control and intra row spacing on plant height of habanero pepper is presented in Table 1: significant variation in plant height at 12 WAT in both location among the three rates of manure was shown on table 1: The respond of plant height to increase in farmyard manure rates were significant, while the application of 0-10 t/ha of manure led to a progressive increase in plant height. At 6 and 9 WAT in samaru and 9 WAT in maigana, in the absence of manure and 10 t/ha no significant difference was observe in plant height and further increase to 15 t/ha significantly produce taller plant. However, in 6 WAT in maigana application of 15 t/ha of manure significantly produce taller plant compare to 0 t/ha which is at par with that of 10 t/ha.

Hoe weeded treatment produced significantly taller plant at all the sampling period in both location except at 6 WAT in samaru were application of 2.0 Kg a.i/ha of pendimethalin at pre-emergence produce taller plant which was comparable with application 1.5 Kg a.i/ha of pendimethalin at pre- Emergence at the same sampling period and the weedy check produce the shortest plant and was statistically similar to application of 1.5 Kg a.i/ha of pendimethalin at post-emergence. The intra row spacing shows no significant effect on plant height at all the sampling period in both locations. There was no significant interaction between the factors.

Farmyard manure significantly affects the yield and yield component of pepper (Table 2, 3 and 4) increasing the farmyard manure from 0-10 and further to 15 t/ha significantly increase number of fruit per plant (Table 2). A similar trend was observed for fresh fruit weight and fresh fruit yield per hectare (Table 3 and 4). From the result obtained at both locations three rates recorded a significant variation in number of fruit per plant, fresh fruit weight and fruit yield per hectare. The three rates recorded a significant variation in number of fruit 15 t/ha produced the highest number of fruits. This was followed by 10 t/ha then 0 t/ha produced the least number of fruits. Hoe weeded control treatment significantly produced higher number of fruit per plant, bigger fruit and higher yield per hectare compared to all other weed control treatment including the weedy check.

Increasing the intra-row spacing significantly increased number of fruit per plant, fresh fruit weight and fresh fruit yield per hectare at samaru and maigana. Farmyard manure or weed control or factors interaction had no significant effect on yield and yield component of Habanero pepper. The response exhibited by habanero pepper to farm yard manure was observed through increased plant height as well as increase yield and yield characters in both location could be as a result of positive increased in mineralized nutrient which improve soil physical and chemical condition and also improved availability of macro and micro nutrient in the soil that were necessary for the formation of chlorophyll, efficient rooting and production of biomass. (Anon, 2007b). Apart from increasing soil fertility, manure, serves as a soil amendment by adding organic matter content into the soil. Farm yard manure has been reported to greatly improve water holding capacity, soil aeration, soil structure, nutrient retention and microbial activity (Anon, 2007a). Manure application also results in increased pH and decreased in bulk density, when use in long term basis (Anon, 2006).

All the weed control treatments significantly reduced weed infestation as reflected on growth and yield parameters measure recorded with the weed control treatment compare to the weedy check throughout the period of the study. Application of pendimethalin at 1.5 and 2.0 Kg a.i/ha and plot weeded at 3, 6 and 9 WAT gave effective control of weeds. Pendimethalin at 1.5 and 2.0 Kg a.i/ha was not effective in the control of sedge which could be as a result of tolerance or resistance of sedges to these herbicide. Sedges possess mechanism that prevent the entry or movement of herbicide or deactivates the herbicides completely in converting the toxins to harmless metabolites (Gary and Zo Shey 1974). Effective control of broad leaves, grasses and sedges was achieved with the hoe weeding compared to application of pendimethalin at all rate. This could be attributed to the fact pendimethalin at 1.5 and 2.0 Kg a.i/ha could not adequately control sedges. Rawlinson and Martin (1998) reported that in some cases low herbicides rates may result in incomplete weed control in heavy infested sites. Hoe weeded controlled all weeds (grasses, broadleaves and sedge) this is in line with the finding of Joy *et al*., (2006) who reported that weeds control treatment and hoe weeding at 20 and 40 days after sowing controlled weeds. However, two hoe weeding at 20 and 40 days after sowing was found to be the best with regard to effectively reducing weed biomass and increasing fruit yield. (Jain, 2000; Rakesh and Shirvastava, 2002; Galal, 2003), Intra row spacing has a great effect on the performance of crop in which Habanero pepper is inclusive. Habanero pepper growth decrease and yield declined when intra-row spacing was decreased beyond certain level primarily because of increased in inter-plant competition for growth factors and reduction in the number of harvestable fruits, however, in the case of reducing intra row spacing, intense inter plant competition for light, soil nutrient and water set in; thereby resulting in low crop performance. This result in limited supplies of soil carbon and nitrogen and consequently increase barrenness and decrease fruit number per plant (Inuwa, 2001). Habanero pepper intra row spacing for maximum economic yield varies from 25 – 45 cm depending on the variety, soil fertility, availability of water, maturity and varietal canopy architecture (Sangoi, 2001). The result of this study show a significant response to varying intra row spacing by some growth parameters as well as the yield. 40 cm intra row spacing resulted in taller plant, higher number of fruit, bigger fruit and higher yield. This is as a result of wide spaced plant might have had more environmental resource for growth hence more leaves per plant than those closely spaced plants. Similar finding was reported by Liu *et. al.,* (2004) and Luque *et. al.,* (2006).

Conclusion

Result from this study generally indicated that application of 15 t/ha of farmyard manure and three hoe weeding, while the most suitable intra-row spacing appears to be 40 cm, at a between row spacing of 75 cm.

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Table 1: Effect of farm yard manure, weed control and intra row spacing on plant height of Habanero pepper (*Capsicum chinense* L.) at Samaru and Maigana during 2015 rainy season.

	Plant Height (cm)					
	SAMARU (WAT)			MAIGANA (WAT)		
Treatments	6	9	12	6	9	12
Farm Yard Manure (FYM) (t/ha)						
0	14.32b	25.23b	30.11c	11.63a	18.72b	21.20c
10	14.46b	25.41b	31.19b	11.41ab	18.52b	22.03b
15	15.00a	25.84a	32.89a	11.22b	19.08a	22.86a
S.E.±	0.110	0.100	0.081	0.085	0.106	0.145
Weed control methods (WC) (Kg a.i/ha)						
Pendimethalin (Pre-em) 1.5	15.19ab	27.22b	36.51b	11.43bc	19.71c	23.36b
Pendimethalin (Pre-em) 2.0	15.36a	27.37b	36.79b	11.58b	20.20b	23.32b
Pendimethalin (POE) 1.5	14.08c	23.91c	25.78c	11.07c	17.21d	19.49d
Pendimethalin (POE) 2.0	14.21c	23.93c	25.67c	11.13c	17.31d	19.58d
Hoe weeding at 6, 9 and 12 WAT	14.77b	27.98a	38.91a	12.07a	20.97a	26.25a
Weedy Check	13.99c	22.54d	24.72d	11.28bc	17.24d	20.18c
S.E.±	0.156	0.142	0.115	0.121	0.149	0.206
Spacing (SPC) (cm)						
20	14.56a	25,56a	31.13b	11.54a	18.76a	21.83b
40	14.66a	25.43a	31.66a	11.30b	18.78a	22.22a
S.E.±	0.090	0.082	0.066	0.069	0.086	0.118
Interactions						
FYM x WC	NS	NS	NS	NS	NS	NS
FYM x SPC	NS	NS	NS	NS	NS	NS
WC x SPC	NS	NS	NS	NS	NS	NS
FYM x WC x SPC	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

Table 2: Effect of farm yard manure, weed control and intra row spacing on number of fruit per plant of Habanero pepper (*Capsicum chinense* L.) at Samaru and Maigana during 2015 rainy season.

	Number of Fruit per Plant	
Treatments	SAMARU	MAIGANA

Farm Yard manure (FYM) (t/ha)		
0	27.03c	35.11c
10	28.72b	39.83b
15	30.67a	40.50a
S.E.±	0.196	0.162
Weed control methods (WC) (Kg a.i/ha)		
Pendimethalin (Pre-em) 1.5	33.30b	40.67c
Pendimethalin (Pre-em) 2.0	33.90b	41.50b
Pendimethalin (POE) 1.5	24.39c	35.72e
Pendimethalin (POE) 2.0	25.00c	36.50d
Hoe weeding at 6, 9 and 12 WAT	37.89a	49.67a
Weedy Check	18.28d	26.83f
S.E.±	0.276	0.229
Intra Row Spacing (cm)		
20	28.20b	37.67b
40	29.40a	39.30a
S.E.±	0.159	0.132
Interactions		
FYM x WC	NS	NS
FYM x SPC	NS	NS
WC x SPC	NS	NS
FYM x WC x SPC	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

Table 3: Effect of farm yard manure, weed control and intra row spacing on fresh fruit weight per plant of habanero pepper (*Capsicum chinense* L.) at Samaru and Maigana during 2015 rainy season.

Treatments	Fresh Fruit Weight per Plant (g)	
	SAMARU	MAIGANA
Farm Yard Manure (FYM) (t/ha)		
0	231.11c	219.67c
10	258.5b	258.50b
15	279.19a	279.19a
S.E.±	1.773	1.012
Weed control methods (WC) (Kg a.i/ha)		
Pendimethalin (Pre-em) 1.5	298.90b	288.22c
Pendimethalin (Pre-em) 2.0	301.94b	295.22b
Pendimethalin (POE) 1.5	215.16c	211.72d
Pendimethalin (POE) 2.0	217.06c	215.50d
Hoe weeding at 6, 9 and 12 WAT	355.22a	351.72a
Weedy Check	149.28d	152.33e
S.E.±	2.507	1.432
Intra Row Spacing (cm)		
20	252.00b	246.15b
40	260.54a	258.76a
S.E.±	1.448	0.683
Interactions		
FYM x WC	NS	NS
FYM x SPC	NS	NS
WC x SPC	NS	NS
FYM x WC x SPC	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT
NS=Not Significant

Table 4: Effect of farm yard manure, weed control and intra row spacing on Fresh fruit yield per Hectare habanero pepper (*Capsicum chinense* L.) at Samaru and Maigana during 2015 rainy season.

	Fresh fruit yield per Hectare	
Treatments	SAMARU	MAIGANA

Farm Yard Manure (FYM) (t/ha)		
0	928.40c	792.19c
10	940.58b	848.75b
15	962.78a	876.08a
S.E.±	3.149	1.922
Weed control methods (WC) (Kg a.i/ha)		
Pendimethalin (Pre-em) 1.5	1133.66c	1035.19c
Pendimethalin (Pre-em) 2.0	1155.88b	1044.56
Pendimethalin (POE) 1.5	807.13e	779.69e
Pendimethalin (POE) 2.0	822.13d	793.13d
Hoe weeding at 6, 9 and 12 WAT	1416.71a	1112.13a
Weedy Check	328.09f	258.76f
S.E.±	4.454	2.718
Intra Row Spacing (cm)		
20	932.40b	825.44b
40	955.54a	853.05a
S.E.±	2.571	1.569
Interactions		
FYM x WC	NS	NS
FYM x SPC	NS	NS
WC x SPC	NS	NS
FYM x WC x SPC	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05level of probability using DMRT NS=Not Significant

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Growth and Seed Tuber Yield of Potato (*solanum tuberosum* l.) Varieties as influenced by Intra-row spacing and Potassium fertilization on the Jos Plateau

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Abstract
Field experiment was conducted during 2017 and 2018 rainy seasons at the experimental farm of Potato Programme, Kuru, National Root Crops Research Institute Umudike Abia State. Kuru is located on (Lat. 09° 44'N, Long 08° 44" E, 1239.4m amsl) in the northern Guinea Savanna Ecological zone of Nigeria.The experiment was conducted to evaluate the response of three newly received potato varieties (Daisy, Caruso and Zafira), Intra-row spacing (20, 30 and 40 cm) and three rates of K fertilizer (0, 40 and 60 t ha^{-1}). A split plot design was used where the factorial combination of K and intra - row spacing were assigned to main plots while variety was assigned to sub-plots. The treatments were replicated three times. The result revealed that application of 60 kg K ha^{-1} and 30 - 40 cm intra-row spacing enhanced crop growth and yield of Caruso and Zafira. Plant height and seed tubers yield decreased with corresponding increase in intra-row spacing. The use of 20 cm intra - row spacing in 2018 resulted in higher seed tuber yield compared with 30 and 40 cm intra-row spacing.
Key words: Growth, Seed, Yield, Potato, Varieties, Intra-row, Fertilization

Introduction

Potato (*Solanum tuberosum* L.) is a tuber crop. It belongs to the family Solanaceae. It ranks fourth as the world's economically valuable food crop after rice, (*Oryza sativa*), wheat (*Triticum aestivum*), and Maize (*Zea mays*) (FAO 2015). Potato requires the basic (nutrients (N, P and K) for proper growth and yield especially on the Jos Plateau where mining and continuous cropping has greatly depleted the soil of its major native nutrients (Okonkwo *et al.* 1995). Potato requires K fertilizer for proper tuberization, without which potato will not form tubers. The fertilizer improves crop growth and yield through the provision of K which can in turn enhance absorption of N and P and subsequently maximize growth and yield. N is an indispensable plant major nutrient without N, growth is retarded, leaves will turn yellow and reproductive growth is retarded. Also, importantly, P is responsible for proper growth, cellular activities and proper functioning of roots and photosynthesis while intra-row spacing in plant give room for optimum plant population and for the plant to express its potentials. In - appropriate spacing may result in competition between stands and specifically between plant (Hillary, 2009). Report by Okonkwo *et al.,* (1995) recommended 30 cm intra-row spacing for potato production on the Jos Plateau. Pavlista (2014) reported that when potato is spaced 40 cm, it yields more of ware tubers than seed tubers whereas when intra - row spacing is at 20 cm, seed tubers will out-yield ware tubers. It is therefore, the objective of this study, to evaluate the response of varieties to K fertilizer and intra-row spacing on potato growth and yield.

Materials and Methods

Field experiment were conducted in 2017 and 2018 rainy seasons on Potato Programme's Farm Kuru, National Root Crops Research Institute, Umudike, Abia state. Kuru is in the Northern Guinea Savannah Ecological Zone, located on latitude 09° 44'E and longitude 08° 44'N, 1,239.4 m above mean sea level, with an annual rainfall of 1,289.89 mm distributed across 150 days within the months of May to October. Potato varieties: Daisy, Caruso and Zafira was used as test varieties. The soil is a sandy loam and of feralgilic origin. Treatments were: varieties (Daisy Caruso and Zafira), intra-row spacing (20, 30 and 40cm) and potassium (0, 40 and 60kg K ha-1). Factorial combination of K and intra-row spacing was assigned to main plots while variety was allocated to sub-plots. The gross plot size was 3 x 6 m (measured 18 m^2) while the net plot size was 2 x 6 m (measured 12 m^2) consisting of two inner ridges. The experiment was laid out in a split plot design replicated three times. Planting was done on the crest of the ridge spaced 100 cm apart while the intra-row spacing was 20, 30 and 40 cm. Planting was carried out on 26 April, 2017 and 5th May, 2018. N, P and K used in the experiment were from Urea, Single supper phosphate and muriate of potash respectively. P, K and half of N was applied at planting by placement on the crest of the ridges while, the remaining half of N was applied by side banding at 4 WAP. Weeds were controlled with pre-emergence herbicide (combination of Alachlor – EC at 1.92 kg a.i ha^{-1} and Atrazine 500 Sc at the rate of 4 kg a.i ha^{-1} using CP-15 Knapsack sprayer at a pressure of 2.1kg cm^{-2} and by hoe weeding at 4 and 8 WAP. Tubers were harvested manually by lifting, using garden fork, five stands were selected and tagged from the net plot and growth and yield parameters were taken and recorded accordingly. Tubers harvested from the plot were weighed and later the yield per net plot was expressed in tons per hectare. The data collected was analyzed using Gomez and Gomez (1984) statistical package while Duncan Multiple Range Test (Duncan, 1955) was used to separate the means. The result was recorded and interpreted accordingly.

Results and Discussion

Variety: In 2017, 2018 and the combined data in terms of plant height, (Table 1) varieties Caruso and Zafira were at par and significantly taller than variety Daisy. However, in terms of seed tuber yield, (Table 2) Daisy and Caruso were at par and statistically inferior to Zafira during 2017, 2018 and the combined data.

Spacing: In terms of plant height, In 2017, 30 cm intra-row spacing was not different from 20 and 40 cm intra-row spacing however 40 cm intra-row spacing proved superior to 20 and 30 cm intra-row spacing. In 2018, 30 and 40 cm intra-row spacing were at par and inferior to 20 cm intra-row spacing while in the combined data, intra-row spacing did not exert significant effect on this parameter. In terms of seed tuber yield, in 2017 and the combined data, intra - row spacing did not exert significant effect on tuber yield but in 2018, 30 and 40cm intra-row spacing were at par and inferior to 20 cm intra-row spacing.

Potassium: Effects of potassium on plant height is presented in Table 1. The results indicate that in 2017 and the combined data, Potassium fertilizer did not exert significant effect on plant height. In 2018, application of O kg K ha^{-1} was not different from 40 and 60 kg K rates.

In Table 2, in terms of seed tubers, in 2017, application of 40 and 60 kg K ha^{-1} were at par and superior to O kg rate. In 2018, O and 60 kg K per hectare were at par and inferior to 40 kg K. In the combined data, 40 kg K out yielded the other two rates, this was closely followed by 60 kg K rate.

Varietal Response

The significant positive response of varieties Caruso and Zafira in terms of plant height indicates that the two varieties in question are tall status varieties and have responded to the applied treatments. Conversely, Daisy is viewed as small status variety. But in terms of seed tuber yield, Daisy was able to utilize environmental factors and was efficient at producing yield factor hence, the seed tuber yield of Daisy despite its small status was at par with Caruso that grew taller. This is in line with the report of (Pavlista,2005; Guerra *et al*.1990) who reported that Daisy is a small status plant but it is efficient at utilizing environmental factors and DM accumulation by Daisy is rapid. Yield produced by Zafira during the period of this research was consistent and it out-yielded the other two varieties. This could be attributed to genetic factors which gave Zafira advantage over Daisy and Caruso. The result of this finding on Zafira is in line with the report of Pavlista (2005) who reported that Zafira is a tall status plant and high yielding. However, report by Jerome (2007) contradicted report of this findings, the report indicated that in terms of plant height and vegetativeness, Daisy, Caruso and Zafira were at par and produced similar seed tuber yield when grown during rainy season at alberta.

Intra-row Spacing

The significant variation in terms of seed tuber yield in terms of intra-row spacing could be attributed to within row competition which favored wider spacing, this is in line with the report of Okonkwo *et al.* (1995). They reported that when Potato is planted at an intra-row spacing of 40cm, it produced more of ware tubers than seed tubers. Total tuber yield in 2018, increased with 40 cm intra-row spacing. This is in line with the report of (Harris, 2015; White *et al*., 1976) who in a separate report, reported that, yield produced by wider (40 cm) intra-row spacing, out yielded the yield produced by 20 and 30 cm intra-row spacing. However, in 2017, intra-row spacing did not exert significant effect on seed tuber yield. This is in agreement with the report of Ognojovic (2012), who reported no significant difference in seed tuber yield when spacing was varied between 20 to 40cm. But Okonkwo *et al.* (1995) reported 30cm intra row spacing for ware potato production on the Jos Plateau, Nigeria.

Plant height was not influenced by intra-row spacing in 2017 and the combined data. This could be attributed to environmental conditions, particularly prevailing weather condition at the time of initial stage of growth (emergence), this is in consonance with Okonkwo *et al.* (1995) report who indicated slow growth in potato, during the first two weeks after planting. However, in 2018, intra-row spacing influenced plant height with 20 cm spacing producing tallest plants than 30 and 40 cm intra-row spacing. This could be as a result of within row steep competition which led to etiolation hence, the plants spaced 20 cm grow taller with less branches. This is in consonance with the report of Hillary (2009) who reported that potato crops grew taller with 20 cm intra-row spacing than with wider (30 and 40 cm) intra-row spacing but disagreed with report by D'amanto *et al.* (1989) who reported no difference in plant height when potato was planted at 20, 30 and 40cm intra - row spacings and attributed it to genetic constitution of the test varieties.

Effecst of potassium on growth and yield of potato

Potassium fertilizer significantly influenced plant height in 2018. This could be due to its effect on early root establishment, root development and facilitation of absorption of other (e.g. N and P) that has probably been efficient in 2018 than in 2017 and the combined data, weather condition of 2018 must have accounted for this. In 2017 and the combined data, potassium did not influence this parameter. But in 2018 application of O kg K ha^{-1} did not differ from the other rates this could be due to the major role of K in the area of root establishment and development and this tended to be in consonance with the report of Wurr, (1974) who reported that K plays a dominant role in root establishment and development.

The significant effect of K on seed tuber yield in 2017 is due to the fertilizing effects of K on tuber crops. This is in line with the report of Ojeniyi (2009) who indicated that K has fertilizing effect on potato and can maximize yield. Similarly, 40 kg K ha^{-1} out-yielded the other two rates. This means that the fertilizing effects of K at 40 kg ha^{-1} and the wider spacing tend to favour this parameter.

Conclusion

The result of this study revealed significant differences in terms of growth and yield habit among varieties. Variety Daisy proved to be a short status variety but efficient at harnessing environmental resources. Varieties caruso and Zafira were at par in terms of growth, while in terms of seed tuber yield Zafira out yielded Caruso.

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Table 1. Effects of variety, intra-row spacing and potassium fertilizer on plant height of Potato during 2017, 2018 cropping seasons and the combined data at Kuru

Variety (V)	Plant Height (cm)		
	2017	2018	Combined
Daisy	50.26b	51.11b	50.69b
Caruso	55.26a	55.19a	55.23a
Zafira	55.48a	55.41a	55.45a
SE±	0.677	0.473	0.585
Spacing (S) Cm			
20	52.59b	55.44a	52.57
30	53.67ab	53.70b	53.69
40	54.74a	52.55b	55.09
SE±	0.668	0.493	0.581
Potassium K (t ha^{-1})			
O	54.22	53.78ab	54.00
40	53.69	52.81b	53.25
60	53.19	55.11a	54.15
SE±	0.668	0.493	0.581
Interaction			
K x S	NS	NS	NS
K x V	NS	NS	NS
S x V	NS	NS	NS
K x S x V	NS	NS	NS

Means followed by the same letter(s) within a treatment group and column are not significantly different using DMRT (P=0.05).

NS= Not significant.

Table 2. Effects of variety intra-row spacing and potassium fertilizer on seed tuber yield of potato during 2017, 2018 cropping seasons and the combined data at Kuru

Variety (V)	Seed Tuber Yield t ha^{-1}		
	2017	2018	Combined

Daisy	3.20b	1.85b	2.53b
Caruso	4.54b	2.32b	3.43b
Zafira	11.33a	5.55a	8.44a
SE±	0.710	0.166	0.365
Spacing (s) Cm			
20	6.63	3.77a	5.19
30	6.12	3.06b	4.59
40	6.33	2.89b	4.61
SE±	0.699	0.138	0.355
Potassium K ($t\ ha^{-1}$)			
0	3.34b	2.41b	2.87c
40	8.14a	5.19a	6.67a
60	7.59a	2.126	4.85b
SE±	0.699	0.138	0.355
Interaction			
K x S	NS	NS	NS
K x V	NS	NS	NS
S x V	NS	NS	NS
K x S x V	NS	NS	NS

Means followed by the same letter(s) within a treatment group and column are not significantly different using DMRT (P = 0.05). NS= Not significant

ASN 53rd Annual Conference Proceeding (Sub-Theme: Agronomy)

Growth and Yield of Irrigated Wheat Varieties as Influenced by Sowing Method and Fertilizer Treatments in Northern Guinea Savanna of Nigeria

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ABSTRACT
An experiment was conducted at the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Irrigation Research Farm, Samaru (11°11'N, 07°38'E, 686m above sea level) located in the Northern Guinea Savannah ecological zones of Nigeria, during the 2015/2016 dry season to study effect of sowing method and fertilizer treatments on yield and some growth parameters of wheat (*Triticum aestivum* L.) varieties. Treatments consisted of three varieties: (LACRIWHIT-1, LACRIWHIT-4 and LACRIWHIT-5), two sowing methods (broadcast and drill) and four fertilizers (control, NPK at 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}, FYM at 10 t ha^{-1} and combination of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1} and 5 t ha^{-1}. These were laid out in a Randomized Complete Block Design replicated three times. Result indicated significant ($P<0.05$) variation due to variety and sowing method only on grain yield with variety LACRIWHIT-5 and drill sowing excelling. Application of at 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} followed by combined application of 5 t ha^{-1} FYM and 60 kg N, 30 Kg P_2O_5 and 50 Kg K_2O ha^{-1} proved better in most growth characters and grain yield. Therefore, the choice of variety LACRIWHIT-5 and application of at 5 t ha^{-1} FYM and 60 kg N, 30 Kg P_2O_5 and 50 Kg K_2O ha^{-1} with drill sowing is suggested for better growth and yield of wheat in the Northern Guinea Savannah of Nigeria.

Keywords: **Establishment count, Tillers, FYM; bread wheat, Varieties**

Introduction
Wheat (*Triticum aestivum* L.) belongs to the family Poaceae and is the most extensively grown cereal worldwide. It also contributes more calories and proteins to the world's human diet than any other cereals. In Nigeria, it is becoming a major staple crop as main component of breakfast and snacks (Falaki and Mohammed, 2011). Average yield in Africa, Central and West Asia is less than 1 t ha^{-1} in contrast to about 8 t ha^{-1} in Western Europe (Rajaram and Braun, 2009). The areas between latitudes 10-14^0 N (covering the Sudan and Sahel Savanna zones) are suitable for wheat production, during the cold harmattan period between the months of November and February, under irrigation in Nigeria (Olugbemi, 1994). Currently, Nigeria's production stands at 60,000 tonnes from about 51,000 hectares (Anon., 2016).
Cereal yield is generally low in soils of West Africa because of low soil phosphorus and nitrogen (Okpara and Igwe, 2014). Nigeria's Savannah soils are generally low in organic matter (Abdulkadir and Abu, 2013), nitrogen and phosphorus (Lawal and Girei, 2013). Therefore, wheat production is not profitable without soil nutrition. Chemical fertilizers are expensive and associated with risks of soil and water pollution (Zhang *et al*., 2010). Human population is expected to reach 8.3 billion by 2025, and coupled with continuous deterioration and losses of agricultural lands (Mannion, 1998), it has become imperative to develop ways to harness the limited resource for maximum production to feed human population. Use of organic fertilizers or integrated with inorganic is an alternative to reduce environmental consequences and high cost of inorganic fertilizers (Oyedeji *et al*., 2014). Integrated plant nutrient management (INM) enhances soil productivity and sustains crop production (Aslam *et al*. 2011). It also improves soil fertility, soil physical and chemical properties and increases crop yields (Ezekiel, 2010). Application of Farm Yard Manure (FYM) is one form of INM used by farmers. Benefits of FYM and in combination with inorganic fertilizer have been reported in wheat (Zahoor, 2014) and other crops. Traditionally wheat is sown using broadcast method (Abbass *et al*., 2009) and recently there is a shift from the broadcast to drilling (Soomro *et al*., 2009; Amin *et al*., 2013a; Naresh *et al*., 2014). However, there are conflicting results on the relative advantages and ultimate yield as broadcasting is easy to sow (Carver, 2005), drilling is easy to weed (Singh *et al*., 2005). However, Ahuja *et al*. (1996); Abbass *et al*., (2009) recorded higher grain yield in broadcasted wheat compared to drilled while the reverse was reported by (Amin *et al*., 2013). The degree of response to management and environment differ with variety (Orakwue *et al.*, 1991; Miko *et al.*, 2006; Bibinu and Gwadi, 2014). Several wheat varieties have released by LCRI. These varieties vary in their yield potentials hence the need to evaluate for their response to management conditions, particularly fertilizer and sowing method. This is important where soil fertility is low and appropriate sowing enhances crop establishment and easy management. The objective of this study was to assess the response of three wheat varieties to sowing method and fertilizer treatments.

Materials and Methods

The experiment was conducted at the Institute for Agricultural Research Irrigation Farm, Samaru (11°11'N, 07°38'E, 686m above sea level) located in the Northern Guinea Savannah ecological zones of Nigeria, during 2015/2016 dry season. Prior to sowing, random soil samples were collected from experimental site at 0-30 cm depth using soil auger and bulked for physical and chemical analysis. Meteorological data during period of the experiment were obtained from Institute for Agricultural Research Samaru meteorological station. Treatments consisted of three wheat varieties (LACRIWHIT-1 (Seri-M82), LACRIWHIT-4 (Atilla Gan Atilla) and LACRIWHIT-5 (Norman)), two sowing methods (broadcast and drill) and four fertilizers (control, NPK at 120kg N, 60 Kg P_2O_5 and 60 Kg K_2O ha^{-1}, FYM at 10 t ha^{-1} and half dose each of NPK and FYM. These were laid out in a Randomized Complete Block Design in a split block arrangement replicated three times. The gross and net plot sizes were 3 x 4 m (12 m^2) and 1.8 x 4m (7.2 m^2) respectively.
The FYM was obtained from National Animal Production Research Institute, *(NAPRI)* Shika, Ahmadu Bello University, *Zaria* and incorporated to depth of 5 cm into the soil according to treatment and irrigated instantly to stimulate its biodegradation. Seeds were sourced from Lake Chad Research Institute, Maiduguri, Borno State, Nigeria and sown according to treatment on 6th December, 2015. Crops were irrigated every five days up to 30 days after sowing and later at seven days' interval up to hard dough stage when irrigation was stopped. All other agronomic practices were followed. The crops were harvested at full physiological maturity, dried for three days and threshed. Data were collected on establishment count at 3 weeks after sowing (WAS), number of tillers, LAI, RGR each at 6 WAS and grain yield. These were subjected to Analysis of Variance as described by Gomez and Gomez (1984) using SAS (2003) software. Treatment means were separated using Duncan's Multiple Range Test (DMRT) at 5 % probably level (Duncan, 1955).

Results and Discussion

Table 1 shows the physical and chemical properties of the soil. The results showed that the soil was loam and slightly acidic with pH of 6.01. The soil nutrient status was 1.34 g kg^{-1} organic Carbon, 0.15g kg^{-1} total Nitrogen, 3.53 g kg^{-1} of available Phosphorus while exchangeable bases values were Calcium (2.31 C mol kg^{-1}), Magnesium (0.90 C mol kg^{-1}), Potassium (0.015 C mol kg^{-1}) Sodium (0.17 C mol kg^{-1}) as well as Cation Exchange Capacity (CEC) of 3.40 C mol Kg^{-1} of soil. Weather data for the period of the experimental are shown in Table 2. Maximum temperature ranged from 27.40 to 40.04 ^{0}C while minimum temperature ranged from 13.60 to 26.30 ^{0}C. Relative humidity and Daily pan evaporation ranged from 11.40 to 57.60% and 7.1 to 15.3 mm day^{-1} while mean sunshine hours was between 5.9 to 9.4 hours.
Effect of sowing method and fertilizer on establishment count, number of tillers, Leaf Area Index, Relative Growth Rate and grain yield of wheat varieties at Samaru in 2015/2016 dry seasons is presented in Table 3. The result showed that the varieties varied significantly only on grain yield. LACRIWHIT-5 significantly produced higher yield than LACRIWHIT-1 and 4 which were at par. Similarly, variation due to sowing method was significant only on grain yield with drilled sown wheat exceeding broadcast. The effect of fertilizer was significant on all the growth parameters studied and grain yield of wheat.
Application of NPK alone resulted in significant increase in establishment count number of tillers, Leaf Area Index and grain yield but was similar to when FYM alone was applied for establishment count, combined NPK and FYM for number of tillers and grain yield. The unfertilized plots recorded the least values except for RGR when it excelled other treatments but similar to FYM alone and for number of tillers also at par with FYM alone. There was significant interaction between variety and sowing method (Table 4) and between sowing method and fertilizer on establishment count (Table 5) and between variety and fertilizer on grain yield (Table 6). In 2015/2016 at Samaru, LACRIWHIT-4 and LACRIWHIT-5 when drilled or broadcasted recorded similar and more stand count than LACRIWHIT-1. However, LACRIWHIT-5 was at par with LACRIWHIT-1 throughout and broadcasted LACRIWHIT-4 were similar to drilled LACRIWHIT-1. Variation in sowing method had no significant effect on stand count of each of the varieties. The highest and the least stand count was from drilled LACRIWHIT-4 and broadcast LACRIWHIT-1, respectively. In the combined means at Samaru, significantly higher stand count was recorded in all the varieties when drilled and when LACRIWHIT-4 and 1 were broadcasted. However, broadcasted LACRIWHIT-5 was at par with drilled LACRIWHIT-4 and 1 at both sowing methods (Table 4). Table 5 shows the interaction between sowing method and fertilizer at Samaru in 2015/2016 dry season. When only NPK fertilizer was applied, drilled wheat had more stand count which was at par with broadcast supplied with combined NPK and FYM. On the other hand, the fertilized broadcast were at par with the drill when supplied with FYM alone. At Samaru in 2015/2016 irrespective of applied fertilizer, LACRIWHIT-1 and 4 recorded similar grain yield that was lower than that of LACRIWHIT-5. When fertilizer was fixed, LACRIWHIT-1 and 4 under NPK alone or combined with FYM produced similar grain yield that was

lower than that of LACRIWHIT-5. Application of NPK alone or in combination with FYM to LACRIWHIT-5 recorded the highest grain yield while least yield was obtained from the control treatments irrespective of the varieties used (Table 6).

Crop growth performance and yield are influenced not only by genetic factors but also by environmental condition. These factors influenced crop growth and modify the genetic potential of plant to use them effectively. The non-significant variation in all the growth parameters could be credited to similar growing conditions at early growth stages when plants are still vigorous and struggling to establish. Similar result was reported by Sokoto *et al*. (2012). However, LACRIWHIT-5 was superior in grain yield than LACRIWHIT-1 and 4. This might be attributed to the genetic variability and adaptability which allow for robust growth and more dry matter production by LACRIWHIT-5. The superiority of LACRIWHIT-5 over other wheat varieties has been reported that Ibrahim (2016) in the same environment.

All the parameters assessed were not significantly affected by sowing method except grain yield. This could be due to the soil and atmospheric conditions (Tables 1 and 2). A number of workers reported contrasting results on the effect of sowing method on wheat growth attributes and grain yield Abbas *et al*. (2009); Soomro *et al*. (2009); Amin *et al*. (2013); Ata-Ul-Karim *et al*. (2015). None significance response was observed by Abbas *et al*. (2009), while Amin *et al*. (2013) reported higher stand establishment with drill sowing over broadcast. Khan *et al*. (2007) and Singh *et al*. (2005) observed higher tiller number and grain yield in drill planted wheat than broadcasted while lager LAI and high grain yield in broadcast sowing was reported by (Ahuja *et al*., 1996; Carver, 2005; Singh *et al*., 2005) and these might be due to varying environmental and soil conditions. The significant effect of fertilizer on all parameters assessed is expected considering the positive role of fertilizer on growth and development of crops particularly when applied to soils with low fertility (Table 1). The higher response to application of NPK alone could be due to fast release and easy absorption of mineral fertilizer. Organic manures release nutrients slowly even when combined with inorganic and their effects are cumulative hence the overall effects are not noticed early (Abdelgadir *et al*., 2016). Fertilizer application to wheat particularly N during early stages of development greatly increased leaf area by delaying leaf senescence, sustained leaf photosynthesis and extended leaf area duration which ultimately resulted in maximum LAI for higher RGR and ultimately yield (Zhang *et al*., 1998). This was realized as application of NPK alone or in combination with FYM increased the grain yield by 153.17 and 150.88 % over the control plots respectively. Fertilizer application improves grain yield by increasing tillers per m^2 and early plant vigour. This is in line with the studies of Gomaa *et al*. (2015), Kousar *et al*. (2015), Abdur *et al*. (2016) and Abebe and Manchore (2016) who reported highly significant influence of NPK fertilizer on grain yield of wheat. Mueen-ud-din *et al*. (2015) also recorded high yield of wheat as a result of application of FYM.

Conclusion

The research findings indicated that variety and sowing method effect were significant only on grain yield. LACRIWHIT-5 excelled LACRIWHIT-1 and 4 in grain yield while drll sowing outperformed broadcast in grain yield. Application of 120 kg N, 60 Kg P_2O_5 and 60 Kg K_2O ha^{-1} proved better in growth and yield but statistically similar to combined application of 5 t ha^{-1} FYM and 60 kg N, 30 Kg P_2O_5 and 50 Kg K_2O ha^{-1}. Therefore, the choice of variety LACRIWHIT-5 and application of at 5 t ha^{-1} FYM and 60 kg N, 30 Kg P_2O_5 and 50 Kg K_2O ha^{-1} with drill sowing is optimum for better growth and yield of wheat in the Northern Guinea Savannah of Nigeria.

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Table 1: **Physical and chemical properties of soils at experimental locations in Samaru during 2014-2015 dry seasons**

Physical Properties (g Kg-1)	
Sand	530
Silt	350
Clay	120
Textural class	Loam
Chemical Properties	
pH (H_2O)	6.01
pH (in 0.01M. $CaCl_2$)	5.56
Organic carbon (g Kg-1)	1.34
Available phosphorus (Mg Kg-1)	3.53
Total Nitrogen (g Kg-1)	0.15
Exchangeable base (cmol Kg-1)	
Ca^{++}	2.31
Mg^{++}	0.90
K^{++}	0.015
Na^{++}	0.17
CEC	3.40

Soil sample analyzed at Agronomy Department, A B U, Zaria

Table 2: Mean maximum and minimum temperature (⁰C), Relative humidity (%), sunshine hours and Pan Evaporation (mm/day) at 10-day interval during 2015-2016 dry season at Samaru

Month/decade	Rel. humidity (%)	Air temperature (⁰c) maximum Minimum		Sunshine (Hours)	Open pan evaporation (mm/day)
December					
1-10	28.3	34.5	13.6	9.0	7.5
11-20	16.5	31.3	13.9	9.4	9.7

21-31	18.3	30.6	16.1	8.3	10.7
January					
1-10	17.3	30.5	16.2	7.5	
11-20	16.8	31.8	15.3	8.8	7.8
21-31	18.6	27.4	14.6	7.5	8.6
February					
1-10	16.6	31.2	16.0	7.9	8.2
11-20	12.6	35.8	17.5	7.7	7.8
21-29	11.4	36.7	20.8	6.7	8.3
March					
1-10	20.5	32.3	23.2	7.5	8.7
11-20	45.9	33.9	24.5	6.1	7.5
21-31	33.6	37.6	24.5	5.9	7.6
April					
1-10	45.1	38.3	25.8	7.2	15.3
11-20	57.6	39.7	26.3	7.7	7.1
21-31	50.0	40.4	25.3	8.6	8.3

Source: I A R Samaru, Agrometeorological station, A. B. U, Zaria NA=Not available

Table 3: Growth parameters and yield of wheat varieties as influenced by sowing method and fertilizer application at Samaru in 2014-2015 a dry season

Treatment	Establishment count (m^2)	Tiller number (m^{-2})	LAI at 6 WAS	RGR at 6-9 WAS	Grain yield (kg ha^{-1})
Variety (V)					
LACRIWHIT-1	201.17	665.07	1.41	0.32	2003.95b
LACRIWHIT-4	209.92	685.20	1.67	0.14	2066.37b
LACRIWHIT-5	205.13	670.67	1.81	0.33	2526.54a
SE±	9.931	30.784	0.158	0.027	67.752
Sowing Method (S)					
Broadcast	203.94	651.27	1.47	0.34	2072.00b
Drill	206.86	696.02	1.80	0.31	2325.90a
SE±	8.109	25.135	0.129	0.022	55.319
Fertilizer (F)					
Control	135.44c	495.07b	0.41d	0.40a	1094.40c
NPK (120: 60:60 kg ha^{-1})	246.89a	856.00a	3.59a	0.30b	2770.70a
FYM (10 t ha^{-1})	227.78ab	586.31b	0.95c	0.32ab	2185.20b
NPK (60 :30 :30 kg ha^{-1})+ FYM (5 t ha^{-1})	211.50b	757.20a	1.58b	0.28b	2745.60a
SE±	11.467	35.547	0.183	0.031	78.234
Interaction					
Vx S	*	NS	NS	NS	NS
V x F	NS	NS	NS	NS	*
S x F	*	NS	NS	NS	NS
V x S x F	NS	NS	NS	NS	NS

Means followed by same letter(s) within the same column and treatment group are not significantly different at 5% level of probability. WAS = Weeks after sowing, **= significant at 1% level of probability. NS = Not significant

Table 4: Variety and sowing method interaction on stand count m^{-2} of wheat at Samaru in 2015/2016 dry season and the combine mean

	Variety		
Treatment	LACRIWHIT-1	LACRIWHIT-4	LACRIWHIT-5
Sowing Method	**Samaru 2015/2016**		

Broadcast	176.17c	221.67ab	198.17abc
Drill	188.34bc	234.08a	214abc
SE± 19.862			

Means followed by the same letter are not significantly different at 5% level of probability using DMRT

Table 5: Sowing method and fertilizer interaction on stand count of wheat at Samaru in 2015/2016 dry season

Treatment	**Sowing Method**	
	Broadcast	Drill
Fertilizer		
Control	138.67d	132.22d
NPK (120: 60:60 kg ha^{-1})	212.89bc	280.89a
FYM (10 t ha^{-1})	226.22b	229.33b
NPK (60 :30 :30 kg ha^{-1})+ FYM (5 t ha^{-1})	249.67ab	173.33cd
SE± 22.935		

Means followed by the same letter are not significantly different at 5% level of probability using DMRT

Table 6: Interaction between variety and fertilizer on yield (kg ha^{-1}) at Samaru in 2015/2016 dry season

	Variety		
Treatment	LACRIWHIT-1	LACRIWHIT-4	LACRIWHIT-5
Fertilizer		**Samaru 2015/2016**	
Control	1120.0e	1172.4e	907.0e
NPK (120: 60:60 kg ha^{-1})	2388.9bc	2602.5b	3320.6a
FYM (10 t ha^{-1})	2033.4cd	1947.8d	2574.4b
NPK (60 :30 :30 kg ha^{-1})+ FYM (5 t ha^{-1})	2473.4b	2542.8b	3220.5a
SE± 191.63			

Means followed by the same letter are not significantly different at 5% level of probability using DMRT

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Growth and Yield responses of Pungent and Non- pungent Peppers (*Capsicum annum*) to Nitrogen Fertilizer rates

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Abstracts

The objective of this study was to evaluate the effect of different rates of nitrogen fertilizer on the growth and yield of pungent and non-pungent peppers. The trial was conducted at the Research farm of the Department of Crop Production and Landscape Management, Ebonyi State University, Abakaliki. The experiment was laid out in a randomized complete block design with four replications using two varieties of peppers (Pungent and non-pungent) and six nitrogen fertilizer rates (0, 30, 60, 90,120 and 150 kg ha^{-1}). All the parameters measured showed significant differences for the two pepper varieties with respect to different rates of fertilizer applied. However, pungent pepper had significant difference for all the parameters measured while the fertilizer rate of 90 kg ha^{-1} recorded the highest in all the parameters except number of leaves where 120 kg ha^{-1} recorded the highest. The Control treatment had the least values for all measured parameters, although were statistically similar with 30 kg ha^{-1} in some parameters. The rate of fertilizer above 90 Kg ha^{-1} showed some negative effects on certain parameters. Best fertilizer regimes observed fall between 90–120 Kg ha^{-1}. Therefore, this research recommends that farmers in the study area should plant pungent pepper with fertilizer rate of 90 kg N ha^{-1}.

Introduction

Pepper is the second most important vegetable after tomatoes and belongs to the Solanaceae family. Pepper encompasses about 30 species, but *Capsicum annuum* L. is the most cultivated species in both tropical and temperate zones (Grubben and El Tahir, 2004). According to FAOSTAT (2012), the average world's fresh chili and sweet pepper production in 2010 was 27.6 million tons, to which West Africa contributed 888 tons, 400 tons or 3.2% with Nigeria and Ghana ranked 8th as the biggest West African contributors respectively. The vast majority of West Africa's pepper is sold in local, regional and international markets. Pepper has economic, nutritional and medicinal values. It is an excellent source of natural colours and antioxidant compounds and the dried fruit is used as a spice and seasoning (Dagnoko et al., 2013). They are consumed in large quantity daily by almost every household across the Globe. The crop constitutes a source of income for resource poor households in urban, peri-urban as well as the rural areas. This makes pepper suitable for use in poverty reduction programmes targeting resource poor households, including women in developing countries. Pepper can be cultivated on varieties of soils but preferably sandy to loam soils with adequate organic manure. The crop requires an average temperature of 25- 280C and 16 - 180C for day and night times respectively. Supply of adequate clean water to the root zone is critical (Madisa, 2006). The production and yield of plant depend on sufficient availability of required nutrients. The mineral nutrients, N, P and K are known to affect growth and yield of the capsicums. Applications of N fertilizer levels showed significant effect on all growth and yield parameters. Yield in pepper increased with increase in nitrogen (N) level but excessive N application may also decrease the yield (Khan et al., 2014). The Nitrogen application increases the productivity but the geography including soil, climate plays an important role in the response of nitrogen fertilizer for overall effect on the productivity (Lebauer and Treseder,2008).It was reported that N fertilizer increased fruit weight, yield and fruit number of chili peppers (Tumbare and Niikam,2004). Improved nitrogen management can be achieved by matching nitrogen supply with crop need and selecting appropriate nitrogen level to minimize nitrate nitrogen accumulation in soil at times, when the leaching potential is high (Papendick, 1987). In severe cases of excess nitrogen, leaves developed necrotic lesions followed by defoliation. It is evident from literature, that potash affects mostly the quality of fruits and vegetables. Potassium is one of the three major nutrients (N, P and K) needed for plant growth. Potassium plays a main role in plant metabolism such as photosynthesis, translocation of photosynthesis, water relation as well as enzyme activation. Although, potassium is not a constituent of any plant structures or compounds, but it plays a part in many important regulatory roles in the plant, i.e. osmo-regulation process, regulation of plant stomata and water use, translocation of sugars and formation of carbohydrates, energy status of the plant, the regulation of enzyme activities, protein synthesis and many other processes needed to sustain plant growth and reproduction. It is a highly mobile element in the plant and has a specific phenomenon, it is called luxury consumption. In addition, it plays a very important role in plant tolerance of biotic and a-biotic stresses (Marschner, 1995). Potassium is also known as the quality nutrient because of its important effects on quality factors (Lester, 2006).With the exception of nitrogen, potassium is required by plants in much greater amounts than all the other soil-supplied nutrients (Tisdale *et al*; 1985). In the Urban and Peri-urban areas, vegetable production is the major agricultural activity and mostly undertaking by small-scale women farmers. The high costs of inputs, unavailability of high yielding varieties, inadequate research on pepper and other standard production practices results to poor yields, low quality produce and low returns. Inevitably, the rapid increasing population unequivocally requires corresponding food supply especially vegetables. But vegetable growers in Nigeria are faced with numerous problems including inability to determine appropriate rate of fertilizer. Thus the aim of this research was to evaluate different rates of NPK fertilizer to increase the productivity of pungent and non-pungent peppers.

Materials and Methods

The field study was conducted at the Teaching and Research Farm of the Faculty of Agriculture and Natural Resource Management, Ebonyi State University Abakaliki during 2016 and 2017 cropping seasons. The experiment was laid out as 2 x 6 factorial in a randomized complete block design with four replications.The treatments used were two pepper species (Pungent and non-pungent pepper), the six nitrogen rates (0, 30, 60, 90, 120 and 150 kg ha^{-1}) which gave a total of 12 treatment combinations in each replicate. Each plot size was 2 m x 2m with a net plot size of 1.5 m x 1.5 m and the plots were separated by a distance of 0.5 m and the replicates by 1m. Preplanting herbicides, glyphosate (round up) was applied to the experimental site at the rate 2 kg a.i. ha^{-1} two weeks before land preparation in each year of the study in order to control the prevalent weeds on the field. Thereafter, the field was harrowed twice to ensure fine tilth of the soil and the soil was demarcated into plots. Transplant of the varieties were done manually on 20th June of both cropping seasons. The nitrogen fertilizer were applied as split, half of the nitrogen fertilizer together with 30 kg P_2O_5 ha^{-1} and 30 kg K_2O were applied once at two weeks after planting using NPK (15:15:15) while the second half of the nitrogen were applied using urea (46% N). Weed control was done by pre-emergent application of premetra (Atrazine +Metalachlor) at the rate of 2 kg a.i ha^{-1} immediately after sowing in both years of the study. This was later supplemented by hand weeding using traditional hoe at 7 weeks after Sowing. Data collected for the two cropping seasons on the growth and yield parameters were pooled and subjected to analysis of variance technique using a General Linear Model in Minitab and turkey test was used to separate the treatment means.

Results and Discussion

Soil physical and chemical properties

Soil analysis report of the study area revealed that the soil was sandy clay loam with a bulk density of 1.2g/cm^3 which is considered an optimum bulk density for most crops (Lal and Shukla, 2004). The soil is acidic, low organic carbon with available P and exchangeable bases Table 1. The acidic soil with Low soil nitrogen content at the experimental site was associated with the history of continuous cultivation with little no addition of organic or inorganic fertilizers. Soil available nitrogen is essential for vegetative growth as such, addition of nitrogen fertilizers at low rate as starter dose to some crops are necessary especially where soil nitrogen content is low. A very low status of available p was a major limiting factor for crop production and as such its application to enhance optimum yield was important. Phosphorous deficiency constitutes a serious limitation to crop production in weathered tropical soils containing high Fe and Al oxides that quickly fix or added P. Moazed *et al.* (2010) reported that low quantities of soluble P in oxisols limit crop production and productivity. Exchangeable cations i.e. Ca Mg and K ranged from low to high. The level of soil Ca was affected by level of organic matter resulting in the inability of the soil to hold the amount required for crop growth. The soil showed that the soil fertility status is low and therefore, requires supplementary nutrients through soil amendment for optimum growth and yield to be achieved.

Growth parameters

Mean values for growth parameters of pungent and non-pungent peppers on plant height, number of leaves, number of branches and days to 50% flowering are presented in Table 2. All the growth parameters increased as the fertilizer rates increases up to 90 kg ha^{-1}. However the mean values decreased after 90kg ha^{-1} except for number of leaves where 150 kg ha^{-1} recorded the highest. The tallest plants, highest number of branches and more days to flowering were recorded at 90 kg ha^{-1} followed by 120kg N ha^{-1} which was statistically similar with 150kg N ha^{-1} while 0 kg ha^{-1} which was at par with 30kg ha^{-1} recorded the least mean values. This result is in conformity with Omotoso and Shittu (2007) and Awodun *et al*., (2007) who reported that NPK fertilizer significantly increase growth parameters of plant height, number of leaves, yield and yield components in Okra and Pepper. The highest number of branches was recorded at 90 kg ha^{-1} (46.88) while the lowest (22.75) were obtained by 0 kg ha^{-1}. This result conforms to the findings of Law Ogbomo and Egharevba (2010) who reported that number of branches associated with various soil amendments were at par and significantly different from control treatment. The observed differences in days to 50% flowering among the rates of fertilizer applied could be perhaps attributed to effective uptake and efficient utilization of available nutrients for growth and development of the crop.

Significant differences were recorded between the genotypes in all the growth parameters. The pungent pepper significantly produced higher mean values than non-pungent pepper in all the growth parameter. The variation between the two genotypes were due to the genetic makeup of the crops.

Yield and yield components of pepper

Mean values for yield and yield components of pungent and non-pungent peppers which include number of fruit per plant, fresh weight of fruit, dry weight of fruit and total yield are presented in Table 3. All the yield and yield component of the pepper significantly increased as the fertilizer rates increased from 0 to 90 kg ha^{-1}. However the mean values decreased after 90kg ha^{-1}. The fertilizer rate of 90 kg ha^{-1} significant recorded the highest yield in all the yield parameters followed by 120 kg ha^{-1} which was statistically similar with 150 kg ha^{-1} while control (0 kg ha^{-1}) which also was statistically at par with 30 kg ha^{-1} recorded he least yield in all the parameters. The influence of nutrient sources on pepper fruit weight might be due to effect of K^+ which is associated with fruit formation and quality of seed and fruits. This result agrees with the findings of Costa and Campos (1990).

There was significant variation between the two pepper genotypes Table 3. Pungent pepper significantly produced higher number of fruits, fresh weight of fruits, dry weight of fruits and total yield than the non-pungent pepper. The significant variation was due to differences in genetic makeup of the pungent and non-pungent pepper. This is in conformity with Gardner et al. (1990) and Zaki *et al*. (1999) who ascribed the yield variances in crop cultivars to the stomata of its value and the differences in the allocation of photosynthetic material in economic performance.

Conclusions

It could be concluded from the present study that the rates of fertilizer influenced growth and yield of pepper considerably. This shows that fertilizers applied to the soil were readily available and in the best form for easy absorption by the plant roots, hence there was a boost in the growth and yield of the crop. The study further indicated that pungent pepper should be plant at 90 kg N ha^{-1} by the farmers in the study area.

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Table1: Physical and Chemical properties of soil (0-30cm) sampled from the Experimental site

Physical properties	
Sand (g/kg)	205.00
Silt (g/kg)	327.00
Clay (g/kg)	201.00
Chemical properties	
pH in 0.01m $CaCl_2$	4.02
Organic carbon (g/kg)	2.57
Total nitrogen (g/kg)	1.02
Available P (mg/kg^{-1})	2.20
K + (cmol/kg^{-1})	0.12
Mg + (cmol/kg)	0.61
Ca + (cmol/kg)	0.40
Na + (cmol/kg)	4.20
CEC + (cmol/kg)	3.11

Table 2: Effect of Nitrogen fertilizer rates on growth parameters of pungent and non-pungent peppers

Treatment	Height (Cm)	Number of leaves	Number of branches	Days to 50% flowering
Nitrogen rates (Kg ha^{-1})				
0	24.61c	113.0c	22.75c	39.75c
30	24.97c	124.0bc	31.cb	36.00c
60	29.42b	154.0b	37.75b	44.38b
90	36.23a	176.0b	46.88a	58.13a
120	31.58b	219.0a	42.63ab	56.38a
150	31.57b	239.0a	40.25ab	48.29b
SE ±	**1.47**	**28.30**	**5.56**	**3.14**
Varieties				
Pungent	37.88a	271.00a	62.17a	52.13a
Non-pungent	21.58b	71.10b	11.58b	44.46b
SE ±	**0.85**	**16.34**	**3.21**	**1.81**

Means followed by the same letter (s) are not statistically different at 5% level of Probability using Turkey test.

Table 3: Effect of Nitrogen fertilizer rates on the yield and yield components of pungent and Non-pungent peppers.

Treatment	Number of fruits	Fresh weight of fruit (g)	Dry weight of fruits (g)	Total yield (kg ha^{-1})
Nitrogen rates Kg ha^{-1}				
0	18.16c	9.59c	6.49d	16219.00d
30	23.33c	13.39c	9.26cd	23156.00d

60	33.00bc	35.88b	16.18c	40438.00c
90	83.79a	66.28a	53.13a	68188.00a
120	40.50b	28.89b	27.28b	50813.00b
150	38.87b	24.28b	20.33bc	44269.00c
SE ±	**6.94**	**3.67**	**2.98**	**439.96**
Varieties				
Pungent	76.48a	56.43a	42.40a	8990.00a
Non-pungent	24.54b	32.00b	21.82b	4552.00b
SE ±	**4.01**	**2.12**	**1.72**	**294.80**

Means followed by the same letter (s) are not statistically different at 5% level of Probability using Turkey test.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Growth Response and Proximate Analysis of *Amaranthus caudatus* on Different Rates of Pig Dung

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Abstract

Amaranthus caudatus has been rediscovered as a promising food crop mainly due to its resistance to heat, drought, diseases and pests, and the high nutritional value of both seeds and leaves. Amaranthus caudatus is rich in proteins and micronutrients such as iron, calcium, zinc and magnesium. This current study was carried out to evaluate the performance of Amaranthus caudatus planted with three rates of organic manure (pig dung) which are (2.0g, 2.5g, and 3.0g) and the control soil with no addition of organic manure. The results from this study shows that plant with soil treatment (2.0g and 2.5g) of pig dung significantly influenced the growth performance of Amaranthus caudatus in respect to plant height, number of leaves, area of leaves, stem width.

Introduction

Vegetables are herbaceous plants (such as the cabbage, bean, or potato) grown for an edible part that is usually eaten as part of a meal. Wild vegetables play an important role in the diet of inhabitants of different parts of the world. Among the wild vegetables are *Chenopodium album*, *Sonchusasper*, *Solanumnigrum* and *Urticaurens*. The leaves of these plants were analysed for their nutritive value, anti-nutritive components and polyphenolic contents. Different edible species of *Amaranthus* are being consumed widely as leafy vegetable across the world due mainly to its lower price and rich source of protein, carotenoids, vitamin C, dietary fiber (Shukla*et al.,* 2006) and minerals such as calcium, iron, zinc and magnesium (Kadoshnikov*et al.,* 2008). Several species of *Amaranthus* have been reported to contain various bioactive phytochemicals such as carotenoids, ascorbic acid, flavonoids and phenolic acids etc (Amin *et al.,* 2006). *Amaranthus* has well been documented to possess important pharmacological properties including anticancer (Sani*et al.,* 2004; Baskar*et al.* 2012), anti-inflammatory (Tyszka-Czochara*et al.,* 2016) and antioxidant activity (Amin *et al.,* 2006). Amaranth is extensively cultivated as a green, leafy vegetable and grain crop in many temperate and tropical regions. In pre-Columbian times, large areas were grown during the height of the Aztec civilization in Mexico (Brenner *et al*., 2000). Meanwhile, amaranth had spread around the world and had become established for food use (grain or leaves) in places such as Africa, Central America, Southeast Asia, the Andean highlands in South America and North America (Brenner *et al*,. 2000). Amaranths exhibit C4 photosynthesis and grow rapidly under heat and drought stress, and they tolerate a variety of unfavorable abiotic conditions, including high salinity, acidity, or alkalinity, making them uniquely suited for subsistence agriculture. By implication, amaranth has the potential for significant impact on malnutrition (Maughan *et al*., 2011). Vegetable amaranths grow well at day temperatures above 25 C and night temperatures not lower than 15 C. Shade is disadvantageous except in cases of drought stress. Amaranth is a quantitative short-day plant, which is an advantage in the subtropics where the generative stage is delayed during summer. Amaranths like fertile, well-drained alkaline soils (pH 6) with a loose structure. The mineral uptake is very high (Grubben, 2004a).

The aim of this study is to assess the effect of pig dung used as organic fertilizer on the growth and physiological response of *Amaranthus caudatus.*The specific objective are: to determine the effect of different rates of pig dung used as organic fertilizer on growth response of *Amaranthus caudatus* and to ascertain the impact of different rate of pig dung on proximate result of the cultivated *Amaranthus caudatus.*

Material and Method

Field studies were carried out in the year 2018, at the Teaching and Research Farms, LadokeAkintola University of Technology, Ogbomoso (latitude 80 10' N and longitude 40 10' E), Nigeria, different of rates (2.0g, 2.5g, 3.0g) of pig dung were applied, the pig dung were collected from and there material are: Plastic Pot, Soil, Organic fertilizer (Pig dung), Seed (*Amaranthus caudatus*), Water, Tape rule, Oven, Blender. The manure used was prepared mainly from cured pig manure. The pig manure was obtained from Best Food Farm, Ogbomoso. Land clearing and preparation were carried out manually, conventional practice, using hoe, cutlass, rake etc. Nursery ridges were made and dressed in preparation for the nursery of *Amaranthus caudatus* seeds of variety Ogbomoso-Local. The seeds were planted and watered daily until the seedlings sprout out and of about 2 weeks when the seedlings were transplanted into pots. Loaming soil where collected from the botanical garden of Ladoke Akintola University of Technology, Ogbomoso, for planting plastic pot of 5kg capacity with 12 diameter. Different rates (2.0, 2.5, 3.0,) g of pig dung were randomly applied to the soil in each pot to make up 5kg. Each of the treatments was replicated 10 time.1 seeding of *Amaranthus caudatus* was transplant into each of the pots. The results were taken to the Department of Agronomy, Faculty of Agricultural University of Ibadan for physic-chemical analysis before planting on it. The samples were watered and left for few days. The space was manually cleared and the analyzed soil was put inside plastic pot. Bed was raised to above ground level manually made with hoe. Seed were sown at 1m x

1m and later transplanted to the pot three weeks after planting. Application of organic fertilizer treatment was done before transplanting seeding was transplanted at week 4°C leaf stage

Data collection: Plant height was measured on each pot by tape rule. Total number of leaves on each pots was counted per plant. Total number of leaves on each pot was directly counted per plant. The leaf width on each pot was measured. On each pot, leaf height, width, of the largest leaf, middle and small leaf was measured using tape rule. The plant was uprooted after five weeks of transplanting. Washed and dried under drying oven at 40 c using electric light for 72 hours. After which was blended using electric blender and kept in 4 for future use.

Statistical analysis: a one way analysis of variance was used to compare the means of variance growth parameters among the treatment. A two way analysis of variance was also used to determine interaction between plant age and treatment on various growth parameters. Means were compared using Fisher Pair wise comparisms. The means were treated as significantly different at <0.05.

Method used for proximate analysis: Moisture content determination, fiber content, ash content: determined by method of AOAC 985.35(2005), protein content, Carbohydrate, total nitrogen was determined in samples according to Cresser and Parsons (8) method and total phosphorus was determined in samples according to Cresser and Parsons (8) method. The proximate analysis was carried out at National Horticultural Research Institute (NIHORT), Ibadan.

Results and Discussion

The analysis of pig dung and soil is presented in table 1.

Plant height: Plant height increased steadily from the first to the fifth week in all treatments except in Am (*Amaranthus caudatus*) grown in non-inoculated control. Am grown in 3.0 Pig dung concentration had the highest growth at week 5. Plant heights are significantly different. *Amaranthus caudatus* grown in control soil had the least growth. Fig.1

Number of leaves: Number of leaves increased steadily from the first to the third week in all treatment, although *Amaranthus caudatus* grown in control soil show slow growth yet the growth was continuous from the first to the fifth week. *Amaranthus caudatus*grown with 2.0 pig dung concentration shows increment in numbers of leaves while *Amaranthus caudatus*grown with 2.5 pig dung concentration and 3.0, 2.5 pig dung concentration had reduced number of leaves at week 4. Number of leaves are significantly different with *Amaranthus caudatus* grown in control soil having the least number of leaves. Fig. 2

Area of leaves: *Amaranthus caudatus* grown with 2.0 concentration of pig dung had sharp increase at week 1 compared to all other treatments. *Amaranthus caudatus* grown in 2.5 pig dung concentration and 3.0 pig dung concentration also shows steady increment. *Amaranthus caudatus* grown in control soil had the slowest increment. Areas of leaves are significantly different. Fig. 3

Stem width: Stem width increased gradually in all treatments from the first to the fifth week. *Amaranthus caudatus* grown with control soil had the least increment in all the weeks. Stem width is significantly different having the *Amaranthus caudatus* grown in 2.5 pig dung treatment with the highest increment and the *Amaranthus caudatus* grown with control soil with the least growth. Fig. 4. This finding is in line with those obtained by (Satyanarayana*et al*., 2002; Adeniyan and Ojeniyi, 2005; Adediran*et al*., 2005; Obasi*et al*., 2006. Most of their findings indicate better effect of organic materials on *Amaranthus*. Generally, the fresh yields obtained from all the treatments were high except the control. These are the optimum yields reported by Tandon (1991) and Messiaen (1992). This shows that *Amaranthus* responded positively to the various types of soil amendment except on untreated control soil where it shows the least growth.

Conclusion and Recommendation

This study showed that balanced use of organic manure enhanced optimum growth, yield, nutrient and composition contents of *Amaranthus caudatus* compared to control soil. However, *Amaranthus caudatus* grown in 2.0 pig dung concentration has yielded more in most of the measured parameters compared to other pig dung concentrations, therefore it recommended as the best for optimum production of *Amaranthus caudatus* with similar environments and climatic conditions. Although the control treatment does not give yield as it was recorded in other treatments, it is environmentally safe. It is recommended that 2.0 pig dung treatment is the best therefore is good for the growth of the vegetable.

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Table 1: Pig dung and soil analysis

PIG DUNG	DETECTED QUANTITY	SOIL TREATMENT	DETECTED QUANTITY
Total Nitrogen %	2.438	SOIL NUTRIENT	
Phosphorus %	2.518	P^H (H_2O)	7.6
Calcium %	3.813	Average phosphorus mg/kg	73.12

Magnesium %	1.025	Total Nitrogen g/kg	0.67
Potassium%	0.663	O.C g/kg	5.70
Sodium%	0.313	Clay g/kg	74.0
Manganese %	265.00	Silt g/kg	114.0
Iron%	4192.50	Sand g/kg	812.0
Copper%	42.50	Exchange H^+	0.26
Zinc kg	218.50	Exchange AL^{+++}	-
Cadmium kg	0.85	Calcium	2.81
Chromate kg	10.60	Magnesium	0.73
Cobalt kg	37.00	Potassium	0.10
Lead kg	4.30	Sodium	1.01
Nickel kg	19.50	Manganese	12.40
		Iron	8.32
		Copper	0.79
		Zinc	0.72
		Chromate	8.15
		Cadmium	0.55
		Lead	3.65
		Nickel	6.15
		Cobalt	8.60

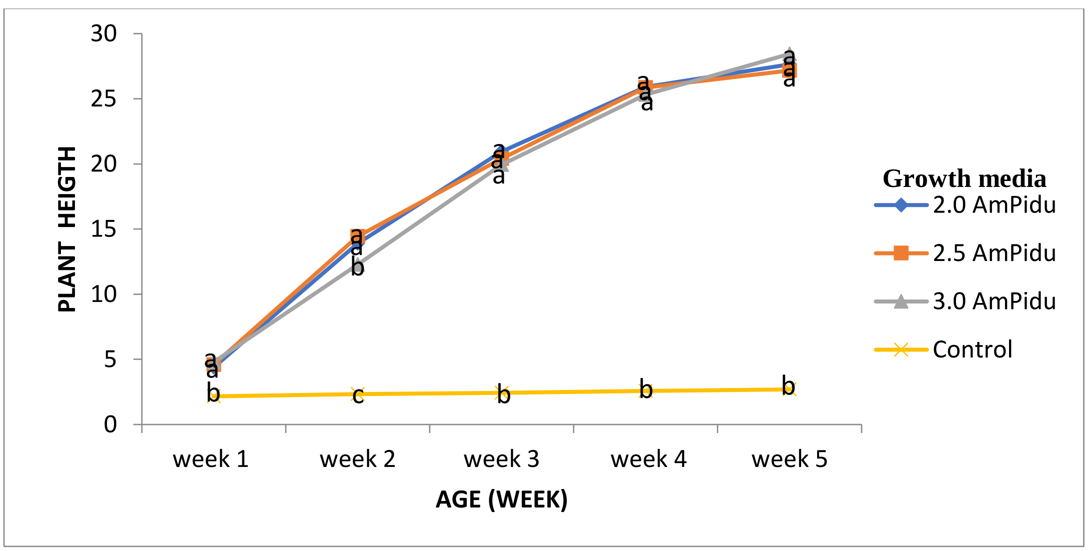

Fig. 1: Effect of organic fertilizer (pig dung) on *Amaranthus caudatus* plant height.
KEYS: Am: *Amaranthus caudatus,* Pidu: Pig dung treatment

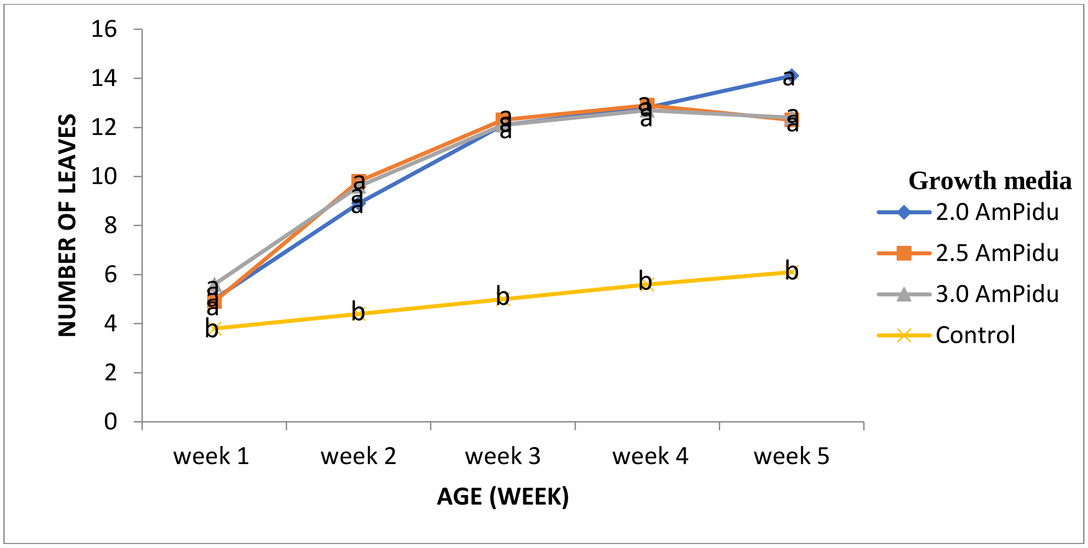

Fig. 2: Effect of organic fertilizer (pig dung) on *Amaranthus caudatus* number of leaves.
KEYS: Am: *Amaranthus caudatus,* Pidu: Pig dung treatment

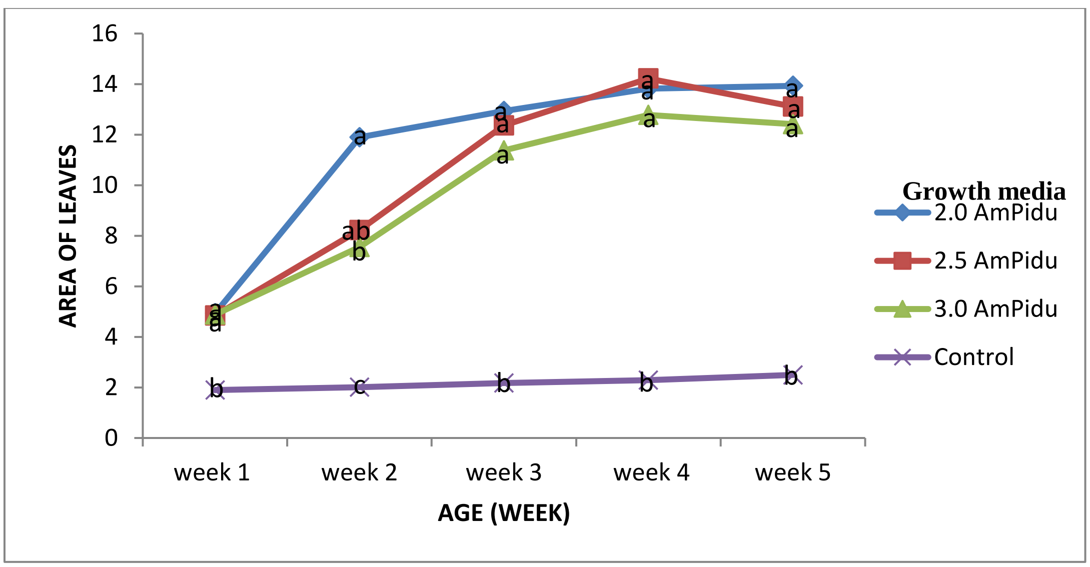

Fig. 3: Effect of organic fertilizer (pig dung) on *Amaranthus caudatus* area of leaves.
KEYS: Am: *Amaranthus caudatus,* Pidu: Pig dung treatment

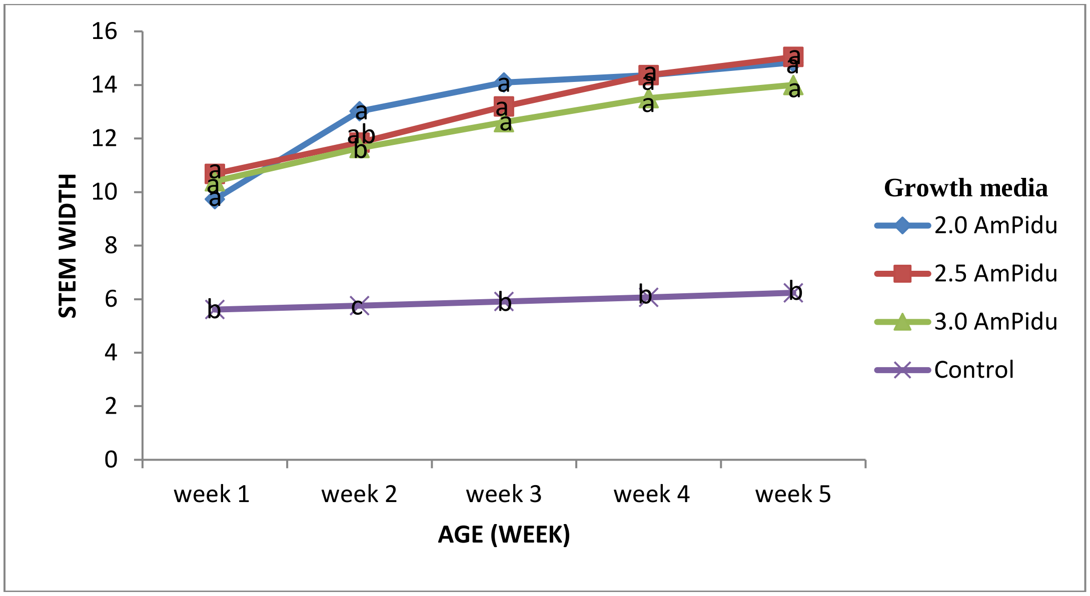

Fig. 4: Effect of organic fertilizer (pig dung) on *Amaranthus caudatus* stem width.
KEYS: Am: *Amaranthus caudatus,* Pidu: Pig dung treatment

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Influence of nitrogen and poultry manure on growth and yield of tomato *(Lycopersicon esculentum* Mill*)* in a semi-arid environment

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Abstract
The trial was conducted to determine the influence of poultry manure and nitrogen on tomato *(lycopersicon esculentum* Mill*)*. Field experiment was carried out in the dry season of 2017/2018 at the Teaching and

Research Farm of Federal University of Dutsin-Ma, Katsina State, Nigeria. Three rates of Nitrogen fertilizer (0, 45 and 90 kg/ha) and four levels of poultry manure (0, 5, 10 and 15 tons ha^{-1}) were used. All the treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Nitrogen fertilization significantly (P<0.05) increased number of leaves, number of branches, number of fruits and fruits yield of tomato. Fertilization of tomato plants with 90kg N ha^{-1} gave significantly higher tomato fruit yield (13727.6 kg ha^{-1}) than fruit yields (11266.3 and 12883 kg ha^{-1}) obtained for fertilization of tomato plants with 0 and 45kg N ha^{-1}, respectively. Application of 90kg N ha^{-1} was observed to be suitable for tomatoes production in the study area. Application of poultry manure significantly (P<0.05) increased number of leaves, number of branches, number of fruits and fruits yield. Application of 15t poultry manure ha^{-1} produced significantly higher tomato fruit yield (16014.4 kg ha^{-1}) than fruit yields (9696.1, 11399.8 and 13392.2 kg ha^{-1}) obtained for application of 0, 5 and 10 ton poultry manure ha^{-1}, respectively. Application of 15t poultry manure ha^{-1} was observed to be the best rate for tomato production in the study area.

Introduction

Tomato (*Lycopersicon* esculentum Mill) belongs to the family Solanaceae and genus Lycopersicon and is one of the most important vegetable crops in the world. This is because tomato plays a vital role in human diet and is a good source of vitamins and minerals. The fruits are eaten raw or cooked and can be processed into soup, juice, sauce, ketchup, puree, paste and powder (Olaniyi and Ajibola, 2008). Medically, tomato produces lycopene and lycopene is an antioxidant which has been associated to the reduction in the risk of prostrate and any other form of cancer plus heart diseases (Barber and Barber, 2002). Despite the usefulness of this crop, its production is very low. Nigeria produced 4.1 million tonnes from 589,234 hectares which represented 2.25% of the world's total production in 2017 (FAO, 2019). The Nigeria's tomato yield per hectare in 2017 was 69579 hectograms per hectare (6958kg ha^{-1}) compared with 39996.4 hectograms per hectare (39996.4kg ha^{-1}) obtained by Egypt (FAO, 2019). This is a clear indication that average tomato yield in Nigeria is relatively low. It has been reported that low soil fertility is one of the main challenges working against tomato production in Africa (Mbah, 2006). Soil infertility has remained an unsurrendering challenge facing farmers in Nigeria where crop yields are still very low. Soil degradation has been a very challenging factor working against Nigerian agricultural systems due to the fact that most farmers put little fertilizers to their crops and the crops in turn absorb greatly from the soil 'reservoir' without much effort to revitalize the soil (Adesoji *et al*., 2011). Hence, this leads to soil nutrient mining which further impoverishes the soil. Savanna soils of Nigeria hardly support a worthwhile crop production in the absence of a strategy to improve their fertility capacity either through the addition of organic or inorganic fertilizer. The use of inorganic fertilizer is appreciated by farmers because they are easy to handle, have a faster release of soil nutrients and are effective in fertility delivery (Adesoji 2015). However, their usage is limited by high costs and unreliable availability of inorganic fertilizers, even the few farmers who use fertilizers cannot afford the recommended rates (Loks *et al*., 2016). It becomes very pertinent to explore organic fertilizers such as poultry manure as a very good alternative to mineral fertilizer. The high organic matter content of organic fertilizers causes them to slowly release soil nutrients, increase soil microbial population, improve soil quality and leave the soil safe and healthy(Adesoji, 2015). Therefore, this study was designed to assess the influence of nitrogen and poultry manure on growth and yield of tomato.

Materials and Methods

The experiment was conducted in the dry season of 2017/2018 at the Research and Teaching Farm of Federal University Dutsin-Ma, at Badole (Longitude 07^{0}29'29" E and Latitude 12^{0}27'18" N) with altitude of 605 m in Sudan savanna ecological zone of Nigeria. The soil of the experimental site was sandy loam. The treatment consisted of three levels of Nitrogen fertilizer (0, 45 and 90kg N ha^{-1}) and four level of poultry manure (0, 5, 10 and 15t Poultry manure ha^{-1}). The experiment was laid out in a randomized complete block design (RCBD) with factorial combinations of nitrogen levels and various poultry manure levels and was replicated three times. The gross plot size was 2m x 2m (4m^2) and the net plot was 1.5m x 2m (3m^2). The ROMA variety of tomato was sowed in prepared nursery of a mixture of soil and poultry manure at a ratio of 1:2. The seedlings remained in the nursery for four weeks with routine management like watering and weeding when necessary. Seedlings were transplanted and sown two plants per hole in the field and were thinned to one plant per stand and seedlings were supplied to missing stands a week after transplanting (WAT). The experimental field was harrowed and consequently watered by flooding method. The field was further harrowed to give fine tilths and prepared into raised beds (plots) of 2m x 2m in basin form for irrigation purpose. Poultry manure was added to various plots by thoroughly mixing the manure with soil according to the treatments at two weeks before transplanting. Seedlings were transplanted at a spacing of 50cm x 50cm. Nitrogen fertilizer as urea (46%N) was applied to the tomato at 4 WAT according to treatments. The field was irrigated every four days using basin method. Weeds were controlled using hoe at 3 and 5WAT. Samplings on number of leaves and branches per plant of tomato were done at 4, 6 and 8 weeks after transplanting (WAT) while number of fruits per hectare and fruit yield (kg/ha) of tomato were obtained at harvest. Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984) using SAS package version 9.0 of statistical analysis (SAS institute, 2002). The differences among treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955). Effects were considered statistically significant at 5% level of probability.

Results

Application of 90kg N ha^{-1} significantly ($P<0.05$) increased number of leaves of tomato at 4, 6 and 8WAT but there was no significant difference between application of 45kg N ha^{-1} and 90kg N ha^{-1} at 4WAT (Table 1). Application of 15t poultry manure ha^{-1} gave significantly ($P<0.05$) highest number of leaves of tomato at 4, 6 and 8WAT which was significantly different from application of other rates of nitrogen (Table 1). Nitrogen fertilization significantly ($P<0.05$) increased number of branches at 6 and 8WAT only where application of 90kg N ha^{-1} significantly produced highest number of branches but there was no significant difference between application of 0 and 45 kg N ha^{-1} on number of branches (Table 1). Application of 15t poultry manure ha^{-1} gave significantly ($P<0.05$) highest number of branches except at 4WAT where application of 10t poultry manure ha^{-1} was at par with application of 15t poultry manure ha^{-1} on number of branches (Table 1). Increasing rate of nitrogen from 0 to 45kg N ha^{-1} significantly ($P<0.05$) increased number of tomato fruits per hectare while a further increase of nitrogen level from 45 to 90kg N ha^{-1} significantly ($P<0.05$) increased number of fruits per hectare (Table 2). Application of 15t poultry manure ha^{-1} gave significantly highest number of fruits per hectare when compared with other rates of poultry manure (Table 2). Increasing nitrogen rate from 0 up to 90kg N ha^{-1} significantly ($P<0.05$) increased tomato fruit yield per hectare and application of 90kg N ha^{-1} produced 13727.6kg fruit yield per hectare (Table 2). Application of poultry manure significantly ($P<0.05$) increased tomato fruit yield per hectare (Table 6). Application of 15t poultry manure ha^{-1} produced significantly highest tomato fruit yield per hectare (16014.4kg ha^{-1}).

Discussion

The mark performance observed on growth parameters after nitrogen application as exemplified in significant increases recorded on number of leaves and number of branches per plant could be attributed to the important role nitrogen plays as a protein constituent and also major component of many other compounds essential for plant growth processes including chlorophyll and many enzymes (Onasanya *et al*., 2009). It has also been reported that nitrogen application facilitates vegetative growth and fruit yield of tomato (Hokam *et al*., 2011). These significant increases noticed on number of tomato fruits per hectare and tomato fruit yield per hectare after nitrogen application could also be attributed to the fact that tomato plants that were treated with nitrogen produced taller plants, more number of branches, higher number of leaves and larger stem diameter for better photosynthetic activity which could have caused higher assimilate production and consequent translocation to the fruits for adequate development and production in N-treated plants than plants in N control plots. It could also be due to the vital roles of nitrogen in chlorophyll formation and photosynthesis. Application of 90kg N ha^{-1} produced the highest growth and fruit yield of tomato which was in line with the findings of Samaila *et al*. (2011) and Oyinlola and Jinadu (2012). Significant increases observed on number of leaves and number of branches as a result of poultry application could be attributed to the capacity of poultry manure to cause increase in soil organic matter content and consequently release plant nutrients in available form for plant use (Okoli and Nweke, 2015). This improvement observed on tomato growth after application of poultry manure could be to the fact that organic manure allows a soil to hold more water, improve the drainage and organic acids that assist to dissolve soil nutrients and then make them available for the use of crops (Deskissa *et al*., 2008). These increases could also be attributed to the ability of poultry manure to release of nitrogen, phosphorus, potassium, calcium as well as magnesium needed for crop growth (Awodun, 2007). The significant increases on number of fruits per hectare and fruit yield per hectare of tomato could also be attributed to the marked effects of poultry manure that enhanced growth performance of tomato as shown by the significant increases observed in the number of leaves and number of branches which culminated in increases observed on number of fruits per hectare and fruit yield per hectare of tomato. Application of 15t poultry manure ha^{-1} poultry gave the highest performance on yield of tomato. Other workers have also reported that poultry manure produced significant increases on yield of tomato (Adekiya and Agbede, 2010; Usman, 2015; Ilodibia and Chukwuma, 2015).

Conclusion

Based on the results obtained from this study, conclusion can be drawn that nitrogen fertilization at 90 kg N ha^{-1} was found to be most suitable for growth and yield of tomato in the study area. Poultry manure application at the rate of 15 t ha^{-1} exerted significant influence on growth and yield performance of tomato. Thus, application of 15 t ha^{-1} of poultry manure was observed to be best rate for tomato production in the study area.

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Table 1: Influence of nitrogen and poultry manure on number of leaves and branches of tomato per plant

Treatment	No. of leaves plant^{-1}			No. of branches plant^{-1}		
	4WAT	6WAT	8WAT	4WAT	6WAT	8WAT
Nitrogen (N) kg ha^{-1}						
0	18.27^{b}	31.30^{c}	36.27^{b}	9.18	12.10^{b}	15.17^{b}
45	21.38^{a}	33.88^{b}	38.78^{b}	10.23	12.77^{ab}	15.82^{b}
90	22.30^{a}	36.68^{a}	41.53^{a}	9.37	13.43^{a}	17.78^{a}
SE±	0.35	0.86	0.86	0.43	0.25	0.30
Poultry manure (P) t ha^{-1}						
0	17.87^{d}	29.93^{c}	34.76^{c}	8.69^{b}	11.91^{b}	15.09^{c}
5	19.31^{c}	32.62^{bc}	37.16^{bc}	10.07^{ab}	12.40^{b}	15.51^{bc}
10	21.80^{b}	34.98^{b}	40.06^{b}	10.38^{a}	12.64^{b}	16.18^{b}
15	23.62^{a}	38.29^{a}	43.47^{a}	9.24^{ab}	14.11^{a}	18.24^{a}
SE±	0.41	0.99	0.99	0.50	0.29	0.34

SE±: Standard Error. The means followed by the same superscript(s) within the same column and treatment are significantly the same at 5% level of probability using Duncan's multiple rate test (DMRT).

Table 2: Influence of nitrogen and poultry manure on number of fruits per hectare and fruit yield of tomato per hectare

Treatment	**No of Fruit ha^{-1}**	**Fruit yield (kg ha^{-1})**
Nitrogen (N) kg ha^{-1}		
0	788334^{c}	11266.3^{c}
45	862222^{b}	12883^{b}
90	971112^{a}	13727.6^{a}
SE±	21897.3	248.55
Poultry manure (P) t ha^{-1}		
0	730371^{d}	9696.1^{d}
5	837037^{c}	11399.8^{c}
10	918519^{b}	13392.2^{b}
15	1009630^{a}	16014.4^{a}
SE±	25284.8	287.0

SE±: Standard Error. The means followed by the same superscript(s) within the same column and treatment are significantly the same at 5% level of probability using Duncan's multiple rate test (DMRT)

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Influence of urea supergranule, rate and time of bio-stimulant application on the performance of some growth component and yield of Rice (*Oryza sativa* l.) in Sudan Savanna.

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Abstract

A field experiment was conducted in 2017 dry seasons at the Irrigation Research Station Farms of the Institute for Agricultural Research, Ahmadu Bello University at Kadawa to study the influence of urea supergranule (USG), rate and time of biostimulant application on the performance of some growth component and yield of rice (*Oryza sativa* L.) in Sudan savannah. The treatment consisted of 3 rates of urea

supergranule (USG) (farmers practice, 1.8 and 2.7g size of USG) at the rate of application of 0, 50 and 100ml/100L and at the various time of biostimulant application at 3 and 5, 3 and 10, 5 and 10 and 3, 5 and 10 weeks after transplanting (WAT). The experiment was laid out in a split plot design replicated three times. USG and rate of biostimulant was assigned to the main plots while time of biostimulant application was assigned to the sub plots.The application 2.7g size of USG significantly recorded substantial increase in plant height, number of effective tillers (NET), shoot dry weight (SDW), crop growth rate (CGR), leaf area index (LAI), days to 50% heading, days to physiological maturity and Paddy yield. Applying 100ml/100L rate of biostimulant enhanced better performance while biostimulant applied at 3, 5 and 10 WAT substantially increased plant height, NET, SDW, CGR, LAI, days to 50% heading, days to physiological maturity and Paddy yield of rice.The general trend in this study revealed that paddy yield was enhanced when 2.7g size of USG at the application of 100ml/100L rate of biostimulant was applied at 3, 5 and 10 WAT. There was significant interaction between urea supergranule and biostimulant which resulted in the paddy yield of 5396.83 kg ha^{-1}.
Keywords: urea, supergranule, bio-stimulant.

Introduction

Rice (*Oryza sativa* L.) is an importance staple food crop grown in Africa as indicated by its importation by various countries in the continent (WARDA, 2000). It is the extensively cultivated crop for half of the world's population (FAO, 2010). It is the most important food crop of the world, since it is the staple food for more than 90% of the world's population (Rothschild, 1995). Rice is the leading staple food crop in Nigeria; it is cultivated and consumed in virtually all the agro-ecological zones, from the mangrove and swamps environment of the coastal area, to the dry zones of the Sahel in the north (Ayanwale *et al*., 2011). Rice ranks third with 495.87 million tonnes in its milled form after Maize (1,099.61 million tonnes) followed by wheat (734.74 million tonnes) (Statista, 2019a).

Anonymous, (2019) reported that Nigeria is the largest rice producer in Africa with 4 million tonnes annually. FAO – RMM, (2018) also reported Nigeria to be the largest paddy rice producer in Africa with 7.2 million tonnes followed by Egypt with a reduction of 3.8% of 6.1 million tonnes. Paddy rice harvest in Nigeria rose from under 1 million tonnes in the 1970s to 4.2 million tonnes in 2010, production has however not kept pace with demand for consumption (Bamba *et al*., 2010). This is because; rice production in the country is characterized by low yield due to high weed infestation, lack of appropriate fertilizer application and cultivation of low yielding varieties. According to Ishaya and Dauda (2010) which reported that total crop failure may occur due to lack of fertilizer application, especially nitrogen which is the most limiting nutrient in the Nigerian soils and cultivation of poor yielding varieties. The encroachment of livestock on farms has become a serious problem due to conflicts between pastoralists and farmers (Selbut, 2003). Also, low soil fertility due to soil erosion results in loss of plant nutrients and moisture, low and imbalanced use of fertilizers. Productivity of rice can be increased by the on balanced use of plant nutrients and method of applying required nutrients in standing water using the deep placement of urea supergranules by the applicator, the adoption of non-monetary inputs like timely sowing, maintaining optimum plant population, timely irrigation, efficient use of fertilizers, need based plant protection measures and timely harvesting of crop and agricultural bio-stimulants to include diverse substances and microorganisms that enhance plant growth and vigour. Biotechnological approaches are adopted to increase quality and quantity of rice as well as its resistance to pests, diseases and environmental stresses (Datta, 2004). According to Crasswell and De Datta (1980), broadcast application of urea on the surface soil causes losses up to 50% but point placement of urea super granules (USG) at 10 cm depth may result in negligible loss. USG is an important source of nitrogen and has great impact for increasing the nitrogen use efficiency and yield of rice by its method of slow release to the plant when needed which is in accordance with Alberto *et al*. (2014) who stated that controlled and slow release fertilizers are prepared to release their nutrient content gradually, and if possible, match their release with the crop nutritional requirements. Positive responses have been reported on growth and yield of rice using urea supergranule by 7-10 days after transplanting (Tarfa and Kiger, 2013). USG generated available NH4-N slowly in rice field water properties spontaneously over the entire growth period compared to prilled urea indicating a beneficial role of USG (Rubel Husan, 2013). It is observed from the literature that nitrogen use efficiency of rice could be increased by root zone placement of USG as it would reduce the magnitude of nitrogen losses to a considerable extent and increase its use efficiency for better grain production (Crasswell and De Datta, 1980). Some reasons of this higher production may be due to high response to fertilizer, especially N fertilizer. Selection of potential variety, planting in appropriate method and application of optimum amount of nutrient elements, can play an important role in increasing yield and national income. The benefit of using deep placement USG is to increase nitrogen use efficiency by keeping most of the urea nitrogen in the soil, close to plant roots and out of the irrigation water for increased yield of produce via its slow release of nitrogen when needed by the plant. Cost and wastage of fertilizer by the farmers will be minimized. The use of biostimulant and improve yield. In order to increase rice productivity, it is necessary to find agent that can improve and promote rice growth. The use of Biostimulant for this research will foster plant growth and development throughout the crop life cycle from seed germination to plant maturity by improving the efficiency of the plant's metabolism to induce yield increases, help the crop withstand shock and improve crop vigour and enhanced crop quality. Despite the positive potentials of USG and biostimulant, improper use of the rates and time of application can also limit productivity. In the most part of Nigeria, lowland rice production is not extensively done during the dry season due to poor or inadequate irrigation facilities. The knowledge about the research will aid to improve the production of irrigated rice by maximizing the use of urea supergranule and application of biostimulant.

Objectives of the study include

i. To determine the effect of urea supergranule on the growth, yield and yield components of lowland rice.
ii. To evaluate the effect of biostimulant on the growth, yield and yield components of lowland rice.
iii. To access the effect of time of application of bio-stimulant on the growth, yield and yield components of lowland rice.

Materials and Methods

The experiment was conducted during the 2017 dry seasons on the experimental Farm of the Institute for Agriculture Research (IAR), Ahmadu Bello University, Kadawa, Kano State (11^{o}38. 581'N, 008^{o}26.043'E; 500m above sea level), under Sudan Savanna ecological zone of Nigeria. The soil was well drained sandy loam and slightly alkaline pH in water of 7.64; having 1.56 g kg^{-1} total nitrogen (Table 1). The experiments consisted three rates of Urea supergranule (USG (0,1.8, 2.7g/granule), three rates of bio-stimulant (0, 50 and 100 ml/100L of water) and four times of application of biostimulant [3 (tillering stage) and 5 (panicle initiation stage) weeks after transplanting (WAT), 3 and 10(milky stage) WAT , 5 and 10 WAT and 3, 5 and 10 WAT]. The treatments was laid out in a split plot design with the combinations of USG and biostimulant in the main plot, time of application of biostimulant in the sub plots and each was replicated three times. Prior to land preparation each year, 10 soil samples were collected at a depth of 0-30 cm at random from the experimental sites using an auger of 5.5cm diameter for laboratory analysis. The soil samples were thereafter bulked into a composite sample, air-dried, sieved (2 mm mesh) and analysed for basic physical and chemical properties. Glyphosate (Roundup ®) was applied to the experimental sites at the rate of 2.0 kg a.i. ha-1 two weeks before land preparation during the dry season to control the prevalent vegetation on the field. The field was ploughed and harrowed twice with a disc harrow to ensure a weed free soil and ridged 75cm apart. The area was marked into main plots and each which consisted of three sub plots. The blocks were separated by a distance of 1 m alley and the sub plots by 0.5 m. The gross plot consisted of 6 ridges (4.5 m X 5.0 m) each (22.5 m2) but the 4 inner ridges (3.0m X 5.0 m) were levelled and planted to rice; the net plot comprised all the gross plot (15 m^2) less 2 crop rows all round 2.2 m X 4.2 m (9.24 m^2). Treated seeds (FARO 44) with a maturity period of 110 – 120 days was sown, mulched and raised in a seedling nursery adjacent to the experimental plot. The seedlings were watered every three days till the seedlings reach 21 days after sowing. The rice seedlings were carefully uprooted and transplanted at 21 days after sowing from the nursery to the field, at the rate of one seedling per hole at 20cm inter-row and 20cm intra-row spacing. There were 15 rows per plot, 25 stands per row, and 375 seedlings per gross plot and 231 per net plot. At land preparation and layout, 60kg P_2O/ha_5 single super phosphate (SSP) and 60kg K_20/ha muriate of potash (MOP) was applied to plot that received 1.8 and 2.7g size of USG. However, Urea supergranule (USG) was applied once ten days after transplanting. USG was placed 5cm deep into the soil, between 4 rice stands and applied to every other row and to every other plant. Each plant had access to one briquette. It was applied once per cropping season. The field was irrigated, puddled and ponded after application of the USG fertilizer. The field was kept under water till crop maturity. Fertilizers were applied in the farmers' practice at the rate of 120 N, 60 P_20_5 and 60 K2O kg ha^{-1} as basal as per treatment. The first dose was applied at planting using NPK (15:15:15) to supply 60kg N/ha, 60kg P_2O_5/ha and 60kg K_20/ha recommended dose; and the second dose was top-dressed using urea (46% N) at 4 WAT in the farmers' practice.

Biostimulant was applied as per treatment using a CP16 knapsack sprayer at 100 L/ha spray volume and at a pressure of 2.1 kg/cm^2 using a green deflector nozzle. Table 2 gives result of the bio stimulant analysis. The crop was harvested after maturity when the mature rice panicle changed colour from green to a golden brown colour on the 22nd of July, 2017 using a sickle by cutting the rice plants above ground level. The harvested net plots were sun dried in the field and threshed. Threshing was done by placing the panicles on tarpaulin spread on flat floor and beaten with sticks. The paddy were thereafter winnowed in the air to remove the chaff, cleaned, dried and weighed to determine the yield per plot. Data was collected on plant height, number of effective tillers per plant, leaf area index, shoot dry weight, crop growth rate (CGR, days to 50% heading, days to physiological maturity and paddy yield. The data was subjected to analysis of variance using a General Linear Model in Statistical Analysis System (SAS) package and the treatments were separated by Duncan Multiple Range Test (DMRT) at 5% probability level (Duncan 1955).

Results

The results in Table 2 show that, the response of plant height, shoot dry weight, CGR, LAI and paddy yield of rice to urea supergranule, rate and time of biostimulant application at Kadawa 2017 dry season was significant with the exception of number of effective tillers, days to 5% heading and days to physiological maturity which was not significant. All the USG treatments resulted significantly influenced the crop growth and yield parameters than the farmers practice. The application of 0 and 50ml/100L rate of biostimulant were statistically at par recording a higher SDW and CGR while 100ml/100L rate of biostimulant recorded the highest. Rate of biostimulant did not significantly influence of number of effective tillers, LAI, days to 5% heading and days to physiological maturity. Regardless of the factors, 100ml/100L recorded the highest growth and yield parameters while where biostimulant was applied recorded the lowest values. However, in shoot dry weight and CGR, 100ml/100L was higher and comparable to 50 and where no bio stimulant was applied which were statistically at par. Differences in time of biostimulant application were significant only in plant height, shoot dry weight, LAI, days to physiological maturity and paddy yield. Considering plant height, 3, 5 and 10WAT recorded the tallest plant height. Subsequently, 5 and 10 WAT was statistically similar to 3 and 10 WAT which was in turn similar to 3 and 5 WAT which recorded the shortest plant height value. However, shoot dry weight and LAI recorded a higher value at 3, 5 and 10 and 5 and 10WAT time of biostimulant application which were statistically at par when compared to 3 and 10 and 3 and 5 WAT which were also statistically at par and recording the lowest values. However, days to physiological maturity and paddy yield followed same trend with 3, 5 and 10 WAT having the highest value when compared with the varying treatments. Interaction between USG and rate of biostimulant was significant only on plant height, CGR, days to physiological maturity and paddy yield (Table 3) where 2.7g size of USG and 100ml/100L rate of bio stimulant recorded the highest value while where no biostimulant was applied and farmers' practice recorded the least value.

Discussion

From the results, plots that received the highest rate of USG produced more vigorous and taller rice plants; heavier shoot dry weight, longer days to physiological maturity and heavier paddy yield than the farmer's practice. This is probably due to the fact that, since nitrogen is the most limiting nutrient in the savanna soils, higher rates of nitrogen were utilized by the plants. According to anonymous (2017) all assimilates produced after anthesis are partitioned to the grain, channelling the stored carbohydrate to the stem which is transported to the sink. This finding was in accordance with Anonymous (2017) who reported photosynthetic efficiency and production of more assimilates for dry matter production translates to yield. This allows for photosynthetic efficiency and production of more assimilates for dry matter production which translates to yield.

The application of the highest rate of bio stimulant resulted in better growth component and yield of rice this was due to the nutrient compostion of the bio stimulant which was not present in the soil. Mulyatni *et al.,* (2018) stated that biostimulant increased the length and dry weight of upland rice roots. This is as a result of better utilization of the biostimulant at the time needed by the plant for enhanced growth which translated to the high paddy yield. Three application stages of biostimulant were better than the two application stages which coincided with the critical stages of the crop. The interaction between USG (2.7g size) and rate of biostimulant (100ml/100L) was observed in the growth parameters which may be due to the translocation of assimilate for improved photosynthetic activities for higher crop growth and yield.

Conclusion

It can be concluded that based on the findings from this study that 2.7g size of USG with the application of 100ml/100L rate of biostimulant application at 3, 5 and 10 WAT is best suitable for rice production (5396.83 kg ha^{-1}) at Kadawa for increased growth and yield component of rice.

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Table 1: Physical and chemical properties of soils from Kadawa 2017 dry season.

Soil Properties	**Kadawa**
	2017
Soil depth	0-30cm
Physical composition	
Sand (g kg^{-1})	706
Silt (g kg^{-1})	150
Clay (g kg^{-1})	144
Textural class	Sandy loam
Chemical composition	
pH in water	6.28
pH in 0.01M $CaCl_2$	5.78

Organic Carbon (g kg^{-1})	14.24
Total Nitrogen (g kg^{-1})	1.56
Available Phosphorus (mg kg^{-1})	6.24
Exchangeable Bases (cmol kg^{-1})	
Ca^{++}	2.97
Mg^{++}	0.84
K^{+}	0.12
Na^{++}	0.14
CEC	4.22

Table 2: Effect of urea supergranule, biostimulant rate and time of bio stimulant application of rice at Kadawa 2017 dry season.

Treatments	Plant	Shoot	Leaf	CGR 9-	Days to	Days to	Paddy

	heights (cm)	Number of effective tillers	dry weight (g)	area index	12WAT (g m^{-2} wk^{-1})	50% heading	physiological maturity	yield (kg ha^{-1})
Urea supergranule (U) (g)								
0(Farmer's practice)	56.04c	14.44	62.56c	1.43b	16.25c	73.22	96.11	2023.81c
1.8	66.04b	14.76	87.75b	1.77a	22.80b	73.33	96.33	3050.26b
2.7	83.34a	14.86	129.38a	1.87a	30.57a	73.38	96.80	4375.68a
SE ±	0.875	0.610	5.280	0.051	1.419	0.190	0.657	26.543
Biostimulant Rate (B) (ml)								
0	62.36c	14.08	77.53b	1.59	20.27b	73.11	96.05	2693.12c
50	67.03b	14.82	88.33b	1.61	22.12b	73.22	96.33	3047.62b
100	76.03a	15.16	113.82a	1.86	27.23a	73.61	96.80	3708.99a
SE ±	0.875	0.610	5.280	0.089	1.419	0.190	0.657	26.543
Time of application (T) (WAT)								
3 and 5	64.82c	14.10	76.39b	1.73	19.02b	73.00	74.96d	2913.58d
3 and 10	66.54bc	14.59	83.87b	1.63	20.13b	73.22	76.69c	3065.26c
5 and 10	68.26b	14.88	101.32a	1.69	27.76a	73.44	78.77b	3223.99b
3, 5 and 10	72.27a	15.18	111.33a	1.69	25.92a	73.59	82.48a	3396.83a
SE ±	1.01	0.061	0.061	0.103	1.638	0.219	0.759	30.649
Interaction								
U x B	NS	NS	**	NS	**	NS	*	**
U x T	NS	NS	NS	NS	NS	NS	NS	NS
B x T	NS	NS	NS	NS	NS	NS	NS	NS
U x B x T	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within the same column and treatment groups are not significantly different at 5% level of probability using DMRT. ** = Significant at p 0.01, * = Significant at p 0.05, NS = Not significant, WAT = Weeks after transplanting

Table 3: Interaction between urea supergranule and biostimulant rate on shoot weight (g), CGR 9-12 WAT (g m^{-2} wk^{-1}), Days to physiological maturity and Paddy yield (kg ha^{-1}) of rice at 12 WAT at Kadawa in 2016 and 2017 dry season.

Treatment	**Biostimulant rate (ml)**		
Urea supergranule (g)	0	50	100
		Shoot dry weight (g)	
0	66.95h	77.78gh	85.03efg
1.8	94.11ef	94.19de	103.01cd
2.7	109.53bc	120.10ab	137.46a
SE ± 0.407			

		CGR 9-12 WAT (g m^{-2} wk^{-1})	
0	9.69e-h	17.11c-h	19.95c-g
1.8	21.96b-f	22.41b-e	25.08bcd
2.7	26.06bc	29.31ab	37.32a
SE ± 2.457			
		Days to physiological maturity	
0	94.6bc	95.4abc	95.6abc
1.8	95.8abc	95.8abc	96.3abc
2.7	96.4abc	97.0ab	97.3a
SE ± 0.66			
		Paddy yield (kg ha^{-1})	
0	1595.24h	2095.24gh	2380.95fg
1.8	2785.71ef	3015.87de	3349.21cd
2.7	3698.41bc	4031.75ab	5396.83a
SE ± 45.974			

Means followed by the same letter(s) are not significantly different at 5% of probability using DMRT.
CGR = Crop growth rate

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Morphology, Agronomy and Utilization of Polynesian arrowroot (*Tacca leontopetaloides* (l.) Kuntze) in Nigeria

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Abstract
Polynesian Arrowroot (*Tacca leontopetaloides* (L.) Kuntze) is wild growing plant found in many parts of Nigeria but consumed mainly in Plateau, Benue and Nasarawa States. Starch extracted from its tubers can be used for culinary, industrial and medicinal purposes. In recent years, the population of the plant in the wild has dwindled probably due to increasing use of herbicides and urbanization. This coupled with the increasing recognition of the industrial quality of its starch have brought to the fore the need to domesticate the plant. There is therefore a dire need to assemble the scarce and widely dispersed information on this under-utilized crop as a prelude to its domestication. This forms the purpose of this review on morphology, agronomy and utilization of Polynesian arrowroot.

Keynote: Polynesian arrowroot, Morphology, Agronomy, Nutritional, Composition, Utilization

Introduction

Polynesian Arrowroot (*Tacca leontopetaloides* (L.) Kuntze) is wild growing plant (Figures 1 and 2) found in many parts of Nigeria especially in the middle belt (Manek *et al*, 2005, Pate *et al*, 2014), south east (Amadi *et al*., 2018) and south west ((Borokini *et al*., 2014) with an annual production estimated at over 20 million MT (Omolaja, 2013). It belongs to the genus Tacca and family Taccaceae (IPNI, 2005, Meena and Yadav, 2010). However, some taxonomists group it with the yam family Dioscoreaceae (Caddick *et al*. 2002). It is a monocot with autonomous self-pollination habit (Amadi *et al*., 2018). It is popularly known as Amora, or Gbache some ethnic nationalities in the middle belt of Nigeria who the starch from its tubers are used to make local delicacies. It is one of the under-utilized food crops that has the potential to support food security. The categorization of Polynesian arrowroot as an annual or perennial is a bit difficult. Though the underground tubers serve as the perennating organ, the above ground part die down every year like an annual and re-grow the next season from underground tubers when they break dormancy. In recent years, the population of the plant in the wild is dwindling probably due to increasing use of herbicides and urbanization (Amadi, *et al*., 2018). This coupled with the increasing recognition of the industrial quality of its starch (Kunle *et al*., 2003; Ukpabi, *et al*., 2009; Vu *et al*, 2017) have brought to the fore the need to domesticate the plant. Because of the wild and under-utilized status of Polynesian arrowroot, information on its morphology, agronomy and utlilization are scarce and widely dispersed. This paper seeks to assemble available information on the morphological, agronomy and utilization of the crop with a view to highlighting its features, management and uses in order to encourage its domestication.

Morphology of Polynesian arrowroot

Amadi *et al*., (2018) describes in details the morphology of Polynesian arrowroot. The crop is acaulescent (having no apparent above ground stem). The stem is an underground tuber with apical and auxiliary buds. 2-7 leaves extend from the apex of the underground tuber. The leaves have longitudinally ribbed long hollow petioles of variable lengths which extend from the underground apex of the tuber and bear large trifid pinnately lobed leaflets at their apex. The base of the petioles are sheathed while the lamina of leaflets are reticulately veined (Fig 1). Hollow Peduncles (0-2 per plant) of varying length with sheathing base arise from the underground tubers. Peduncles subtend at their apex an umbellate inflorescence bearing many flowers (10-50) subtended by several green to purple whiskers-like filiform bracteoles (almost as many as the flowers) about 10-14 cm long and greenish two whorled bracts. Anthers are attached to a hood-like structure which brings them very close to the stigma. The Stigma is 3-lobed with each lobe divided into two.

Fruits are many (1-20), ovoid, ribbed, with persistent tepals at the apex. They are subtended by short pedicels 3-5cm in length. The fruit - a berry develops from an inferior unilocular ovary with parietal placentation. They are green when immature but turn yellow when matured. Each fruit contains numerous striated brownish seeds with various shapes such as spherical, ovate, obovate, and elliptical. Seeds like tubers are dormant at harvest. The tubers subtended by the stolon are spherical and somewhat flattened at the apex. They have cream coloured skin and white flesh colour. Most plants produced only one tuber but a few produced two to four tubers. Tubers weighed mostly between 200-600g each but a few weighed up to 900g.mThe main roots are adventitious ranging from 20-50 depending on the size of the mother tubers. They arise from the base of the apex of the tuber and grow to lengths ranging from 10-25cm. There are roots on the surface of developing tubers.

Agronomy of Polynesian arrowroot

Optimum yield of this crop can be reached if the farmers gained an understanding of appropriate agronomic management practices. It grows best in a fertile, humus-rich soil under the shade of trees. It can be planted on beds, mounds or on ridges. To allow for easy root penetration and tuber bulking, the soil should be well prepared. It should be ploughed, harrowed before bed making or ridging. Seed tubers should be sprouted before planting for uniform emergence.. However they can be planted while dormant like yam in December - January so that as they break dormancy with the onset of rains, they can emerge from the soil. Herbicides used for weed control in other root and tuber crops like yam, cassava and potato will also be appropriate for weed control in Polynesian arrowroot. Atrazine/Metachlor applied at the rate of 2-5 ai per hectare is an effective pre-emergence herbicide. If weeds have already emerged at planting, glyphosate at the rate recommended on the labels can be applied to kill the emergent weeds. Subsequent weeding after plant emergence should be manual. Two or more manual weeding may be required before harvesting. In a study conducted to find the best combination of planting media and the size of mini-tuber for growing the crop Aziz and Susanato, (2015) reported that Polynesian arrowroot grow best on sand : rice hull charcoal : cow manure (1:1:1 v/v) and rice hull charcoal : cow manure (1:1 v/v) media. Both propagules sizes (1-5 and 5.1-20g) can be used, but plants from large mini tuber had better growth and produced larger mother and daughter tubers. Pate *et al*, (2014) that among the intra-row spacing tried 20 and 25 cm were most appropriate, while among fertilizer sources tried NPK fertilizer and poultry manure were most appropriate as these gave the highest tuber yields. Polynesian arrowroot is a shade loving crop. The results presented by Oktafani *et al*., (2018) (Table 1) showed that in arrowroot another low light adaptive plant, under the light intensity 7400 lux (27% full light), the number of leaves and tillers, tuber weight, tuber length and tuber diameter is not significantly different than under full light.

Nutritional Composition and Utilization

Nutritional Composition; The proximate composition, elemental analyses and phyto-chemical composition of the tuber starch of Polynesian arrowroot reported by Ogbonna *et al*., (2017) revealed the presence of moisture, 8.66%, crude protein, 6.79%, crude fibre, 5.44%, crude fat, 0.51%, ash, 0.41%, and NFE (total carbohydrate), 78.19%. The elemental analysis indicated presence of some trace elements including sodium, 34.71 mg/100 g, potassium, 40.18 mg/100g, calcium, 0.25 mg/100 g, magnesium, 1.40 mg/100 g, iron, 1.37 mg/100 g, zinc, 1.64 mg/100 g, manganese, 0.72 mg/100 g, copper, 0.68 mg/100 g and phosphorus, 0.06 mg/100 g. The results of anti-nutrient composition of revealed the presence of tannins, 2.50 mg/100 g, Phytate, 49.77 mg/100 g, oxalate, 15.51 mg/100 g, cyanide, 0.18 mg/100 g, alkaloids, 42.90 mg/100 g, saponins, 14.67 mg/100 g and flavonoids, 1.46 m g/100 g. It was observed that steeping in water for sometimes had effects on the concentration of the anti-nutritional components.

Edible Uses: The tubers are a rich source of starch but are usually bitter and almost inedible when raw because of the presence of the bitter substance (taccalin) (Ukpabi *et al*., 2009) which is said to be poisonous hence good washing is essential during the extraction of the starch (Caddick *et al*., 2002). To obtain the starch, the tubers are washed, peeled, grated, and the resultant pulp washed in water several times, finally in a sieve or cloth. The aqueous starch solution is collected and the starch grains allowed to settle out, collected and dried in the sun. This starch can then be put into a many different used. It can be gelatinized in hot water and mixed with other ingridients and spices to form many different delicacies. It can also be used to thicken soup.

Industrial uses: Its features in the formation of compacts (tablets) were comparable to those of maize starch with tacca starch being more resistant to deformation (Kunle *et al*., 2003). The extracted starch (over 30 % wt/wt basis) and the modified derivative (citrate) have been found to be better disintegrants in drug formulations than corn starch, because of higher swelling power, and amylose content, almost zero fat and lower gelatinization temperature. It could also be used in the textile industry for stiffening fabrics (Omolaja, 2013).

Medicinal uses: Zhang *et al*., (2007), reported the following uses of Polynesian arrowroot: detoxification, diminishes inflammation and acesodyne, can cure abscesses of the stomach and duodenum, high blood pressure, hepatitis, gastralgia, scalds, burns, tumefaction, and ulcers.. Abdel *et al*, (1991) found extracts from Polynesian arrowroot to have very good anti cancer properties. The extract of peels possessed potential antimicrobial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa, Escherichia coli* and *Enterococcus faecalis* whilst the extract of others did not show any significant inhibition at the same concentration (Vu *et al*., 2017).

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Figure 1: Shoot of Polynesian Arrowroot **Figure 2: Tubers of Polynesian Arrowroot**

Table 1. Arrowroot tuber yield on various light intensity

LI	NL	NT	TW (g)	NT	TL (cm)	TD (cm)
274	34.83	10.67	705.0	20.0	24.08	1.76
189	16.16	4.67	410.83	12.50	20.83	1.72
135	26.50	7.83	651.67	17.16	22.65	1.88
74	42.33	9.83	607.50	14.50	25.06	1.91

Description: LI, light intensity (x100 lux); NL, Number of leaves, NT, Number of tillers, TW, tuber weight; NT, number of tubers; TL, tuber length; TD, tuber diameter. Source: Oktafani *et al.*, (2018)

Tubers are harvested when the aerial parts have died off. It usually takes about 8 months from planting the crop to harvest, but sometimes it can be as much as 10 - 12 months

Optimization of Fertilizer Application Dose for Maize (*Zea Mays*) Grown with Waste Water from Fish pond

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Abstract

Field experiment was conducted to study the effect of fish pond waste water with basal dose of NPK on the morphological traits of maize during 2018 planting season. This experiment was laid out in randomized complete block design (RCBD) with five replications. The parameters studied include days to 50% germination, plant height, leaf area, plant wet weight and plant dry weight. The days to 50% germination and plant height decreased with reduction in the recommended doses of N, P and K with application of waste water. However, the maximum value were recorded for 50% seed emergence, leaf area, fresh and dry weight in T1 (Full N + Full P + ½ K + waste water) while minimum value were recorded for 50% seed emergence, leaf area and fresh weight in T9 (Full N, Full P and full K).It was recommended that application of waste water with NPK could be favorable effects on the maize crop production.

Keywords: NPK, Fertilizer, waste water, Maize, Morphological traits, Optimization of fertilizer

Introduction

Maize (*Zea mays* L.) is a major cereal crop for human consumption, worldwide. Several million people, particularly in the developing countries like Nigeria, derive their protein and calorie requirements from maize. It is cultivated on an area of 147 million hectares with production of 692 million tonnes in the world (FAO, 2005). During 2010 fiscal year, over 27 billion bushels of maize was produced globally (USDA, 2010). Intensive cropping system requires highly fertilized soils and those soils should be maintained through integrated plant nutrient management system. The fertilization can affect enzymatic activities inside the soil profile. Proper applications of waste water with inorganic fertilizers can increase the activities of soil micro-organisms and enzymes and soil available nutrient contents (He and Li, 2004). He and Li, (2004) indicated that combined application of organic and inorganic fertilizers with waste water can increase the activities of soil invertase and available nutrient content. Furthermore, the application of waste water with chemical fertilizer can prove to be an excellent procedure in maintaining and improving the soil fertility, and increasing fertilizer use efficiency. For this reason, it could be helpful to study the effect of application of waste water with chemical fertilizer by using integrated nutrient management system, which has been the research focus all over the world. The influence of different nutrients applied to soil on farmland ecosystem was different. Therefore, the present study was carried out to evaluate the effect of different maize variety under the integrated use of inorganic fertilizers with waste water under the agro-climatic conditions of South-Eastern Nigeria.

Materials and Methods

The experiment was conducted at the teaching and research farm of Ebonyi State University during the year 2018 planting season. It was laid out in a randomized complete block design (RCBD) with five replications, in other to study the effect of different does of NPK with waste water on maize plant. Each replication comprises nine (9) ridges, giving a total of 45 ridges. Two seed were sown per hole. With a daily observation, emergence date was recorded for each treatment after start of the experiment. Seed germination was noted daily up to day 7. A seed was considered germinated when radical emerged by about 2 mm in length. Then the mean germination rate was calculated according to the following equation:

$$R = \sum n / \sum D.n$$

Where, R is mean germination rate

n is the number of seeds germinated on day

D is the number of days from the start of test

Different levels of fertilizers with waste water were applied in the plots (Table 1). All cultural practices from sowing till harvest were observed. The data collected during the experiment were statistically analyzed by using the computer statistical program (GenStat). Analysis of variance technique was employed to test the overall significance of the data, while the least significance difference (LSD) test at P = 0.05 was used to compare the differences among treatment means (Steel *et al.,* 1997).

Results and Discussion

Data pertaining to days to 50% germination are presented in Table 2. As evident from the table, maximum values of germination % age (83.40) were recorded in Full N + Full P + ½ K + waste water treatments while the minimum values were recorded in T9 (65.00). The result exhibited that all the treatments were statistically significant to each other for seed germination. The results indicated that application of waste water with the recommended fertilizer have a favorable effect on the germination of maize crop. These results are in opposite with those reported by Shahnaz and Sheikh (1980) who observed a decrease in days to 50% germination when the levels of waste water application were increased. Data in Table 3 showed that maximum plant height of 25.02cm was obtained in the case of T5 after 25days of seed germination while after 50days, maximum plant height of 41.28cm was taken in case of T1 followed by T2 (38.30cm). Minimum plant height of 16.13 and 29.97cm was recorded in control as T1 after 25 and 50days, respectively. The results of T1, T2, T3 and T5 were significantly higher compared to other treatments but were statistically significant to each other. It was concluded from the results that the plant height increased by addition of waste water with the addition of recommended fertilizer for maize crops. These results also confirmed the findings carried out by Borin and Sartori (1989) and Tamayo *et al*., (1997). Maximum leaf area (58.20) was recorded in T1 followed by T3, while minimum leaf area (48.00) was noted in control treatment as T9. It was observed form the result that T1, T3, T5 and T2 had significant effect on leaf area of maize crop. The result exhibited that all the treatments were statistically significant to each other for leaf area. The results are in line with those reported by Pietz *et al*., (1982) who observed a decline in leaf area with higher rates of waste water application. The data in the table also exhibited that maximum fresh plant weight (8.40g) was noted in T1 followed by T2 and T4 (3.78g) while minimum fresh plant weight (3.40g) was showed in T9. The results of all treatments were significantly different to one another. It showed that application of waste water at the various fertilizer rate were having favorable effect on the fresh plant weight of maize crop, while further increase in the rate of waste water application had negative effect on it. As showed from the table, maximum values of dry plant weight (2.00g) were recorded in T1 and T2 while the minimum values were recorded in T7 (0.80g). The result exhibited that all the treatments were statistically significant to each other for dry plant weight. The results indicated that application of waste water with the recommended fertilizer rate was having favorable effect on the germination of maize crop.

Conclusions

After studying the physical parameters i.e. days to 50% germination, plant height, plant fresh and plant dry weight. On overall basis, Sammaz-15 variety of maize was proved to be best with the recommended doses of N, P and K with waste water and it was most susceptible when K was not applied so its performance could be enhanced by applying more K fertilizers. The hybrid Sammaz-15 gave excellent results with respect to morphological components as well as, 50% germination, plant height, fresh plant weight, plant dry weight and leaf area. Among different fertilizer treatments, maximum value was observed for morphological components in the case of T1(Full N + Full P + ½ K + waste water) gave outstanding results as compared to other treatments, in hybrid maize under agro-climatic conditions of South-Eastern Nigeria.

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Table1. Randomization of different doses of fertilizers with waste water

Treatments	Doses
T1	Full N + Full P + ½ K + waste water
T2	½ N + ½ P + ½ K + waste water
T3	½ N + Full P + full K + waste water
T4	Full N + ½ P + Full K + waste water
T5	Full N + Full P + nil K + waste water
T6	½ N + ½ P + Full K + waste water
T7	Full N + ½ P + ½ K + waste water
T8	Full N + nil P + Full K + waste water
T9 (Control)	Full N + Full P + Full k

Table 2. Mean Square values

Parameters	Replications (df-4)	Treatments (df-8)	Error (df-32)
Seed germination (%)	3.87	210.09**	5.80
Plant height after 25 days	1.32	5.22**	0.72
Plant height after 50 days	1.00	8.49**	1.11
Leaf Area	8.31	46.90**	12.82
Plant fresh weight	1.19	13.25**	0.51
Plant dry weight	0.52	0.99**	0.40

** = Highly significant at P≤0.01

Table 3. Effect of different fertilizer on various morphological components

Treatments	Seed Germ.	Means at 25days	Means at 50days	Leaf Area	Fresh weight (g)	Dry weight (g)
T1	83.40f	24.66c	41.28d	58.20d	8.40e	2.00bc
T2	75.40c	23.22bc	40.13cd	55.00bcd	6.80d	2.00c
T3	79.40cd	22.50bc	38.61bcd	56.80cd	5.40c	1.60abc
T4	82.26ef	22.81bc	37.59bc	54.60bcd	6.80d	1.80bc
T5	82.46ef	25.02c	36.07b	56.00bcd	5.60c	1.20abc
T6	70.20b	21.84b	39.62cd	53.80bcd	4.80bc	1.60abc
T7	70.20b	22.68bc	38.10bcd	52.80bc	4.00ab	0.80a
T8	76.60cd	21.11b	39.12bcd	51.40ab	4.00ab	1.00ab
T9 (Con.)	65.00a	16.13a	29.97a	48.00a	3.40a	1.10ab
LSD	3.11	1.10	1.36	4.62	0.92	0.82

Performance of lowland rice as influenced by method of planting in sawah rice technology.

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Abstract
Field trial was carried in 2016/2017 cropping season to evaluate the sowing methods of rice varieties and economic optimum of sowing methods on farmers' field at Federal University of Agriculture, Abeokuta Nigeria. The inland valley was designed into sawah. bunds were manually done while power tiller was used for tilling, puddling and leveling of the soil. The 2 x 2 factorial experiment had 2 rice varieties (WITA 4 (improved variety) and FUNAABOR 11 (local variety)) in main plot and two sowing methods (transplanting and broadcasting) in sub plot. The treatments were replicated three times. The data collected were on number of tillers, number of days to 50% heading, panicle length, panicle weight and grains panicle^{-1}, panicle m^{-1},1000- grain weight and grain yield ha^{-1}. The result obtained from sawah technology showed that transplanting and broadcasting of WITA 4 had 4.38 and 2.75 t ha^{-1} grain yields, respectively while FUNAABOR II variety had 2.22 and 2.58 t ha^{-1}, respectively. Partial budget revealed that net benefit obtained from transplanted and broadcast improved variety had ₦593,300 and 453, 100 ha^{1}, respectively while transplanted and broadcast local variety was ₦536,000.00 and 313, 500 ha^{1}, respectively. Based on this study, this technology could offer the greatest potential for closing the gap between food production and consumption via efficient water and soil fertility management.
Keywords: Broadcast, rice, sawah technology transplanting, yield

Introduction

Food and Agriculture Organization (FAO) conducted survey on rice production and consumption in 2001 and 2003, and estimated rice production in Nigeria at 2.03 million tonnes while consumption was 3.96 million tonnes. The balance of 1.90 million tonnes was obtained by importation (FAO, 2004). In 2006, it was estimated that 2.10 million tonnes was locally produced while consumption was 3.71 million tonnes. In the same year, it was reported that Nigeria was the second largest importer of rice in the World after Philippine (Africa Rice Center, 2008a). Rice growing ecologies in Nigeria include Mangrove Swamp which contributes 1% to rice production in Nigeria, Deep water (5%), Irrigated lowland (16%), Rainfed lowland (48%) and Rainfed upland (30%) (Africa Rice Center WARDA/ FAO/ SAA, 2008b). The estimated grain yield obtained from the various ecologies in West Africa are 1.0, 2.0 and 3.4 t ha^{-1} for rainfed upland, rainfed lowland rice and irrigated lowland rice, respectively (Africa Rice Center WARDA/ FAO/ SAA, 2008b). There is a preponderance of fadama in West Africa, where valley bottoms, flood plains and hydromorphic fringes are estimated to occupy 22-52 million ha of land (Windmeijer and Andriesse, 1993). In Nigeria, 3 million hectares of fertile fadamas have been estimated which if judiciously harnessed could produce enough rice for the country (World Bank, 2006). It has long been established that yield of rice in fadamas is generally much higher than on the uplands (IITA, 1980; 1988). From the above, it is very obvious that the best ecologies for rice production are fadama and irrigated lowlands. However, resources constraint accounted for 75% of rice production in Nigeria due to inability of farmers to afford the irrigation facilities to maximize rice production. Farmers could afford to utilize the high potential fadama (inland valleys and the flood plains) without additional cost on irrigation rather than dissipating energy in the less productive upland ecology.

Rice cultivation requires a lot of work particularly amid transplanting which often results in its shortage and thereby increasing the cost of production. Alternate methods that require less labour without sacrificing productivity are therefore needed. Considering the cost, direct seeding is a fitting option. However, poor germination, uneven crop establishment and high weed infestation are the main constraints to its adoption. The appropriate methods of sowing and the right varieties needs to be resolved in the existing anaerobic niche in-between lowland rice. Consequently, Adigbo *et al*. (2013) evaluated the productivity of the triple system in sawah based rice system which lay emphasis on the improvement of the rice environment. Sawah rice production system is based in fadama soils. The concept and term 'sawah' refers to manmade improved rice growing environment with demarcated, bunded, puddled and leveled rice field with water inlets and outlets using power tiller for weed and water control in the fadama which can be springs or pumps (Wakatsuki *et al*., 2005). The Sawah system of rice production ensures proper management of the rice environment leading to efficient and higher rice grains production with higher returns which is a better option to the current systems (Wakatsuki, 2005). It is one of the most efficient systems that will ensure adequate production to meet the ever increasing demand and save the country from the use of scare foreign exchange resources for its importation (Buri *et al*., 2007).

Given the aforementioned background, FUNAAB sawah team felt the stage is set for the sawah rice technology to be showcased to our local farmer for possible adoption. In sawah, high yielding variety coupled with puddling of the soil and transplanting method are the basic requirements. But the farmers prefer broadcast method which was considered labour saving and cheap in addition to preferred local variety with peculiar taste, market niche and higher premium price but lower yield. Therefore, this study aims to evaluate effect of sowing methods on yield performance of improved and local varieties and economic optimum of sowing methods in sawah rice technology

Materials and methods

Field trials were carried out in two locations at Federal University of Agriculture, Abeokuta and Sowumi village Mokoloki, Obafemi Owode LGA of Ogun State. The 2 x 2 factorial experiment had 2 rice varieties (WITA 4 and FUNAABOR 11) in main plot and two sowing methods (transplanting and broadcasting) in sub plot. The treatments were replicated three times. FUNAABOR II variety which is upland rice was accepted as the farmers' variety because of it price premium and market niche (control), while WITA 4 is improved variety.

Sawah fields were established at the FUNAAB and Sowunmi village in Obafemi Owode LGA of Ogun State. The selected inland valleys were designed into sawah and bunded manually around each plot to impound water from an irrigation canal. A power tiller was used to till, puddle and level the soil in FUNAAB but manual in Sowumi because of the nature of the terrain. The experiments were laid out in a split block design. There were two and three replicates in Sowunmi village and FUNAAB, respectively. Each block had only one variety alongside the sowing methods (transplant and broadcast) for ease observation and understanding by the farmers. The block size was 55.5 m x 7 for each variety, sowing methods were assigned to 27 m x 7 m. Spacing for the transplant was 20 cm x 20 cm.

Half of each block was puddled in readiness for broadcast method while the second half was left unpuddled but the nursery bed were made. Each variety was broadcast onto the nursery bed and the puddled half block on the 12th of April 2016. Four weeks after broadcasting, the second half of the block was puddled and the 30 days old seedlings were transplanted. Two seedlings were planted per hole at spacing of 20 cm x 20 cm on the 12th May 2016 at FUNAAB. Water from the irrigation canal was allowed into the plots 2 WAS or WAT. Prior fertilizer application, the water inlet was closed while weeding and fertilizer application at the rate 60 kg ha^{-1} (NPK 15 15 15) were carried out in all plots 4 WAS. Hand weeding was done at 6 WAT/WAS were carried out for each plot.

Data collection

Data were collected on number of tillers, leaf chlorophyll, number of days to 50% heading, panicle length, panicle weight and grains panicle^{-1}, panicle m^{-1},1000- grain weight and grain yield ha^{-1}. The grain yields harvested from the net plot (3 m X 2 m) was dried, threshed and weighed. The grain yield was converted to t/ha.

Economic data: Farm records of cost data on input used, cost and output quantity and prices were collected. Partial budgeting was used to determine the profitability of each crop and sowing methods. Data collected were subjected to analysis of variance using split plot with GenStat discovery 12th edition. Treatment means which are significant were separated using Least Significant Different.

Results

The effects of showing methods on rice variety was shown in Table 1. The number of tillers of WITA 4 was significantly higher than of FUNAABOR II whereas the sowing methods were similar. The chlorophyll content of the leaves measured before fertilizer application of the two varieties was similar but the transplanting method had higher chlorophyll content. The chlorophyll of the flag leaf at heading of FUNAABOR II was significantly higher than those of WITA 4. The WITA 4 variety and transplanting methods had higher number of days to 50% heading compared to FUNAABOR and broadcast, respectively. WITA 4 variety had longer panicles but lower weight while the reverse was the case of FUNAABOR II. WITA 4 and transplanting method had higher grain yield compared to their respective counterparts. The interaction of variety and method of sowing was significant. Table 2 showed that transplanted FUNAABOR II, broadcast FUNAABOR II and broadcast WITA 4 had similar yield but significantly lower than those of transplanted WITA 4

Differential input/ operations cost and revenue analysis in sawah technology

The partial budget analysis is presented in Table 15. The addition of costs that differ for the sawah technology is ₦170, 500/ha while that for broadcast is ₦26, 500. Transplanting accounts for about 88% of this ₦170, 500. Deducting this value respectively from the value of output gives net benefit of 593, 300/ha for the sawah technology. The low yield of upland FUNAABOR II and its poor response to transplanting explain the low net benefit of 313, 500 whereas broadcasting gives 536, 000 (net benefit).

Discussion

Transplanting is the planting of seedlings from the nursery to the field, which is not culturally practiced for upland rice in the upland ecology, was exploited with a view to selecting the transplanting shock tolerant genotypes capable of increasing productivity of inland valley. Upland rice is usually sowed by direct seeding which could be by dibbling, drilling or broadcasting (Oikeh *et al*., 2008). The higher number of tillers observed in WITA 4 variety was a clear manifestation of the characteristics of lowland variety. Lowland varieties are known to have better tillering ability than the upland rice. The lower tillers observed in broadcast methods of planting agrees the existing facts that there is negative relationship between planting density and tillering. Thus, the spacing in the transplanted methods pave way for higher tiller compared to closer spacing in broadcasting. The observed lower chlorophyll content of leaf in the broadcasting method before fertilizer application could be attributed to higher pool of nutrient associated to close spacing and higher plant density. However, the variation in leaf chlorophyll between the two rice varieties could be genetically inherent. The higher number of days to heading observed in WITA 4 and Transplanting method were associated to genetical and transplanting shock, respectively. The longer panicles and higher 1000-grain weight in observed in WITA 4 and FUNAABOR II varieties respectively were also attribute to genetically inherent. The significant interaction od variety by sowing methods indicated that the two varieties responded differently in the two sowing methods. Transplanting and the use of improved variety in sawah prove it superiority over local rice variety and broadcasting methods.

Conclusion

Based on this study, it was concluded that the performance of transplanted improved variety gave highest yield. Estimated net farm income for transplanted lowland rice couple with improved variety in sawah was ₦314, 660/ha while those of broadcast alongside with local variety was ₦257, 360/ha for the main crop. Partial budget revealed that net benefit obtained from transplanting improved variety had 593,300 N/ha while broadcast local variety was 536,000.

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Table 1: Effects of sowing methods on rice variety in sawah rice based technology

Treatments	Tiller no.	Chlorophyll b/4 fertilizer	Chlorophyll @ heading	Days to 50% heading	Panicle m^2	Panicle length (cm)	Panicle wt. (gm)	Grains panicle^{-1}	1000 - grain wt	Grain yield t ha^{-1}
Variety (V)										
WITA 4	4.2	34.4	39.7	99.3	64.2	16.1	7.17	217.0	30.37	3.57
FUNAABOR II	2.4	34.0	44.4	85.5	60.5	12.4	6.08	185.2	33.97	2.40
LSD	0.838	NS	2.75	7.04	NS	0.62	NS	NS	1.74	0.54
Sowing methods (S)										
Transplant	4.23	37.2	42.3	100.0	64.5	14.0	6.42	201.8	31.68	3.30
Broadcast	2.33	31.2	41.8	84.8	60.2	14.4	6.83	200.4	32.65	2.67
LSD	0.838	4.851	NS	7.04	NS	NS	NS	NS	NS	0.54
V x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	S

Table 2: Interaction of variety and sowing methods on grain yield per plant

Treatments	Transplant	Broadcast
WITA 4	4.38	2.75
FUNAABOR II	2.22	2.58
LSD	0.76	

Table 3: Differential input/ operations cost and revenue analysis in sawah technology

Input/operation	Transplanting improved	Broadcasting improved	Transplanting local variety	Broadcasting local variety

Pre-transplanting (₦)	4, 500	-	4, 500	-
Seed (₦)	16, 000	25, 000	16, 000	25, 000
Transplanting (₦)	150, 000	-	150, 000	-
Broadcasting (₦)	-	1, 500	-	1, 500
Total differential cost (₦)	170, 500	26, 500	170, 500	26, 500
Average. experimental yield t ha^{-1}	4.38	2.75	2.22	2.58
Adjusted yield t ha^{-1}	3.819	2.398	1.936	2.250
Value of output t ha^{-1}	763, 800	479, 600	484, 000	562, 500
Net benefit ₦/ha	593, 300	453, 100	313, 500	536, 000

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Performances of Maize in Maize/Cassava Intercrop as influenced by Four different Times of Planting in Derived Savannah.

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Abstract
The unpredictability and unsteadiness of rainfall occasioned by climate change during cropping season necessitated the investigation of the performance of maize in maize/cassava intercrop planted simultaneously in 2018 at the Federal University of Agriculture, Abeokuta, Nigeria in 2018 cropping season. The experiment was laid out in RCBD and arranged in split plot and replicated three times. The time of planting (May, June, July and August) and cropping systems (sole maize, maize in 419 and 30572 varieties of cassava) constituted the main and subplot treatment, respectively. The intercrop proportion mixture and population adopted in this study was additive series. Number of stand per plot in May was significantly higher than the others whereas the maize planted in June had the highest shelling percentage. Maize planted in May and August produced longest cob whereas those of June were the shortest. The cob length obtained from the intercrop systems were longer than the sole maize. The maize cob length in the various cropping systems responded differently in the different times of planting. The cob diameters obtained from the maize planted in May and August were similar but significantly higher than those of June and July. The relative yield of the intercrop of maize obtained from May produced the highest whereas those of July and August were similar. The grain yield of maize in May planted was higher than the others while the sole maize produced higher grains than those of intercrop. It was concluded that maize planted in May ending plots consistently had the best performance while the maize relative yield in the intercrop showed an indicative of more than LER.

Introduction
Maize (*Zea mays* L) is a major important cereal crop being cultivated in the rainforest and the derived savannah zones of Nigeria (Olaniyi and Adewale, 2012). It is the world's most widely grown cereal and it is ranked third among major cereal crops (Ayisi and Poswall, 1997). On the African continent, it is the most dominant food crop and mainstay of rural diets. Maize can be intercropped with cassava, yam, cowpea etc. Intercropping involves the cultivation of two or more crops at the same time in the same field (Ouma and Jeruto, 2010). It has been reported to increase crop yield and land use efficiency (Amanullah *et al.*, 2006) particularly when intercropped with cassava. Cassava (*Manihotesculenta*L. Crantz) originated from Central and Southern America and has since then spread to various parts of the world (FAO, 2001). It is an important food security crop in tropical areas of the Africa with its edible starch-storage roots (Tewodros and Yared, 2014).

Planting date was reported to affect the growth and yield of maize significantly. To date, the challenge for maize growers is finding the narrow window between planting too early and planting too late (Nielson *et al*., 2002). Farmers who plant maize early are concerned about rainfall cessation which could cause drought spell. On the other hand, farmers who plant late wonder how late planting might affect the final grain yield (Lauer *et al*., 1999). Either early planting or late planting can result in lower yield because the probability exists that unfavorable climatic conditions can occur after planting or during the growing season. Norwood (2001) suggested that farmers should plant on more than one planting date in order to safeguard against unpredicted seasons. Various studies show that cassava, maize/cassava intercrop can be planted any time of the year during the rainy season. However, concerted efforts have not been made to plant cassava alone, intercrop or sole maize separately in each of the month across the major part of the five months (April, May, June, July and August) when the rains commence and become steady. There is, therefore a need to ascertain the performance of sole maize, maize/cassava intercrop and sole cassava sequentially planted in May, June, July and August. The objective of trial is to determine the performance of sole maize and maize intercropped with cassava planted at monthly interval.

Materials and methods

The study was conducted at the Federal University of Agriculture, Abeokuta, Nigeria to investigate effect of time f planting and cropping systems in the performance of maize; Latitude 7^0 14'0'N and Longitude 3^0 25'E. Abeokuta has bimodal rainfall pattern in locate in derived savannah zone of South Western Nigeria. The total annual rainfall was 1403.6 mm in 2018. The site had Latitude 7^0 14'0'N and Longitude 3^0 25'E. The soil had pH of 5.6, N 0.171, P 36.27, K 0.562 and organic carbon 0.52%. The textural class of the site was 72 (sand), 5.5 (clay) and 22.5 (silt). The experiment was laid out in RCBD arranged in split plot. The main and sub plot treatments were Time of planting (May, June, July and August ending) and cropping systems (sole maize, maize intercropped with 419 and maize in 30572 cassava varieties).

The entire experimental plot (97 x 31 m) was ploughed and harrowed whereas the portion (97 x 8 m) dedicated for May planting (i.e. main plot size replicated 3 times) was ridged and planted at May ending. But the portions meant for each other main plot (97 x 7m) of June, July and August was marked out and was re-harrowed and ridged at the end of each month and planted accordingly. The sub plot size (10 m x 7 m) was separated by 2 m between and within replicates. For each planting, 8 ridges were done by tractor but 7 ridges were planted while the 8th ridge served as discard and to also create allowance for the tractor operations with a view to protecting the previously planted plots. The spacing for cassava planting was 1 m x 1 m on ridge irrespective of cropping systems. Two seeds were planted per hole but thinned to one at 2 weeks after planting (WAP) for sole maize at spacing of 75 cm x 25 cm whereas three seeds were planted per hole for maize intercrop with cassava and thinned to two seedlings at 2 WAP at the spacing of 1 m x 1m apart but sandwiched between two cassava stands. Consequently, additive series was adopted for the maize/cassava intercrop mixture. The plot was manually weeded up to November, there after contact herbicide was used to control weed. The rate of 60 kg/ha NPK (15:15:15) fertilizer was applied to maize 4 WAP while 45 kg /ha was applied to cassava at 8 WAP. Data collected on the maize in each treatment at 4 WAP were as follows; plant height (m), cob weight (g), shelling percentage (%) and grain yield/ (t/ha). The data collected were analyzed using GNASTAT 12th edition software and the means of treatments that are significant were separated using Least Significant Difference (LSD) method at 0.05% level of probability.

Results and discussion

Planting date is one of the major management practices that affect the yield of crop through seedling establishment and seed development. The plant height obtained from May ending plots had significant increase from 4 to 10 WAP as compared to other months (Fig 1). Plant heights of maize obtained from sole were outstandingly, higher than those of intercrop (Fig. 2). The taller plants observed in the sole crop of maize compared to intercrop could be due to the competition with companion cassava crop. The growth reduction of intercropped maize might be majorly due to partly interspecific competition between the intercrop components for growth resources (light, water, nutrients, air, etc.) and the depressive effects of cassava. Egbe and Idoko, (2012) made similar observations in their study and attributed it to inter- specific competition for light, nutrients, water, air and other growth resources.

The data obtained from yield and yield component of maize planted in May ending plots had the highest grain yield (1.95 t/ha), number of stand (84.3), cob length (15.2 cm) and cob diameter (47.9 mm) as compared to June, July and August ending plots (Table 1). The higher number of stands of maize plants which resulted higher relative yield observed in May ending plots compared to the other planting times could be attributed bird damage at seedling stage. Besides, the distribution and pattern of rainfall particularly during the short break (i.e. August break) also negatively affected the yield and yield component of maize planted in June and July. These environmental changes associated with different sowing dates (sunshine, temperature) have been reported to have modifying effect on the growth and development of maize plant (Maryam *et al*, 2011). Good timing of planting date is one of the key factors that strongly affect production in rain fed agriculture (Ati *et al*., 2002). The higher stand count and grain yield documented for sole compared to intercrop plots was attributed to the differential spacing adopted for sole and intercrop i.e. replacement series. The interaction of cropping system and time of planting in May ending plot was significant indicating that maize intercropped with TMS 419 which is a non-branching cultivar responded differently with higher cob length (Fig. 3).

Conclusion

The maize planted at May ending plots gave higher number of stands, relative yield and grain yield. Furthermore, sole maize gave higher grain yield but the Land Equivalent Ratio as indicated by relative yield of the intercrop suggests that intercrop is more productive than the sole.

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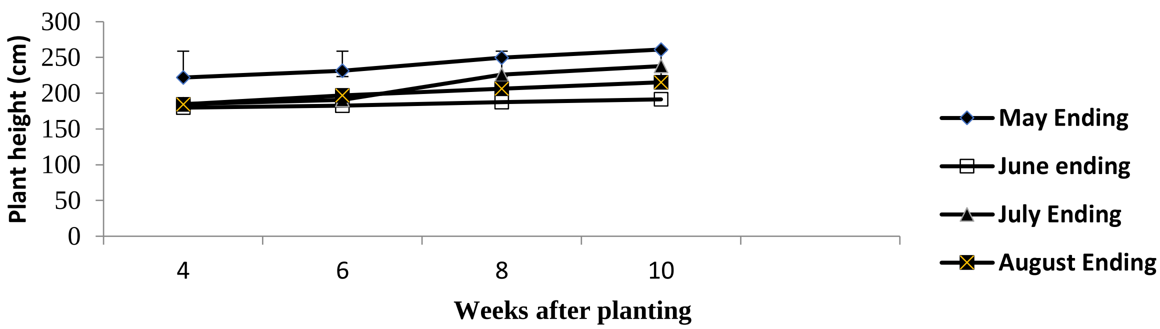

Fig. 1: Plant height of maize as influenced by time of planting in 2018 cropping…

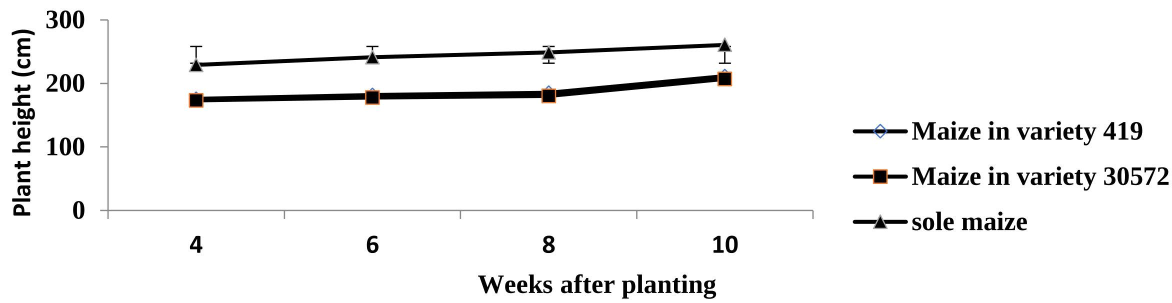

Fig. 2: Plant height of maize as influenced by croppinjng systems in 2018 cropping…

Table 1: Effects of time of planting and cropping systems on agronomic, yield and yield components of maize

Treatment	No of stands maize	Cob height	Shelling %	Cob length (cm)	Cob diameter (mm	Relative yield	Grain yield/ha
Time of Planting (T)							
May Ending	84.3	117.8	0.81	15.23	47.91	0.70	1.95
June Ending	32.2	117.4	0.93	14.01	42.92	0.32	1.21
July Ending	44.2	99.8	0.81	14.61	43.47	0.69	1.39
August Ending	38.7	97.1	0.85	15.12	47.97	0.65	1.40
LSD	26.15	NS	0.05	0.49	1.56	0.27	0.32
Intercrop (I)							
variety 419	36.6	114.4	0.83	15.00	45.17	0.57	1.15
variety 30572	42.3	106.2	0.84	14.83	44.58	0.61	1.20
Sole	70.7	103.5	0.88	14.40	43.88	-	2.11
LSD	22.65	NS	NS	0.43	NS	NS	0.27
T X I	NS	NS	NS	0.86	NS	NS	NS

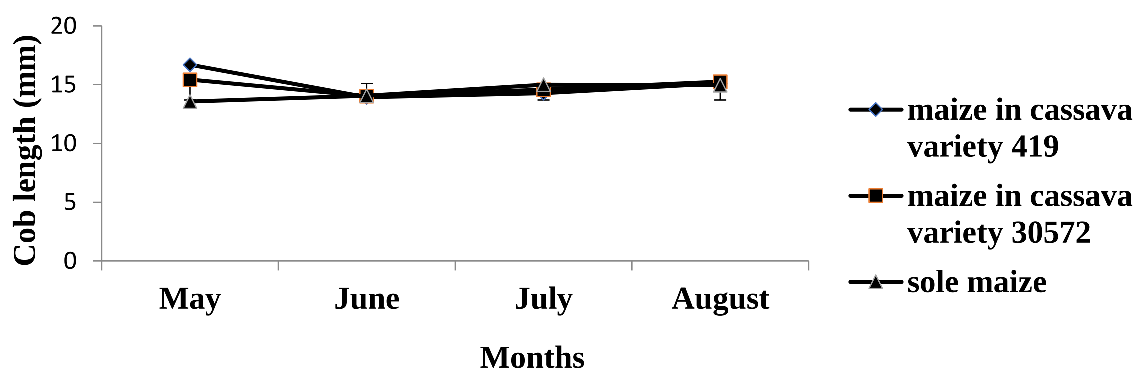

Fig 3: Interaction of cropping systems and time of planting on cob…

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Physiological Responses of Cowpea (*Vigna unguiculata (L.) walp*) varieties Cultivated in Relay with Pumpkin-Maize mixture treated with Poultry manure and nitrogen fertilizer in Samaru

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Abstract
The quantity, quality and physiological responses of cowpea are affected by varietal differences, production system and nutrient management strategies. The research was carried out in the research and teaching field of the Institute for Agricultural Research, Samaru, Zaria during the 2017 cropping season. The treatment consists of three rates of poultry manure (0, 3 and 6 tons/ha), two varieties of cowpea (SAMPEA 11 and SAMPEA 14) and two ways of split N application (three split dose and two split dose) replicated four times. Result showed significant improvement in physiological attributes such as Crop Growth Rates (CGR), Total Leaf Area (TLA) and Leaf Area Index (LAI) at 6-8 WAS with three splits dose of N application relative to double split. Except crop growth rate at 6-8 WAS, poultry manure application had no significant effects on cowpea physiological trait. Result further showed a sudden declined in CGR, LA and NAR at later growth stages. Net Assimilatory Ratio (NAR)was significant among varieties only at 4-6 weeks after sowing with SAMPEA 14 recording the highest 3.70 $gm^{-2}wk^{-1}$ value. From the foregoing, application of nitrogen to maize in three split can significantly enhance N availability to cowpea in mixture irrespective of the genotype; which will ultimately enhanced their physiological growth attributes.
Keyword: split application, varieties, cowpea, physiology, growth

Introduction

Cowpea (*Vignaunguiculata (L.) walp*) is a popular leguminous crop in Africa which is known as 'beans' in Nigeria and 'niebe' in the Francophone countries (Ishiyaku*et al.*, 2010). The bulk of its production is in the moist and dry Savannas of Sub-Saharan Africa (SSA), where it is intensively intercrop with cereal crops like millet, sorghum and maize as well as rice fallows (Ishiyaku*et al*, 2010). Nigeria remains the largest producer and consumer of cowpea in the world with an average annual production of 2.58 +/- 0.31 million metric tons (FAO, 2018) with current production rallying around 350 kg/ha (VON, 2019). The breakdown of the above quoted figure showed that, Nigeria, been the largest producer and consumer of the crop in Africa account for 61% and 58% of the overall production in Africa and the world respectively (AgroNigeria, 2015).In Africa, the crop is grown on approximately 12.5 million hectares of land with a production strength of 5.2 million tons; whereas in Nigeria a deficits of about 500,000 tons/ha is reported (AgroNigeria, 2015). Cowpea (*Vignaunguiculata (L.) walp*) contributes a very important and inexpensive source of protein and providing more than half of the plant protein in human diets. It contains about 23 – 25% of protein (Singh *et al.*, 2007).Cowpeas can be used as a nitrogen fixer and as green manure (Yusuf, 2008). However, quantity, quality and physiological responses of cowpea are affected by varietal differences, production system and nutrient management strategies. Cowpea generally is considered as a nutrient non exhaustive crop which has a mechanism of self-sustenance via symbiotic nitrogen fixation with brady-rhizobium. However, prior to the formation of the cowpea-rhizobium symbiotic, there is often need for readily available nutrient supply in either organic or inorganic forms. The use of organic manures, inorganic fertilizers and leguminous crops has been advocated to restore soil nutrients lost (Feninget al., 2005). Organic manures help in conditioning the physical properties of the soil thereby increasing crop productivity. Findings by Msaakpa (2016) revealed that poultry manure can exert significant boast in the growth and yield of cowpea.

Cowpea (*Vigna unguiculata*) has been proven to be suitable companion crop for multiple cropping without significantly reducing its yield and those of the companion crops. Intercropping is a form of ecological intensification that is potentially sustainable when two or more crops are grown at the same time or in sequence. This approach allowed for the prudent and targeted use of inputs such as fertilizers which help to improve soil quality and moisture whilst minimizing the environmental impact that its excessive use can cause (Fasoyiro and Taiwo, 2012). Like most annual crops, the processes involved in cowpea growth are very complex and vitally influenced by environmental factors which are themselves complex and interdependent (Yellamanda and Sankara 2013). The modification of crop physical, biological and chemical environment could have adverse effects on crop physiological responses in terms of dry matter accumulation, crop growth rate (CGR), relative growth rate (RGR), net assimilatory ratio (NAR), leaf area (LA) and leaf area index (LAI). The analysis of growth and development help in devising methods for attaining maximum growth of crops in the field (Yellamanda and Sankara 2013). Growth analysis points to the limiting factors in the environment and indicates maximum potentialities of crop. However, Radford (1984) original intentions for deriving the growth analysis equation was for comparing data for different experiments as well as comparing treatments differences within a single experiment. Analysis of quantitative aspects of growth can be effectively conducted using the functional growth analysis techniques which predict at a glance the outcome of economic yield of crop (Batish*et al*. 2005). Economic yield of a crop on the other hand comprises of the function of growth rate, duration of growth and proportion of growth realized in the grain component(Batish *et al*. 2005). Considering the complexity of yield as influenced by interaction of morphological, physiological and environmental parameters, it's therefore necessary to diagnose the variations of morphological and physiological traits influencing the yield of a plant in a certain environment to enhance their selection and breeding. Current knowledge of the physiological growth responses of existing hybrid cowpea (*Vigna unguiculata*) varieties to residual organic nutrient addition so far released by research institute in Nigeria is very scanty. Therefore the study seeks to assess the physiological response of cowpea varieties cultivated in relay with pumpkin-maize mixture treated with poultry manure and nitrogen fertilizer in Samaru.

Materials and methods

Experimental Site: The experiment was sited at Samaru (latitude 11°11´008′N and longitude 7°36´52.1´´E) in the Northern Guinea agro-ecological zone. Treatments consist of three levels of poultry manure (0, 3 and 6 tons/ha), two genotypes of cowpea (Sampea 11(Determinate) and Sampea 14 (indeterminate) and two (2) ways of top dressing of N fertilizer (double split dose application and triple split dose application).Nitrogen was supplied in this trial in form of urea. The sum total of amount of N-fertilizer for application in the trial was 50% of recommended rate (90 kg N ha^{-1}) for early maturing maize. First application of N was 22.5 kg N ha^{-1} at two (2) WASM to all plots irrespective of treatment. Second application of N was done at 4 WASM whence 22.5 kg N ha^{-1} (ie balance of total applicable) was applied to half of all the plots, while the other half received 11.25 kg N ha^{-1}. For this group, the remainder of 11.25 kg N ha^{-1} was given at 6 WASM.Pumpkin (*Curcurbita maxima L*) and maize (*Zea may*) were sown as soon as rains were established. The residues of harvested pumpkin were incorporated at about 10-12 WAS, thereafter cowpea was then relayed into the maize. Upon harvest of cowpea, its residues were weighed and incorporated into the soil on the basis of treatments, and soil sampled for physico-chemical analysis. The overall experiment was laid out in randomized complete block design (RCBD) with split plot arrangement in four replications. Each gross plots size was 18 m^2 (6 m by 3 m) , and thus representing eight (8) rows while the net plots size was 9 m^2 (3 m x 3 m) representing the four (4) inner rows. All requisite cultural practices was carried out which could not be detailed due to space restriction. At about 4 weeks after sowing, the following observations were taken as described by Radforth (1955). Total leaf area, leaf area index, crop growth rate, relative growth rate and net assimilatory ratio. Data generated was subjected to analysis of variance using the General linear model of SAS, and mean separated at 5 and 1% using SED.

Results and Discussion

Crop Growth Rate (CGR): Treatment effect on CGR is presented in Table 1. Results showed that poultry manure had significant effect on CGR at 6 and 8 weeks after sowing. The highest CGR was reported with the application of 6 tons/Ha rate of poultry manure at both 6 and 8 weeks after sowing respectively. The highest (74.60 $g^{-2}wk^{-1}$) CGR was reported at 6-8 weeks after sowing with 6 tons/ha poultry manure. Similarly, among varieties, there was no significant difference across sampling dates. However, N rates effect was significant at 4-6 weeks with split N application returning higher (1.43 $g^{-2}wk^{-1}$) CGR relative to single dose application.

Relative Growth Rate (RGR): RGR as shown in Table 1 followed similar trend as earlier reported for other physiological variables of cowpea. Across all the sampling date, poultry manure had no significant effect on RGR. The same non - significant trend was also observed among the varieties. However, methods of N application significantly influence RGR at 4-6 and 6-8 WAS. At 4-6 WAS for instance, split application gave the best (0.21 $gg^{-1}wk^{-1}$) RGR whereas, at 6-8 WAS, single dose application gave the highest (0.28 $gg^{-1}wk^{-1}$)

Net Assimilatory Ratio (NAR): Result of the effects of poultry manure, methods of N application and varieties on NAR is shown in Table 1. Result showed that NAR peaked at 6-8 weeks after sowing and declined drastically from 8-10 weeks. Poultry manure had no significant influenced on NAR. However, there was significant varietal difference only at 4-6 weeks after sowing with SAMPEA 14 recording 23.70 $gm^{-2}wk^{-1}$. On the other hand, influence of N application was significant at 4-6 weeks and 8-10 weeks with split N application giving superior NAR in both cases.

Total Leaf Area (LA): Data on cowpea total leaf area (LA) as influence by poultry manure, nitrogen rates and varieties is shown in Table 2. Among poultry manure rates, significant difference was only reported at 4 WAS with the highest (38.55/33.25 cm^2) and lowest (36.75 cm^2) reported in 6/3 tons/ha and control respectively. Similar trend of non-significant responses was also reported among varieties from 4-8 WAS. Similarly at 10 WAS, SAMPEA 11 had significantly higher (48.53 cm^2) TLA than SAMPEA 14. Also, three split application of nitrogen gave significantly higher total leaf area at 4 and 6 WAS; whereas, no significant effect was observed at 8 and 10 WAS.

Leaf Area Index (LAI): Results of the effects of treatment on LAI is shown in Table 2. Result showed that except at 4 W.A.S, there was generally no significant difference in LAI with varying rate of poultry manure application. In a similar manner, among varieties, significant difference was reported at 8 WAS with SAMPEA 14 giving a higher (2.00) LAI than SAMPEA 11. Like other physiological traits already explained, fertilizer application method also had significant influence on the LAI whose effects was consistence across sampling date. For instance, at 4 and 6 WAS, the highest LAI was consistently reported in three split application of nitrogen. However, at 8 and 10 WAS, there was no significant difference in LAI.

Nitrogen been a highly volatile nutrient is subject to numerous fate, among which is leaching and volatilization loses, hence staggered application will tend to minimized these loses thus encouraging synchrony between nutrient release and uptake. This phenomenon could be responsible for the significant improvement in growth attributes such as CGR, TLA and LAI at 6-8 WAS relative to single dose application.Except crop growth rate at 6-8 WAS, poultry manure application had no significant effects on cowpea physiological trait. This trend of result could be due to the fact that the applied poultry manure was excessively utilized by pumpkin (*Curcurbita maxima*) and maize (*Zea may*) which are known for their luxurious feeding habits thereby leaving little or no residue for cowpea (*Vignaunguiculata*) uptake. This luxurious feeding habit by pumpkin (*Curcurbita maxima*) and maize (*Zea may*) was reflected in the unusual high growth and yield reported in the treated plot relative to the control (Data not included). Similarly, the lack of significant influenced of poultry manure on the selected cowpea physiological growth attributes is contrary to the work of Mariappan*et al*. (2016) who reported significantly high RGR of sunflower with residual poultry manure applied at 5 t ha^{-1} to previous maize. The sudden declined in CGR, LA and NAR at later growth stages could be due to senescence. Yellammana and Sankara (2013) reported that such phenomenon could be attributed to reduction in the rate of cell division and expansion which in most cases are higher at earlier stages of growth. The reduction trend in growth with crop age has also been ascribed to the excessive utilization of applied nutrients for growth. The findings corroborate the earlier works of Banga*et al*. (1994), Afifi*et al*. (2011) and mariappan*et al*.(2016) on maize and sunflower respectively Therefore RGR are less at later stages of growth particularly during the reproductive stage.

Conclusion

From the foregoing, it could be safely concluded that application of nitrogen to maize in three split doses can significantly enhanced increase availability of N to cowpea irrespective of the genotype which will ultimately enhanced their physiological growth attributes.

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Table 1: Influence of poultry manure, methods of N application and varieties on RGR, NAR and CGR of cowpea

Treatment	RGR ($gg^{-1}wk^{-1}$)			NAR ($gg^{-1}wk^{-1}$)			CGR (gm^{-2}/wk^{-1})		
	4-6	6-8	8-10	4-6	6-8	8-10	4-6	6-8	8-10
PM rates(tons/ha)									
0	0.21a	0.20c	0.06a	21.70a	28.30a	12.60a	1.25a	42.50b	-15.80a
3	0.20a	0.28a	0.02a	18.30a	24.00a	-0.60a	1.23a	69.70a	-37.70a
6	0.21a	0.27b	-0.00a	19.60a	10.40b	-9.60a	1.44a	74.50a	-42.50a
Significance	NS	*	NS	NS	*	NS	NS	*	NS
SE±	0.007	0.04	0.053	5.14	12.36	12.2	0.115	15.94	11.27
Methods of N application									

(N)									
Double split	0.21a	0.28a	0.03a	16.70b	25.40a	-8.20b	1.179b	30.50a	-33.80a
Three Splits	0.22a	0.22a	0.03a	23.00a	16.40a	9.90a	1.431a	24.20a	-30.30a
Significance	*	NS	NS	*	NS	*	**	*	NS
SE±	0.006	0.035	0.043	4.2	10.09	9.96	0.094	5.7	9.4
VARIETIES									
Sampea 14	0.21a	0.24a	0.03a	23.70a	24.40a	0.7	1.33a	24.80a	-29.70a
Sampea 11	0.21a	0.26a	0.02a	16.00b	17.40a	1	1.28a	30.00a	-34.30a
Significance	NS	NS	NS	*	NS	NS	NS	NS	NS
SE±	0.006	0.039	0.043	4.13	10.79	10.48	0.111	5.492	13.011
INTERACTION									
PM X N	NS	NS	NS	NS	NS	NS	0.03ns	42ns	0.12ns

NS=Not significance at 5%, PM=poultry manure, N= methods of N application. * and ** represent significance difference at 5 and 1 % level of probability. Means having the same letter within a column are statistically similar while those with different letters within the same column are statistically dissimilar.

Table 2: influence of poultry manure, methods of N application and varieties on TLA and LAI of cowpea

	TLA (Cm^2)				LAI			
Treatment	4	6	8	10	4	6	8	10
PM rates(tons/ha)								
0	36.75a	57.40ab	59.10a	46.90a	1.28b	1.91b	1.97b	1.56a
3	38.55a	60.80a		48.00a	1.29a	2.03a	2.00a	1.60a
6	38.25a	59.10a	57.80a	47.30a	1.28b	1.97b	1.93b	1.58a
Significance	NS	*	NS	NS	*	*	*	NS
SE±	2.417	3.420	3.130	2.430	0.080	0.110	0.104	0.081
Methods of N application (N)								
Double split	33.54b	53.70b	58.80a	48.30a	1.12b	1.79b	1.96a	1.61a
Three Splits	42.16a	64.60a	59.20a	48.50a	1.41a	2.15a	1.97a	1.55a
Significance	**	**	NS	NS	*	*	NS	NS
SE±	1.974	2.790	2.560	1.960	0.070	0.090	0.086	0.066
VARIETIES								
Sampea 14	36.90b	60.00a	58.80a	46.30a	1.23a	2.00a	2.00a	1.54a
Sampea 11	38.80a	58.30a	59.20a	48.50a	1.29a	1.94b	1.93a	1.62a
Significance	*	NS	NS	NS	NS	**	NS	NS
SE±	1.752	3.450	2.560	1.960	0.080	0.120	0.079	0.066
INTERACTION								
PM X N	*	*	NS	NS	*	*	NS	NS

NS=Not significance at 5%, PM=poultry manure, N= methods of N application. * and ** represent significance difference at 5 and 1 % level of probability. Means having the same letter within a column are statistically similar while those with different letters within the same column are statistically dissimilar.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Response of Chickpea (*cicer arietinum* l.) Varieties to *rhizobium* inoculation in Sudan Savanna Ecology

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Abstract
The research was conducted at the Jigawa State College of Agriculture Research Farm Hadejia, (Latitude of 12^0 22′N and 12^0 24′ N and longitude of 7^0 46′ E and 10^0 E) and Jigawa State Research Institute Farm Kazaure (latitude of 12^o 28' and 12^o 32' and longitude of 8^o 10' and 8^o 38' E), in the Sudan savannah ecological zone of Nigeria. The aim was to study the effects of Inoculation on growth and yield of three chickpea (*Cicer arietinum* L.) varieties. The treatments consisted of combinations of three chickpea varieties (ICCV 97105, ICCV 93954 and ICCV 95423), two inoculation levels (Inoculated and Un-inoculated). The treatments were factorially combined and arranged in a randomized complete block design; and replicated three times. Based on the results of this study, chickpea variety ICCV 93954 outperformed other varieties ICCV 97105 and ICCV 95423 in terms of growth and yield characters all through. Inoculation with *Rhizobium loti* was beneficent to chickpea growth and yield at both Hadejia and Kazaure. Chickpea variety ICCV 93954 was superior to ICCV 95423 and ICCV 97105 because it responds more to inoculation and therefore yielded higher than other two varieties. Chickpea seed inoculated with *Rhizobium* resulted in increased number of nodules per plant as compared to un-inoculated (control). The increase in number of nodules per plant due to seed inoculation increased the yield significantly.
Key words: Chickpea Varieties, Growth, Yield and Inoculation

Introduction

Chickpea (*Cicer arietinum* L.) is a grain legume crop belonging to the fabaceae family (Kupicha, 1981) believed to have originated from Asia and Mediterranean region (Kay, 1979). It is mainly grown during summer in temperate countries and as a winter crop in tropical climates. The crop is one of the most important among pulses in the Indian subcontinent and in North Africa where it is cultivated on residual soil moisture, under irrigation or as a rain fed legume. In Nigeria, it is cultivated on a minor scale in parts of Jigawa, Kano, Yobe and Bauchi State (Anonymous, 1988). The crop is grown primarily for its nutritional value. Due to its high protein content, it is an economic source of quality vegetable protein in the human diet. Chickpea seed contains 21% protein, 61% carbohydrate, and 2.2% oil (Muhammad 1998). In the Indo-Pakistan subcontinent, the seed is eaten as split peas or 'dhal' while in Europe and U.S.A it is cooked and eaten whole in salads. In Nigeria, *"moi moi"* and *"akara"* have successfully been prepared with chickpea. The crop has high digestibility and relative freedom from flatulence factors. It is also richer in calcium and phosphorous than other grain legume (Pushpamma and Gervani, 1987). Chickpea is a herbaceous annual 30 - 70cm in height. It has a deep tap root system with lateral roots which develop nodules with symbiotic *Rhizobium spp.* The nodules (slightly flattened, fan-like lobes) are visible about one month after plant emergence, and generally confined to the top 15cm of the surface. The plant surface is densely covered with fine hairs known as trichomes. They have 1 – 8 primary, secondary and tertiary branches. Plants could be erect, semi-erect, semi-spreading, spreading and prostrate. The erect and semi-erect varieties enable mechanical harvesting. The leaves are imparipinnate with 5 – 7 serrated leaflets that arise on alternate nodes from the third. Some varieties have simple leaves. Temperature, day length and availability of moisture are the three major abiotic factors affecting flowering. In general, flowering is delayed under low temperatures and also under short-days. Chickpea is sensitive to extreme temperatures and prefers temperature range of 35-15°C for optimum growth (Guar *et al*., 2010). Chickpea seedlings emerge hypogeally in 7-15 days after sowing depending on soil temperature and sowing depth. The duration of vegetative growth before flowering ranges from 40 to 80 days depending on the variety, location, availability of soil moisture and humidity and temperature. Chickpeas have typical papilionaceous flowers. Most cultivars produce a single flower at each flowering node. A few cultivars with two flowers per node (twin or double flowered) are also found. The flowers are pink, white or blue in color. Under favorable conditions, the time taken from fertilization to the first appearance of pod (pod set) is about 6 days. After pod set, pod wall grows rapidly for first 10 to 15 days while seed growth occurs later. Soon after development of pods and seed filling, senescence of subtending leaves begins. If there is plenty of soil moisture, flowering and podding will continue on upper nodes. Chickpea is harvested when 90% of the stems and pods lose their green color and turn light golden yellow (Guar *et al*. 2010). There are two types of chickpea, '*Desi*' and '*Kabuli*' types (Saxena, 1990). Although they are botanically similar, the seeds of '*Kabuli*' are larger and light coloured with ram head shape, smooth surface and white flowers. Application of phosphorus to legumes improves seed yield considerably (Hussain, 1983). Studies have shown that seed yield was increased significantly with *Rhizobium* inoculation and phosphorous application (Raut and Kohire, 1991). It has also been reported that nitrogen as a starter dose, along with phosphorous and seed inoculation, has a beneficial effect on the yield of chickpea (Patel and Patel, 1991). In view of the paucity of data on chickpea production in Nigeria, this study which is a preliminary step toward finding ways of increasing the crop's production, was carried out with the specific objectives to determine the growth and yield responses of chickpea varieties to inoculation and phosphorous fertilizer rates in Nigeria.

Materials and Methods

The experiment was conducted during 2014 rainy season at Jigawa State College of Agriculture Hadejia Research Farm (Latitude 12^0 22′N and 12^0 24′N and Longitude 7^0 46′ E and 10^0 E) and Jigawa State Research Institute Farm Kazaure. (Latitude 12^0 28′N and 12^0 32′N and Longitude of 8^0 10′E and 8^0 38′E). The soils of the sites were sandy loam. The treatments consisted of three chickpea varieties (ICCV 97105, ICCV 93954 and ICCV 95423), two inoculation levels (inoculated and un inoculated) arranged in a Randomized complete block design with three replications. Main plots sizes were $12m^2$ and $8m^2$ respectively. Chickpea varieties used were sourced from International Crops Research Institute for Semi-Arid Tropics (ICRISAT).

ICCV 93954: semi erect, basal branching variety with small-sized and brown seeds. It is a *desi* chickpea adapted to rain-fed, irrigated and late-sowing situations with medium duration (80-100 days). It flowers between 35 to 45 days with potential seed yield of 3570kgha^{-1}(ICRISAT 1991). It has 21 % crude protein content and mean 100-seed weight of 18g (Khan, 2002).

ICCV 95423: *kabuli* type chickpea characterized by white or beige-colored seeds with ram's head shape, thin testa, smooth seed surface, white flowers, and lack of anthocyanin pigmentation on stem. The *kabuli* types have large sized seeds and commends higher market price than *desi* types. The price premium of *kabuli* chickpea increases with seed size (Guar *et al.,* 2010). The variety is resistant to insect pests, pod borer (*Helicoverpa armigera*). It is adapted to rainy and irrigation condition with potential grain yield of 2,850kgha^{-1}.

ICCV 97105: *desi* variety with brown seeds larger than ICCV 93954. It matures earlier and flowers within 40 days. It is suited to both rain-fed and irrigated conditions and adapted to medium and late sowing with a mean potential grain yield of 3220kgha^{-1} in India. Inoculants culture was prepared by mixing *Rhizobium loti* culture containing 6×10^9 bacterial cells per gram of peat as carrier. The bacteria and soil mixture were mixed with sucrose solution so that the inoculums could adhere to the seed. Inoculated seeds were air dried immediately and then planted. Exposure of inoculated seed to direct sunlight or high temperatures was avoided, to prevent contamination. Phosphorus fertilizer was broadcasted before sowing per treatment using single super phosphate (18% P). The experimental site was cleared and ploughed and harrowed to a fine tilth. The plots were laid out in form of basins with borders. Two seeds were sown per hole manually at 40cm inter row spacing and 20cm intra row spacing first week of August. All plots received a uniform basal application of nitrogenous fertilizer at 20kgNha^{-1} using Urea (46%N) as starter dose incorporated into the soil at planting. Crops were kept free of weeds by hand hoeing at 10 and 20 days after emergence and afterwards as need

arose. Harvesting was done at maturity last week of November when pods dried and leaves senescence. The cut plants with pods were sun-dried before the pods were picked, threshed and winnowed manually.
Soil samples were collected randomly at depths of 0-15 and 15-30cm using tabular auger before fertilizer application. The samples were analyzed for physical and chemical properties using standard procedures. Ten plants were randomly tagged for growth data collection and yield was determined at harvest. All growth parameters were taken at 11 WAS except stand count taken at 4 WAS and at harvest. Stand count (plants m^{-2}), plant height (cm), number of branches per plant, number of days to 50% flowering, number of days to physiological maturity, number of nodules per plant, fresh weight of nodules per plant (g) and grain yield ($kgha^{-1}$). Data collected were subjected to analysis of variance (ANOVA) as described by Snedechor and Cochran (1967) using SAS version 9.1 (SAS, 2003). Treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion
Table 1 presents treatments variations on parameters assessed. Chickpea variety ICCV 93954 produced significantly higher number of nodules per plant and nodule fresh weight followed by ICCV95423, while the least value was recorded by ICCV 97105. Inoculation also significantly influenced the number of nodules per plant in both Hadejia and Kazaure where inoculated seed statistically produced higher number of nodules than uninoculated. Treatment interactions in number of nodules per plant were not significant at both locations except I×P at Kazaure. **I**noculated plants with *rhizobium* recorded higher number of nodules per plant than non-inoculated crops. The results also revealed that ICCV 93954 significantly outperformed ICCV 95423 and ICCV 97105 in all the yield characters studied at both Hadejia and Kazaure. Inoculation treatment significantly influenced all yield parameters except number of pods per plant at both locations.

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Table 1: Response of chickpea varieties as influenced by inoculation at Hadejia and Kazaure, Northwest, Nigeria 2014.

Treatment	**Hadejia**								**Kaz**
	Nodule number plant^{-1}	Nodule fresh weight plant^{-1} (mg)	Average pod weight	No of seeds pod^{-1}	100 seed weight	Grain yield (kg ha^{-1})	Nodule number plant^{-1}	Nodule fresh weight plant^{-1} (mg)	Average pod weight
Variety (V)									
ICCV 93954	18.7a	610.2a	18.8	1.1b	16.2b	3158.8a	18.8a	630.5a	19.9
ICCV 95423	17.3b	543.5c	19.6	1.5a	18.3a	2583.3c	17.5b	552.2c	20.4
ICCV 97105	17.7c	575.1b	18.9	1.5a	16.8b	3025.7b	17.9c	582.6b	19.2
SE±	0.44	42.21	0.43	0.07	0.81	420.02	0.98	26.23	0.58
Inoculation (I)									
Inoculated	20.9a	667.1a	19.1a	1.4a	18.8a	2932.3a	21.0a	670.2a	19.5a
Un inoculated	14.9b	485.5b	18.0b	1.2b	17.7b	2512.8b	14.7b	482.3b	17.9b
SE±	0.46	22.10	0.52	0.04	1.06	100.57	0.67	19.98	0.67
Interaction									
V X I	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) are not significant at 5% level of significant of probability using Duncan multiple range test (DMRT). NS = Not Significant

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Response of Cowpea (*Vigna unguiculata* (L) Walp) Varieties to Irrigation Frequency and Plant Population in Sudan Savannah Ecology

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Abstract
A field study was conducted in 2002 dry season (Feb – May) at Kadawa Irrigation Research Station (IRS) of Institute for Agricultural Research (IAR), Samaru in Sudan savanna ecology of Nigeria to evaluate performance of cowpea varieties under varying irrigation intervals and plant populations. Treatments consisted of three varieties (SAMPEA 7, SAMPEA 8 and SAMPEA 11); four irrigation frequencies (5,10,15 and 20 day) combined in main plots and three plant populations (22, 222; 44, 444 and 66,667 plants ha $^{-1}$) as subplots in split plot design with three replications. Results revealed that varieties were similar in growth characters assessed. However, SAMPEA 11 out-yielded SAMPEAs 7 and 8. The 10-day irrigation frequency resulted in earlier flowering than 5 and 20 day frequencies. It also produced taller plants and higher yield than other frequencies though not significant. The effect of plant population revealed linear in plant height and number of days to flowering (upto 44,444 plants ha^{-1}) and grain yield upto 66,666 plants ha^{-1}. Based on the findings of this study, it could be concluded that cowpea variety SAMPEA 11 out-performed SAMPEAs 7 and 8 while 10 - day irrigation frequency is optimum for cowpea production under irrigation in savanna agro-ecological zone of Nigeria.

Key Words: Cowpea Variety, Irrigation frequency and Plant population

Introduction

Cowpea (*Vigna unguiculata* (L) Walp) is a tropical food legume cultivated more than 4000 years. (Kay 1979). It is second to groundnuts in importance in sub-Saharan Africa. The crop is grown with 600 – 1500 mm rains per annum, with residual soil moisture or irrigation. It prefers light sandy loam soils and soil reaction of p^{H} 5.5 – 6.5; does not tolerate salinity and acidity. Annual production was put at 4.5 million times from 14 million hectares. Nigeria is the largest producer and consumer of cowpea with over 2 million tonnes production from about 5 million hectares of land (FAO, 2008). Over 90% of Nigerian production is from Northern Guinea and Sudan Savanna agro-ecological zones (Leleji 1987) covering about 400,000 km^2 located between latitudes10 and 13^{o}N and longitudes 4 and 14^{o}E (Kowal and Knabe 1972). Africa grows highest hectarage but has lowest average yields (200 – 300 kg ha^{-1}) compared with USA (1 ton ha^{-1}) and other countries (500 – 600 kg ha^{-1}). Singh and Blade (1997) reported yields of 1.5 – 2.0 t ha^{-1} on farm trials using improved technologies. It is highly adaptable and drought tolerant with low – input requirements thus fits well into diverse production systems (rain-fed and irrigated). Cowpea is an important protein food and cash crop. Cowpea's ability to fix up to 70 - 350 kg N ha^{-1} from atmosphere in association with nodule bacteria (*Bradyrhizobium* spp) and replenishes soil with 40 – 80 kg N ha^{-1} yr^{-1} (Quinn, 1997) made it good for soil amendment, green manure and cover crop. The leaf litter from shed leaves and flowers and root residues decay *in-situ*, contributing some organic matter and associated nutrients to soil. The spreading habit of cowpea provides good ground cover thus suppressing weeds and act as protection against soil erosion. Nigeria needed to produce about 4.3 million tonnes of cowpea annually (Shuaib *et al;* 1997) and 2008 production of cowpea was 2.916 million metric tonnes (FAO, 2008). Choice of suitable cowpea varieties in a cropping system ensures optimum crop growth and higher productivity. Other constraints to low cowpea yields included drought stress and low plant density (Singh and Tarawali ,1997). The rain fed crop is inter-cropped and experiences either mid-season stresses or end of season drought due to intermittent rainfall or its early cessation. Irrigated crop remains the surest means for increased production and production practices of a crop under irrigation must be prescribed independently of its rain fed counterpart because the two seasons are not comparable. The present study was conducted aimed to identify suitable varieties for dry season cowpea production, determine optimum irrigation interval for cowpea production under irrigated condition and study effects of plant population for cowpea production under irrigated condition.

Materials and Methods

An experiment was conducted 2002 dry season (February - April) at Kadawa Irrigation Research station of the Institute for Agriculture Research Samaru, Ahmadu Bello University, Zaria. Kadawa (11^o 39'N, 08^o 02'E and 500m above sea level) is located in the Sudan savanna ecological zone of Nigeria. The treatments consisted of three cowpea varieties (SAMPEA-7, SAMPEA-11 and SAMPEA-8), four irrigation intervals (5-, 10-, 15-, and 20-day) and three plant population levels (22,222, 44,444, and 66,667 plants ha^{-1}). These were replicated three times and arranged in a split-plot design. Factorial combinations of varieties and irrigation frequencies were assigned to main plots while plant population levels occupied subplots. Main and subplots sizes were 18.75m and 9:75m^2 respectively. Soil of experimental site is sandy loam with N and P contents of 0.36 g kg^{-1} and 10.80 mg kg^{-1}. The average daily minimum and maximum temperatures were 11.9 – 26.o ^{0}C and 14.1 – 41.8^{0}C respectively. Relative humidity ranged from 12.5 – 28.9 and 14.7 36.8%. Three seeds were sown per hole according to treatment on March 9 2002. Prior to sowing, the seeds were treated with Apron-plus at rate of 3kg seed per 10g sachet. Plants were later thinned to 2 plants per stand at 2 weeks after sowing. All plots received a uniform recommended NPK compound fertilizer at the rate of 20 kg N/ha, 40 kg P_2O_5/ha and 20 kg K_2O/ha using NPK (15:15:15) and single super phosphate (18% P_2O_5) incorporated into soil at planting. Crops were irrigated weekly by furrow method until 4 weeks after sowing (WAS) to enable them attain some growth and be able to withstand treatment variations. Beyond 4 WAS, the crops were irrigated as per treatment. Weeds were controlled manually by hoe weeding at 3 and 6 WAS. Later emerging weeds were hand-pulled or smothered by crops. Sherpa - Plus 280EC (30g/litre Cypermethrin + 250g/litre Dimethoate) was sprayed at rate of 1litre/ha (120mls in 20litre sprayer) twice at onset of flowering and podding to control possible insect pest attack. Crops were harvested by hand-picking 2-3 times and sun-dried before post harvest data collection. Growth data on plant height, dry matter production and number of days to first flowering were sampled at 9 WAS while yield was recorded at harvest. The data collected were subjected to statistical analysis of variance (ANOVA) using SAS software to test for significant effects of treatments as described by Gomez and Gomez (1984). The means were compared using Duncan Multiple Range Test (DMRT) to establish superiority (Duncan 1955)

Results and Discussion

Effects of irrigation frequency and plant population on plant height, dry matter production, number of days to first flowering and grain yield of cowpea varieties are presented in Table 1. The differences in mean values of these characters were not significant except grain yield. However SAMPEA 11 out yielded SAMPEAs 7 and 8. The effect of irrigation frequency was significant on number of days to first flowering only. The 10 day frequency resulted in earlier flowering than either 5 or 20 day frequencies. Plant population affected all characters except dry matter production. The 44,444 plants ha $^{-1}$ recorded shorter cowpea plants than other plant populations while 22,222 plants ha $^{-1}$ resulted in fewer days to first flowering than 44,444 and 66,667 plants ha $^{-1}$ which were at par. A linear increase in grain yield was observed with each increase in plant population up to 66,667 plants ha $^{-1}$.

The cowpea varieties did not differ significantly in the growth characters assessed. However SAMPEA 7 was superior to SAMPEA 11 and SAMPEA 8 in dry matter production. This is attributed to differential varietal vigour and favourable growing season. The non significant response to irrigation on characters assessed except number of days to first flowering implies the drought resistant nature of cowpea (Singh and Matsui, 2002) and high water table of soils of experimental sites. Suliman (2000) reported that the cowpea does not require high moisture levels. However, 10-day irrigation resulted in taller plants attributed to sandy loam soils of the experimental sites which were rated high in terms of water management and provided optimum soil moisture conditions for cowpea growth. The non-significant effect of irrigation on crop dry matter production was due to slow rate of dry matter accumulation as a result of low temperature or slow attainment of full ground cover. This could have aided high water table conditions to produce non significant response of irrigation on grain yield. This finding is at variance with that of Ferreira, (2004) and Uarrota (2010) reported that irrigation had significant effect on cowpea growth and yield. The linear increase in cowpea plant height and number of days to first flowering with increase in plant population from 22, 222 to 44, 444 plants ha^{-1} is logical because plants produced at higher plant populations tended to be taller due to increased competition among plants for space, light nutrients etc. which hastened flowering and crop development . Similar findings were reported by El Naim, and Jabereldar (2010). This result contradicts the findings of Mohammed (2002) who reported non significant effect of plant population on plant height of cowpea. The grain yield increased linearly upto 66, 667 plants ha^{-1} probably because optimum plant population has not been reached.

Conclusion

Based on the findings of this study, it could be concluded that cowpea variety SAMPEA 11 out-yielded SAMPEA 7 and SAMPEA 8 while 10 - day irrigation interval was optimum for cowpea production under irrigation in the savanna agro-ecological zone of Nigeria. Linear increase in yield upto 66,667 plants ha $^{-1}$ was observed.

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Table 1: Performance of cowpea variety as influenced by irrigation and plant population levels during 2002 dry season at Kadawa, Nigeria

Treatment	Plant height (cm)	Dry matter production (g)	Days to first Flowering	Grain yield (kg ha $^{-1}$)
Variety				
SAMPEA 7	40.9	87.67	47.8	930.3b
SAMPEA 11	40.4	82.79	46.7	1038.0a
SAMPEA 8	39.0	83.68	48.0	997.7b
SE ±	0.60	1.410	0.51	69.29
Significance	NS	NS	NS	**

Irrigation frequency (days)				
5	40.1	81.93	48.5a	1063.6
10	40.7	84.76	45.9b	1082.0
15	40.1	82.73	47.1ab	1030.2
20	39.5	88.10	48.4a	1152.1
SE ±	0.69	1.628	0.59	80.01
Significance	NS	NS	*	NS
Plant population (plants/ha)				
22,222	40.6a	82.92	45.9b	947.7c
44,444	39.9b	83.02	47.9a	1091.1b
66,667	40.6a	87.21	48.6a	1207.1a
SE ±	0.44	1.972	0.64	35.82
Significance	*	NS	**	*
Interaction				
V x I	NS	NS	NS	NS
V x P	NS	NS	NS	NS
I x P	NS	NS	NS	NS
V x I x P	NS	NS	NS	NS

Means followed by the same letter(s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT). WAS = Weeks after sowing;
NS[1] = Not significant; * and ** are significant at 5 and 1% level respectively.

Appendix I: Description of cowpea varieties

Variety	Description
SAMPEA 7 (IAR 48)	Improved cowpea variety (light brown seeds) released by IAR, Samaru in 1979. Semi erect, determinate and adapted to savanna and forest zones Photoperiod insensitive with high yield potential (1.5 – 2.0 tons/ha) and medium maturity (90 – 100 days). Stable and consistent variety with good palatability.
SAMPEA 11 (IT 89 KD- 288)	White seeded cowpea variety Semi determinant with medium maturity (70-80 days) High yielding withaverage 100-seed weight of 30g. Pods are easy to thresh. Photoperiod insensitive with high photosynthetic efficiency
SAMPEA 8 (IT 93 K 452-1)	White to yellow rough seeds, medium to large in size with black eyes. Extra early- maturing and semi determinate in habit. Day neutral variety released by IAR, Samaru in 2005. Purplish flowers within 45 days and matures in 65-70 days. It has a yield potential of 1.0 – 2.0 t ha^{-1}

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Response of Maize (*zea mays* l.) And soybean *(glycine max* l. (merr) to soybean variety and row arrangement in maize-soybean mixture

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Abstract
A field experiment was conducted during the 2017 wet season at the Institute of Agricultural Research Samaru, Zaria, ($11^{0}11$ N, $07^{0}38$ E; 686m above sea level) in Northern Guinea Savanna ecological zone of Nigeria. The aim was to study the productivity of maize and soybean mixture as affected by soybean variety and row arrangement. Treatments consisted of three soybean varieties (TGx 1835-10E, TGx 1945-1F and TGx 1951-3F) and three row arrangement (2:2, 2:3 and 2:4 maize-soybean rows) in addition to sole crops of maize and each variety of soybean replicated 3 times in a RCBD. Results revealed that soybean variety TGx1951-3F recorded taller plants and took longer days to mature than the other 2 varieties. The differences in other growth parameters like leaf area, weight of dry matter among the varieties were not significant. TGx 1835-10E out-yielded both TGx 1945-1F and TGx 1951-3F which were at par while all the three varieties were similar in number of pods per plant, pod weight per plant and seed yield per plant. The 2:4 maize-soybean row arrangement produced larger leaf area and higher dry matter than 2:2 and 2:3 arrangements while 2:3 arrangement excelled in number of days to 50%flower, pod weight, seed and grain yields of soybean followed by 2:4 row arrangement. None of the growth characters of maize studied was significantly affected by row arrangement. However, 2:2 maize-soybean with TGx 1945-1F rows matured earlier than other arrangements except 2:4 maize-soybean with TGx 1951-3F. Sole maize recorded similar grain yield with all other row arrangements except 2:3 maize: soybean rows with either TGx 1945-1F or TGx 1835-10E. In conclusion, TGx 1835-10F out-yielded other two soybean varieties although TGx 1951-3F exhibited better growth attributes while 2:3 maize:soybean row arrangement is most suitable for growing maize/soybean mixture in the study area.

Keywords: Soybean, Maize, Variety, Row arrangement, Mixture

Introduction

Mixed cropping is the growing of two or more crops together on same piece of land at same time in a manner that growth of some or all components crops overlap in a space and time (Elemo *et al.,* 1990). This practice is common to small scale farming in less developed tropical countries like Nigeria (Yunus, 1985). In the system there is crop intensification in both space and time and the crops interact during all or part of the growing season. The system especially cereal legume mixture, give more economic use of resources such as land, more efficient use of growth factors (light, water and nutrients) limits the growth of weeds and helps to control erosion as a result of more complete plant cover. It also checks spread of pests and diseases (Norman 1976). Maize (*Zea mays* L.) is an annual cereal crop which belongs to the family known as *Poaceae.* It grows to height of 2.0-3.0m 4 - 48 leaves. Leaf length ranges between 30-15cm. Maize plant is monoecious and bears separate male flowers (tassel) and female flowers (silk) on same plant. The silk emerges from leaf axis of the ear shortly after tasselling. It a major staple food crop in the tropics. Soybean (*Glycine max* (L) Merr) is a legume which belongs to the family Fabaceae. It grows to a height of 0.75 - 1.25m. The leaf is trifoliate with a rapidly proliferate secondary roots which consisted of branched and lateral roots. The seeds are of numerous colour ranging from white and milk colour. Soybean is an important oil (14-25%) and protein (30-50%) crop (Purseglove, 1984). The oil is 85% unsaturated and cholesterol free (Dugje *et al.*, 2009). Soybean has ability to fix nitrogen in symbiosis with *Bradyrhizobium japonica* and enhance nitrogen status of the soil. About 195kg N/ha/yr can be fixed by soybean (Anon, 1978). In view of importance of crop mixtures and the predominance of cereal:legume mixtures, this study wae conducted to evaluate response of component crops to row arrangement and suitable soybean variety for the intercrop.

Materials and Methods

The experiment was conducted during 2017 wet season at the research farm of the Institute for Agricultural Research Samaru-Zaria ($11^0$11 N, $07^0$38 E; 686m above sea level) in Northern Guinea Savanna ecological zone to study response of maize and soybean as affected by soybean variety and row arrangement. Treatments consisted of three varieties of soybean (TGx 1945-1F, TGx 1835-10E and TGx 1951-3F) and three row arrangement (2:2, 2:3 and 2:4 maize:soybean rows) with sole crops of maize and each soybean variety. The experiment was laid out in a randomized complete block design and replicated three times. The field was ploughed and harrowed to obtain a fine tilth. The land was ridged at 75cm intervals. The plots were marked 3 x 4.5m with 1m between plots and 2 ridges between replications. The seeds were planted per treatment at intra-row spacings of 25 cm each for maize and soybean. Seeds of soybean were planted (2.5 - 3.0cm depth) and maize (2.5 - 5.0cm depth). Weeds were controlled by spraying gramaxone (paraquat dichloride) at the rate of 4l/ha after planting. Supplementary hoe weeding was done at two and six weeks after sowing. Both crops were thinned to two plants per stand at two weeks after sowing. NPK fertilizer (20:10:10) was applied at the rate of 60kg N/ha, 30kg P_2O_5/ha and 30kg k2O/ha at 2 WAS and second dose of 60kg N/ha was applied at 6 WAS using urea (46% N) for maize and NPK 15:15:15 was applied at the rate of 60kg/ha for soybean both at first and second application. The fertilizer was band applied to rows at about 5.0-8.0cm away from maize plants while for soybean drilling method was used at about 5-10cm depth. The maize was harvested after maturity which was indicated by complete drying of the silk, leaves and husk. Soybean was harvested when pods turn yellow-brown. The grains were threshed and winnowed manually. Data were collected on plant height, leaf area, dry matter, days to 50% flowering and maturity, number of pods per plant, cob weight per plant, seed yield per plant, grain yield per hectare, shelling percentage. Data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967). Varieties used were:

TGx 1945-1F- this variety has a potential yield of 2,000 $kgha^{-1}$, it is an extra-early maturing variety (75-80 days) that can grow 50-60cm tall and adapted to northern guinea and Sudan savannah.

TGx 1835-10E- it has a potential yield of 2,000 $kgha^{-1}$, it is an early maturing variety (80-90 days) and can grow 50-65cm tall and adapted to northern guinea and Sudan savannah.

TGx 1951-3F- it has a potential yield of 2,500$kgha^{-1}$, it is late maturing (90-100 days) variety that grows between 90-100cm tall. It is adapted to northern guinea savannah. They are all short day, determinate, plant rust and pustule resistant.

Maize Variety 99TZEE-Y-STR- is an extra early variety (75-80 days). It has a potential yield of $2tha^{-1}$. It has a yellow coloured sed and adapted to northern guinea and Sudan savannah. The varieties were sourced from the International Institute of Tropical Agriculture (IITA).

Results and Discussion

Table 1 presents some maize growth and yield data as influenced by soybean variety and row arrangement in maize/soybean mixture during 2017 wet season in in Samaru. The 2:3 maize soybean rows with TGx 1945-1F took longer and similar days to mature with all other combinations of soybean variety and row arrangement except 2:2 arrangement (with same variety) and 2:4 arrangement with TGx 1951-1F which flowered earlier. None of the growth characters of maize studied like plant height, leaf area was significantly affected by row arrangement. This could be attributed to less competition with extra early maize crop at early growth stages which could likely not have been manifested. Trenbeth, (1976) reported similar non significant effect on component crops in crop mixtures. The sole maize recorded higher and similar grain yield with all other row arrangements except 2:3 with TGx 1945-1F and TGx 1835-10F respectively. The relatively high yield in sole maize could be attributed to low competition with soybean crops and high population densities of maize. Olafemi (2005) also reported reported higher sole maize yield followed by 2:1 alternate maize rows with groundnut variety SAMNUT 23. The 2:2 rows with TGx 1835-10E recorded higher and similar shelling percents with 2:4 arrangements with TGx 1951-1F and sole maize. The least shelling percent was registered for 2:2 maize soybean rows with TGx 1835-10E though at par with 2:3 and 2:4 rows with TGx 1945-1F and 2:2 and 2:3 row with TGx 1951-1F respectively. Table 2 shows some growth and yield parameters of soybean as influenced by soybean variety and row arrangement in maize/soybean mixture in Samaru 2017. Soybean variety TGx 1835-10e recorded shorter plants and higher grain yield than other two varieties which were at par. However TGx 1951-3F took longer days to flower than TGx 1835-10E and TGx

1945-1F. The three varieties did not differ in other parameters assessed. The shorter plants produced by TGx 1835-10F could be explained by the fact that it is easily maturing compared to TGx 1951-3F which is late maturing. This finding agrees with Danlukata., (2012) who reported the differences in maturity periods among soybean varieties. Row arrangement significantly affected days to 50% flowering, pod weight per plant and seed yield per plant. The 2:3 maize:soybean rows recorded higher pod weight and seed yield per plantthan other row arrangements and 2:2 maize:soybean row respectively. It also recorded longer days to flower than 2:4 maize:soybean rows. Similar results were reported by Danlukata (2012)

Conclusion

Based on the findings of this study, it could be concluded that soybean variety TGx 1835-10F out-yielded other two soybean varieties although TGx 1951-3F exhibited better growth attributes while 2:3 maize:soybean row arrangement is most suitable for growing maize/soybean mixture in the study

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Table 1: Some growth and yield parameters of maize as influenced by soybean variety and row arrangement in soybean/maize mixture at samara, 2017 wet season

Treatment	Plant height (m)	Leaf Area (m^2)	Dry matter (g)	Days to maturity	Cob weight $plant^{-1}$ (g)	Seed yield $plant^{-1}$ (g)	Grain yield (kg ha^{-1})	Shelling %
Row arrangement								
TGx 1835-10E								
2:2	1.01	5.59	30.93	81.67ab	57.33	44.3	913.3ab	115.47a
2:3	0.97	5.33	21.60	79.68ab	55.80	43.5	373.1c	33.71c
2:4	0.98	5.32	24.97	79.33ab	53.27	37.6	776.3abc	75.98b
TGx 1945 – 1F								
2:2	0.99	5.56	27.80	77.00b	63.07	47.3	727.7abc	75.72b
2:3	1.01	5.36	26.23	82.67a	66.40	46.5	65.2c	46.32bc
2:4	1.01	5.31	23.53	78.67ab	61.93	47.8	638.0bc	57.43bc
TGx 1951 – 3F								
2:2	1.00	5.41	25.07	79.00ab	73.73	54.1	711.4abc	69.59bc
2:3	1.05	5.32	19.93	81.00ab	55.73	44.1	967.0ab	70.18bc
2:4	1.01	5.30	26.90	77.33b	60.87	44.3	868.1ab	80.50ab
Sole maize	1.02	5.16	20.73	9.00ab	57.53	44.3	1166.2a	60.77ab
SE±	0.023	0.472	4.692	0.276	9.232	7.814	141.552	11.968

Means followed by the same letter(s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT). WAS = Weeks after sowing;
NS[1] = Not significant; * and ** are significant at 5 and 1% level respectively.

Table 2: Some growth and yield parameters of soybean as influenced by soybean variety and row arrangement in soybean/maize mixture in Samaru, 2017 wet season

Treatment	Plant height (m)	Leaf area (m^2)	Dry matter (g)	Days to 50% Flowering	Pod number plant^{-1}	Pod weight plant^{-1} (g)	Seed yield plant^{-1} (g)	Grain (kg ha^{-1})
Soybean variety								
TGx 1835-10E	0.28b	1.11	43.36	62.56b	139.62	48.73	18.0	1370.7a
TGx 1945-10F	0.30a	1.14	33.98	61.78b	116.80	46.71	16.9	847.8b
TGx 1951-3F	0.31a	1.13	38.89	67.11a	131.64	41.00	14.4	654.9b
SE±	0.007	0.043	6.134	0.735	24.405	4.641	2.360	180.620
Row arrangement (maize:soybean)								
2:2	0.29	1.07	38.57	63.56ab	100.64	38.51b	13.3b	653.3
2:3	0.29	1.08	36.14	65.11a	139.33	46.49a	16.9a	24.9
2:4	2.0	1.19	37.20	62.22b	126.07	41.64b	16.2a	789.1
SE±	0.007	0.135	6.134	0.735	24.405	4.641	2.360	180.620
Interaction								
V x A	**	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT). WAS = Weeks after sowing;
NS[1] = Not significant; * and ** are significant at 5 and 1% level respectively.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Response of Pigeon Pea (*Cajanus cajan* l. Millisp) Inoculation with Nigerian Indigenous Rhizobia Isolates

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Abstract
Nigerian indigenous rhizobia isolated from groundnut plants were tested for nodulation and subsequent effectiveness on pigeon pea. The treatments were eleven rhizobia isolates (SNN 335, WDL 129, SNN 343, KBU 026, MJR 493, SBG 234, MJR 530, TDW 412A, MJR 518, SNN 382), reference strain (NC 92), uninoculated and positive N control (1.0 mmoles N, applied twice weekly as KNO_3). These were replicated four times in Randomized Complete Block Design (RCBD). The plants were harvested at six weeks after sowing (WAS). Nodule dry matter, shoots dry matter and N concentration of the plants were determined and N uptake was calculated. Analysis of variance (ANOVA) was conducted, while the means were separated using Tukey HSD. Correlation analysis was also conducted. There was significant difference among the treatments ($P < 0.01$) in shoot dry matter, nodule dry matter and N uptake with R^2 values of 0.80, 0.73 and 0.96, respectively. There was strong positive correlation between shoot dry matter and N uptake, shoot and nodule dry matter as well as N uptake and nodule dry matter of the plants. TDW 412A, SNN 335, SNN 343, WDL 129 gave 53, 50, 38 and 35% high shoot dry matter and 85, 82, 84 and 82% higher N uptake, respectively, than the uninoculated control. Hence indicated by the study as the most effective isolates and promising candidate inoculant isolates for the crop.

Key words: Indigenous rhizobia, N_2 fixation, pigeon pea, isolates

Introduction

Pigeon pea is one of the important pulse crops and a very popular food in developing tropical countries (Dubey *et al*., 2010). It is an important grain legume of the semi-arid tropics (Rao and Dart, 1987). It can provide high quality protein (Bhattacharjee and Sharma, 2012; Ahmed *et al*., 2014), best known as human food, even though it has immense medicinal value and used as a fodder crop for livestock (Bhattacharjee and Sharma, 2012; Ahmed *et al*., 2014). Hence, the need to enhance its productivity to meet the demand of growing population. Even though, 90% of the total world production of the crop is in India (Rao and Dart, 1987; Dubey *et al*., 2010), it a potential crop that could be extended to all tropical areas including Nigeria. Particularly, the existence of a wide range of maturity period for the crop is an important factor for its adaptation to diverse agro-climatic areas and agronomic systems (Rao and Dart, 1987). Nitrogen, a vital element for plant growth, constitutes about 79% (by volume) of the earth's atmosphere (Ahmed *et al*., 2014). However, it is one of the most limiting factors for crop production, while inorganic nitrogen fertilizers are costly and difficult to manage (Yakabu *et al*., 2010; Ahmed *et al*., 2014). Inoculation of pigeon pea with *Bradyrhizobium* has increased the number of primary branches, reduced the time to flowering and maturity and increased nodulation and grain yield (Stephen, 2011). Biological nitrogen fixation (BNF) enhanced through rhizobia inoculation is an alternative to the use of the inorganic N fertilizers (Stephen, 2011). Rhizobia inoculation reduces cost of production, groundwater pollution, enhance protein production, residual N for succeeding crops and increase soil fertility (Stephen, 2011; Ahmed *et al*., 2014). Symbiotic nitrogen fixation is one of the most important microbial activities in the soil, provides nitrogen for the legume in the soil, release N to the soil on decomposition of the residues, hence, contributes to the nitrogen cycle in the biosphere (Hardarson and Atkins, 2003; Rao, 2014). Nitrogen fixation through the association between rhizobia and legumes such as pigeon pea, provide the basis for developing sustainable farming systems that incorporate integrated nutrient management (Hardarson and Atkins, 2003). Pigeon pea is non-specific in its rhizobia requirements and can be effectively inoculated by African indigenous soil populations (Ampomah *et al.,* 2008; Grönemeyer *et al.,* 2014). This study therefore, tested the effectiveness of some Nigerian indigenous rhizobia on pigeon pea. The study tested the null hypothesis that indigenous rhizobia isolates do not nodulate pigeon pea, even if they do they are ineffective and even if effective, are same in effectiveness on pigeon pea.

Materials and methods

Source of the isolates: Indigenous rhizobia isolates used in the study were isolated from the root nodules of uninoculated groundnut (*Arachis hypogaea* L.) obtained from the Nigerian savanna by Abdullahi *et al*., 2018). The isolates were grown from glycerol stocks, stored in 20% glycerol at -80^{o}C on Yeast Mannitol Agar (YMA) media (Vincent, 1970) for seven days at 28^{o}C. The inoculants were then aseptically prepared from pure single colonies in each of the plates in 20 ml of sterile 1% sucrose solution. The optical density of the inoculants was measured at 600 nm, using spectrophotometer to ensure uniformity in concentration of the cells. These were stored at 4^{o}C prior to inoculation.

Treatments and experimental design: The treatments include eleven Nigerian indigenous rhizobia (SNN 335, WDL 129, SNN 343, KBU 026, MJR 493, SBG 234, MJR 530, TDW 412A, MJR 518, SNN 382), a standard reference strain (NC 92), uninoculated control and positive N control (1.0 mmoles N, applied twice weekly as KNO_3). These were replicated four times in a Randomized Complete Block Design (RCBD).

Seeds surface sterilization and Sowing: The seeds were surface sterilized by immersing for 10 seconds in 70% ethanol, then in 3% hydrogen peroxide for three minutes, followed by six rinses of sterile deionized (DI) water. They were then pre-germinated in moist paper towel placed in a sterile lunch box at 28^{o}C for three days. They were then sown in five-kilogram free draining pots, lined with absorbent paper, containing a mixture of 1:1 ratio of steam sterile coarse lawn and yellow N free sands. The pots were further flushed twice with hot, sterile DI water to leach out any trace of inorganic N and keep the soil moist, 24 hours prior to sowing. Four pre-germinated seeds were aseptically sown into five-centimetre-deep holes. For the inoculated treatments, one millimetre of the relevant inoculant was used to drench each seed at sowing. Sterile polyvinyl chloride (PVC) tubes (25 cm in diameter) were then inserted into the sand mixture for supply of sterile DI water and nutrients. The surface of the soils in the pots were covered with alkathene beads at sowing. Centre for Rhizobium Studies (CRS) nutrient solution as described by Howieson *et al*. (1995) was uniformly applied to the plants throughout the experiment. The plants were thinned to two at two weeks after sowing (WAS). They were then grown under axenic N-free conditions at 28/20^{o}C day/night temperature.

Harvest and data collection: The plants were harvested at six weeks after sowing (WAS) by carefully washing the sand to assess the root nodules of the plants. The plant shoots and root nodules were oven dried at 60^{o}C for 24 hours and weighed. Nitrogen concentration in the plant shoots was determined using LECO TruMac N combustion N determiner (LECO, FP 528) and N uptake of the plants were calculated.

Statistical analysis: Analysis of variance (ANOVA) was conducted on the shoot dry matter, N uptake and nodule dry matter. Where F values were significant, the means were separated using Tukey HSD. Correlation analysis was conducted between N uptake and shoot dry matter, nodule dry matter and shoot dry matter as well as nodule dry matter and N uptake. The ANOVA was conducted using IBM SPSS Statistics 20 while the correlation was conducted using Microsoft Excel 2013.

Results and Discussion

Response of the shoot dry matter of pigeon pea to inoculation with indigenous rhizobia isolates is shown in Figure 1. There was significant ($P < 0.01$) difference among the treatments in influencing the shoot dry matter of the crop. The reference strain (NC 92), positive N control and inoculation with the indigenous isolate TDW 412A gave the highest shoot dry matter, even though similar to inoculation with SNN 335. Inoculation with SNN 335 gave similar shoot dry matter to inoculation with SNN 343 and WDL 129 and higher than all other treatments (MJR 493, MJR 530, SBG 234, SNN 345, SNN 382 and the uninoculated control). Except that SNN 343, WDL 129, KBU 026, MJR 518 also gave similar shoot dry matter and higher than all other treatments (MJR 493, MJR 530, SBG 234, SNN 345 and SNN 382 and the uninoculated control). Likewise, WDL 129, MJR 518, MJR 493 and the uninoculated control also gave similar shoot dry matter and higher than MJR 530, SBG 234, SNN 345 and SNN 382 and the uninoculated control that also gave similar the lowest shoot dry matter. Higher shoot dry mater of 53, 50, 38 and 35% were observed on inoculation of the crop with TDW 412A, SNN

335, SNN 343, WDL 129, respectively over the uninoculated control. Figure 2 shows the results of nodule dry matter of the plants in response to inoculation with the indigenous isolates. There was significant ($P < 0.01$) difference among the treatments in influencing the nodule dry matter of the plants. The highest nodule dry matter was observed with the plants inoculated with the isolate TDW 412A. Even though similar to inoculation with the reference strain NC 92 and SNN 335. Except that inoculation with NC 92, SNN 335 and KBU 026 gave similar nodule dry matter and higher than all other treatments (WDL 129, SNN 343, MJR 518, MJR 493, SNN 345, MJR 530, SNN 382 and SBG 234). Likewise, SNN 335, KBU 026, and WDL 129 also gave similar nodule dry matter and higher than other treatments (SNN 343, MJR 518, MJR 493, SNN 345, MJR 530, SNN 382 and SBG 234). Likewise, KBU 026, WDL 129, SNN 343, MJR 518 and MJR 493 also gave similar nodule dry matter and higher than other treatments (SNN 345, MJR 530, SNN 382 and SBG 234). Inoculation with SNN 343, MJR 518, MJR 493, SNN 345 and MJR 530 also gave similar nodule dry matter and higher than SNN 382 and SBG 234 which gave the lowest nodule dry matter and similar to each other. Result of N uptake of the plants on inoculation with the indigenous isolates variation among the treatments (Figure 3). There was significant ($P < 0.01$) difference among the treatments in influencing N uptake. The positive N control gave the highest N uptake. Inoculation with TDW 412A, SNN 343, SNN 335 WDL 129 gave similar N uptake and higher than all other treatments (KBU 026, MJR 493, MJR 518, MJR 530, SNN 345, SBG 234 and the uninoculated control). Except that inoculation with SNN 335, WDL 129 and KBU 026 also gave similar N uptake and higher than the rest of the treatments (MJR 493, MJR 518, MJR 530, SNN 345, SBG 234 and the uninoculated control). Inoculation with TDW 412A, SNN 335, SNN 343, WDL 129 gave 85, 82, 84 and 82% higher N uptake than the uninoculated control and close to the performance of the positive N control. There were also strong positive correlations between shoot dry matter and N uptake, N uptake and nodule dry matter as well as shoot and nodule dry matter with high R^2 values of 0.87, 0.71 and 0.81, respectively an indicator of association between the parameters as shown Figures 4-6. The uninoculated and the positive N controls were devoid of root nodules, showing the hygiene of the experimental conditions as observed by Howieson *et al*., 2016. The result indicates the compatibility of the indigenous rhizobia isolates from groundnut on pigeon pea through nodulation and significant influence on its growth parameters. Host range studies in different parts of Africa showed varying levels of compatibility between rhizobia isolated from different crops on other host legumes belonging to the cowpea cross-inoculation group (Ampomah *et al.,* 2008; Grönemeyer *et al.,* 2014). This could be attributed to compatibility of flavonoids released by the leguminous plants and nodulation and nitrogen fixing gens expressed by the rhizobia to nodulate and form effective symbiotic association for N_2 fixation (Dresler-Nurmi *et al.,* 2009; Peix *et al*., 2015). This could be seen in the influence of the isolates on nodulation, shoot dry matter and N uptake of the plants (Figures 5 and 6). It also shows variation among the rhizobia isolates in effectiveness of the symbiotic relationship formed as result of this interaction, which vary with the isolate, crop genotype and level of interaction between the two (Peix *et al*., 2015; Valetti *et al*., 2016). Higher influence of some of the isolates over others on the growth parameters and indicators of N_2 fixation is eminent in terms of shoot dry matter and N uptake. Shoot dry matter has been reported as a function of N_2 fixation and could be used to assess symbiotic N_2 fixation rhizobia-legume relationship (Somasegaran and Hoben, 1985; Lavetti *et al*., 2016). Particularly, TDW 412A, SNN 335, 343 and WDL 129 were similar to the positive N control and the reference strain and higher than other isolates in influencing shoot dry matter and N uptake of the plants with increases over the uninoculated control that is deprived of N. Likewise the highest nodule dry matter, an indicator of the capability of the nodules to fix nitrogen (Somasegaran and Hoben, 1985) were highest in two of these isolates (TDW 412A and SNN 335) than in all others.

The findings were supported by the strong positive correlations between shoot dry matter and N uptake, N uptake and nodule dry matter as well as shoot and nodule dry matter (Figures 5 and 6). These vividly indicate that the shoot dry matter development and N uptake of pigeon pea is directly influenced by the root nodule. Weight of root nodules is an indication of large nodules developed earlier the life of the plants on the tap roots that have taken longer period fixing nitrogen than lighter and root nodules (Cardoso *et al*., 2009). Therefore, heavier root nodules are associated with higher effectiveness in N_2 fixation and higher growth and development of leguminous plants than ligher ones (Woomer *et al*., 2010).

Conclusion

Indigenous rhizobia isolated from groundnut in the Nigerian savanna were compatible with pigeon pea in nodulation and N_2 fixation. The most effective isolates on pigeon pea were TDW 412A, SNN 335, 343 and

WDL 129 indicated by their influence on nodule dry matter N uptake, shoot dry matter of the plants. Hence are the most promising inoculant isolates for the crop.

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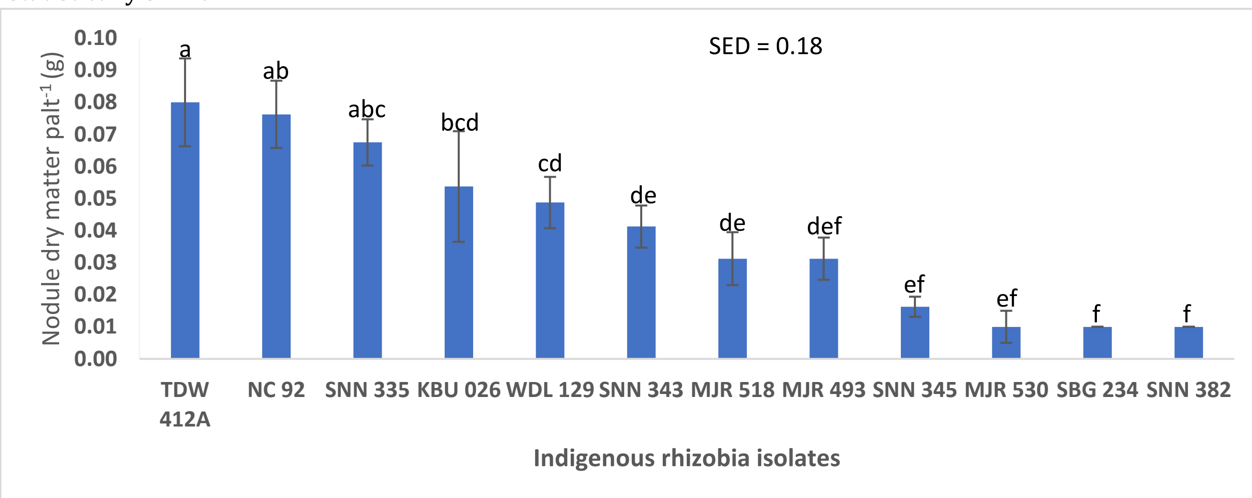
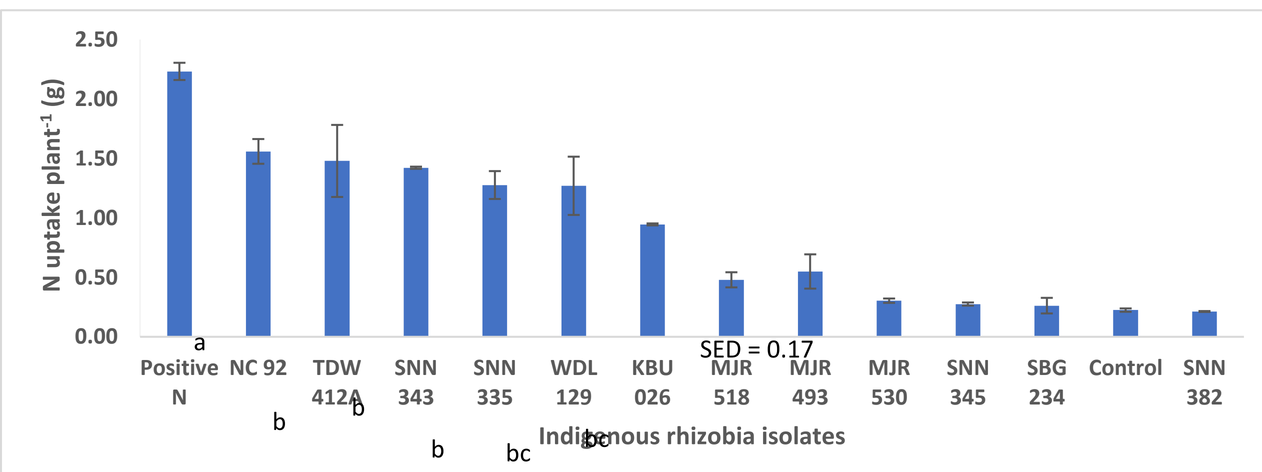
Figure 1. Shoot dry matter accumulation of pigeon pea on inoculation with indigenous rhizobia isolates. Vertical bars represent Standard Error (±). SED = Standard Error Difference. Bars with the same letter are statistically similar.





Standard Error (±). SED = Standard Error Difference. Bars with the same letter are similar.

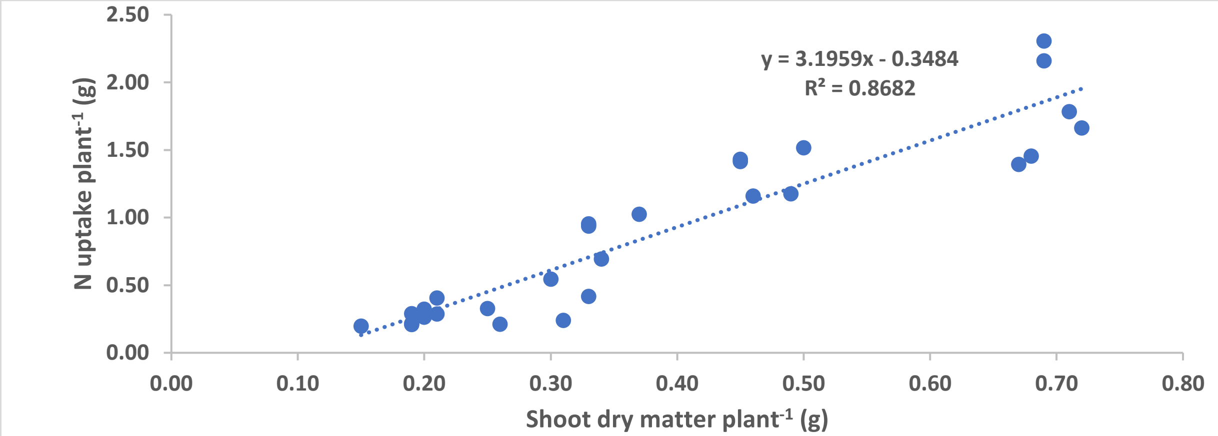


Figure 4. Correlation between shoot dry matter and N uptake of pigeon pea as a result of inoculation with the Nigerian indigenous rhizobia isolates.

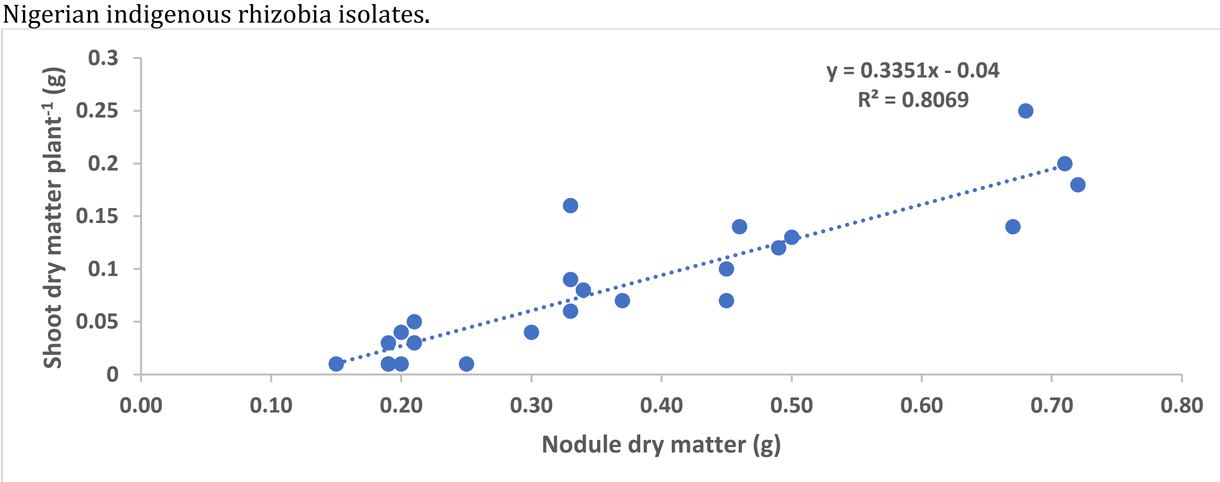


Figure 5. Correlation between shoot and nodule dry matter dry matter of pigeon pea as a result of inoculation with the Nigerian indigenous rhizobia.

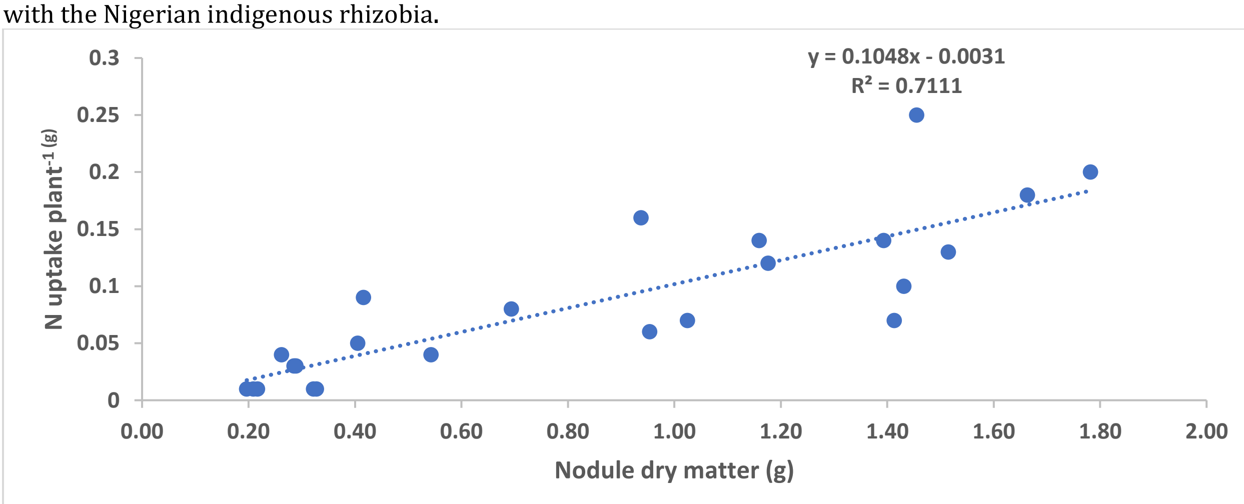


Figure 6. Correlation between N uptake and nodule dry matter of pigeon pea as a result of inoculation with the Nigerian indigenous rhizobia isolates.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Response of Scent Leaf (*Ocimum gratissimum*) to Plant Spacing, Pruning, Heights and Seasons in Delta State

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Abstract
A field experiment was conducted in the teaching and research farm of College of Education, Arbor, Delta State to evaluate the response of O. gratissimum to plant spacing, pruning heights and seasons. The experiment was laid out in Randomized Complete Block Design with three replicates. Treatments were plant spacing (100cm x 60cm, 100cm x 50cm, 100 cm x 40 cm, 100 cm x 30 cm and 100 cm x 20 cm), pruning heights (5 cm, 30 cm and 60 cm) and seasons (rainy and dry season). Data were collected from regenerated shoots and subjected to analysis of variance (ANOVA)., means we're separated using Least significant difference (5 percent) level of significant. The result showed that plants grown at 100 cm x 30 cm and 100 cm x20 cm were taller and had more number of inflorescences than those of wider plant spacing. Plants planted at 100 cm x 40 cm out yielded others in the number of leaves, total leaf area, weight of freshly harvested leaves and inflorescences. Plants that were pruned at a height of 5 cm height were taller with higher numbers of leaves, total weight leave and inflorescences. Plants grown during the rainy season out yielded those of the dry season. It is therefore, recommended that O. gratissimum should be planted at a spacing of 100 cm x 40 cm for efficient utilization of growth resources and 5 cm pruning height adopted for maximum yield.

Keyword: Essential oil Pruning height, Plant spacing, *Ocimum gratissimum*

Introduction

*Ocimum gratissimum*is one of the most valued vegetables that isused in both local delicacies and for medicinal purpose (Okoli, 2009). It belongs to the family *Labiatae*and is widely distributed in the tropical and warm region of the world (Orwa, 2009). It is a perennial herb that is grown primarily for its unique aromatic leaves and inflorescences (Adeoye, 2009). The leaves and young inflorescences are either chopped or ground and used to season meat, especially goat meat (Ojeifo and Denton, 1993).The extracts of the leaves of *O. gratissimum* are used for the treatment of fever, inflammation of throat, headaches, menstrual pains in female, diarrhea, lowering of high blood pressure and skin diseases. The extracts of the plant possess anti-diabetic properties (Nweze, Bayan and Quincy, 2005). The essential oil of the plant has antiseptic and anti-bacteria properties. It also has insecticidal and insect repellent properties.It is used to prolong the life shelf of agricultural produce and acts as a natural alternative to chemical preservatives (Adebolu and Oladimeji, 2005). Despite the soaring demand of the plant in the world, there is a decline in its production in Nigeria (Ekunwe, 2010). The plant *O. gratissimum* has been neglected and relegated to an endangered species (Wiersum, 2003). As the human population increases, unfortunately, human convert land to meet its needs, this threatens the survival of *O. gratissimum* and makes it an endangered species (Charles, 2003). Furthermore, the indiscriminate and unconventional harvesting of the limited stands of *O. gratissimum* without due regard to regeneration and non cultivation of this plant has made it critically endangered (Wilson, 2005). As *O. gratissimum* plant faces an extremely high risk of extinction, the problem is not just the loss of *O. gratissimum* plant, but also the loss of genetic material. This investigation is needed to provide agronomic information suited to build conservation capacity at local level through development of some cultivation practices as means to preserving the endangered species within the human domain, as well as develop the capacity of the local communities for enhancing the production of *O. gratissimum* in commercial quantity (Heywood, 2002).

Materials and Methods

The field work was conducted in the Teaching and Research Farm of Department of Agricultural Education, College of Education Agbor. Agbor is in Ika South local Government Area, Delta state. Agbor lies in the tropical rainforest zone and it is one of the towns in the dissected upland physiographic areas. The upland physiographic nature of the land is the most important hydrographic center in Delta State. Agborriver called Orogodoriver is one of the sources of the major rivers in Delta state. Agbor lies on latitude 6°26/ North, longitude 6°18/ East of the equator at 153 m elevation above the sea level. It is characterized rainfall ranging from 1300 to 1649 mm. (Okafor, 2010).This experiment was conducted across the season that is rainy and dry seasons.The rainy season farming was carried out between the Months of April to September, while the dry season farming started in October when the rain was still falling which enabled the establishment of the transplanted seedlings. The experimental design used was 2 x 5 x 3 factorial layouts using a Randomized Complete Block Design (RCBD), replicated three times. There was a total of 90 plots. The factors were season (rainy and dry season), plant spacing (100 cm x 20 cm, 100 cm x 30 cm, 100 cm x 40 cm, 100 cm x 50 cm and 100 cm x 60 cm) harvesting heights (5 cm, 30 cm and 60 cm). Data that were collected include, plant height, total leaf area, total number of leaves per plant, total number of branches number of inflorescences, total weight of fresh leaves (g/plant), total weight of inflorescences (g/plant) and plant essential oil yield of leaves (ml/plant).Data collected were subjected to analysis of variance (ANOVA) and treatment means were separated with least significant difference according to SAS (2010).

Results and Discussion

Growth parameters: The plants grown at plant spacing's of 100 cm x 20 cm and 100 cm x 30 cm produced taller plants when compared to plant grown on wider plant spacing of 100 cm x 40 cm, 100 cm x 50 cm and 100 cm x 60 cm in both seasons. This may be due to the competition for sunlight among the plants planted at closest plant spacing which they required for photosynthesis. This is in line with Huber *et. al,* (2011) who reported that plants grow rapidly taller as a mechanism to avoid shade when they are overcrowded because they are closely planted or if the planting density per stand is high. The plants harvested at 5 cm (ground level) were taller than others. This may be due to the fact that the harvesting height was closer to the soil. Chang (2008) reported that *O. gratissimum* plants when they are harvested at ground level height always have rapid growth because the tip of the plant which is the growth point is not far from the source where plant roots absorb their nutrients. Plants grown at wider plant spacing of 100 cm x 40 cm and 5 cm pruning height out yielded other plant spacings and pruning heights in the number of leaves and leaf area.The difference in number of leaves of *O. gratissimum* grownat different seasons, plant spacing's and pruning heights could be as a result of effect of competition they faced especially for growth resources caused by overcrowding, effects of changes in seasons and number of leaves available below the harvested height. This corroborates the findings of Aghedo (2001) who reported that when the number of plants per hectare exceeds what it ought to be per hectare, the plants will experience difficulties in receiving direct sunlight from the sun. Also plants are grown at close spacing, they compete for light, soil water and nutrients. Shades or leaves that overlap smaller plants can prevent sunlight from reaching these plants, thus, causing reduction in the rate of photosynthesis in these plants and poor vegetative growth.

The plant grown at plant spacing 100 cm x 20 cm and 100 cm x 30 cm produced higher number of inflorescences than those of wider plant spacing of 100 cm x 40 cm, 100 cm x 50 cm and 100 cm x 60 cm in the different seasons. This may be attributed to the diversion of nutrient absorbed or manufacture by the leaves to the production of inflorescences by plants grown in the closest plant spacing. This is in line with the findings of Chinedu (2003) who posited that plants sown in high density grew with more focus on the growth of reproductive parts than the production of inflorescences. Plants grown at plant spacing of 100 cm x 40 cm, 100 cm x 50 cm and 100 cm x 60 cm had more elongated branchesthan the plants grown in the closest plant spacing during both seasons. This may be as a result of the ample space that the plants planted with wider plant spacing occupied which made them to face less competition for resources.

Yield parameters: The total weight of fresh leaves and inflorescences of *O. gratissimum* showed that the plants grown at plant spacings of 100 cm x 40 cm, 100 cm x 50 cm and 100 cm x 60 cm and pruning height of 5 cm had more weight of the fresh leaves and inflorescences than plants grown at 100 cm x 20 cm and 100 cm x 30 cm and harvested at 30 cm and 60 cm. This may be attributed to the effect of competition for growth resources available in different seasons. This is in line with (Olufolaji, 2004) who indicated that widely spaced plants had more quantity of moisture content, which increases the weights of the plant parts when they are harvested and weighted During dry season, plants total fresh weights tends to decrease because of the reduction of water content in leaves. The plant spacing of 100 cm x 40 cm, 100 cm x 50 cm and 100 cm x 60 cm had more volume of essential oil of leaves at pruning heights 5 cm, 30 cm and 60 cm than plant spacing 100 cm x 20 cm and 100 cm x 30 cm. This variation in oil composition is caused by competition for growth resources.This is in line with the research findings of Evert (2006) who reported that an increase in plant density does not increase the yield of essential oil content in the leaves of *O. gratissimum.* Also when plants are harvested close to source of plant nutrients, they seem to regenerate rapidly which encourages more production of oil in *O. gratissimum.*The plants grown during the rainy season were taller in height than those of the dry season. This may be as a result of closure of stomata which is a mechanism in plant to reduce the amount of water loss through transpiration and quality of water they received during the different seasons. Bollich and Feagley, (1984).said that there is insufficient intake of carbon (iv) oxide required for photosynthesis due to closure of stomata as a mechanism plants adopt to reduce loss of water through transpiration during dry season

Conclusion and Recommendations

The results of this research work have shown that *O. gratissimum* planted at closest plant spacings of 100 cm x 100 cm x 30 cm had more plant height and inflorescences than others. Plants planted at plant spacings 100 x 40 cm and pruning height of 5 cm had more number of leaves, leaf area, weight of leaves and inflorescences than others. It is therefore concluded that *O.gratissimum*yield better when planted at 100 cm x 40 cm and pruned at 5 cm pruning height. In view of the results and findings in the study, it is recommended that Since *O. gratissimum* is cultivated for its leaves and inflorescences it is therefore recommended that the plant should be planted in wider plant spacing of 100 cm x 40 cm, 100 cm x 50 cm or 100 cm x 60 cm when cultivating in commercial quantity. Also, for the production of essential oil, plant spacing 100 cm x 40 cm and harvesting height of 5 cm should be adopted.

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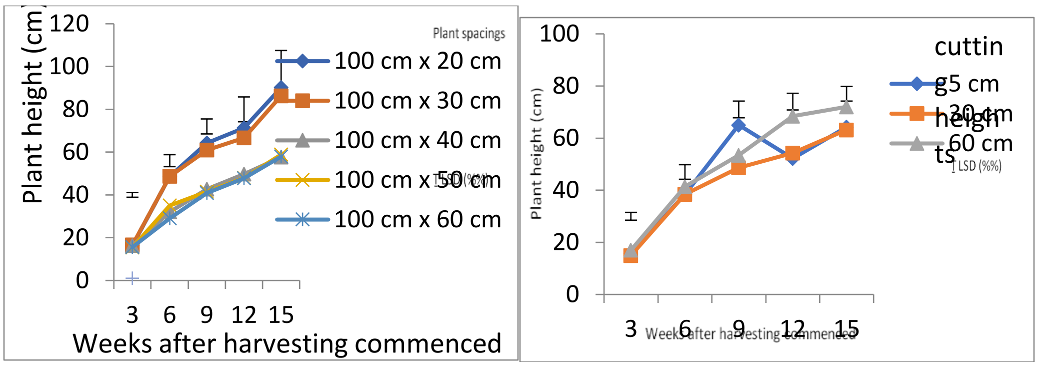
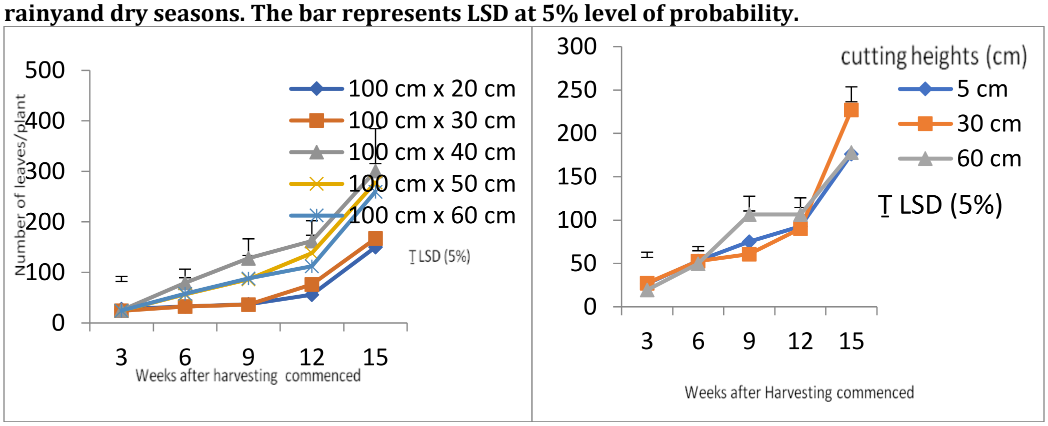
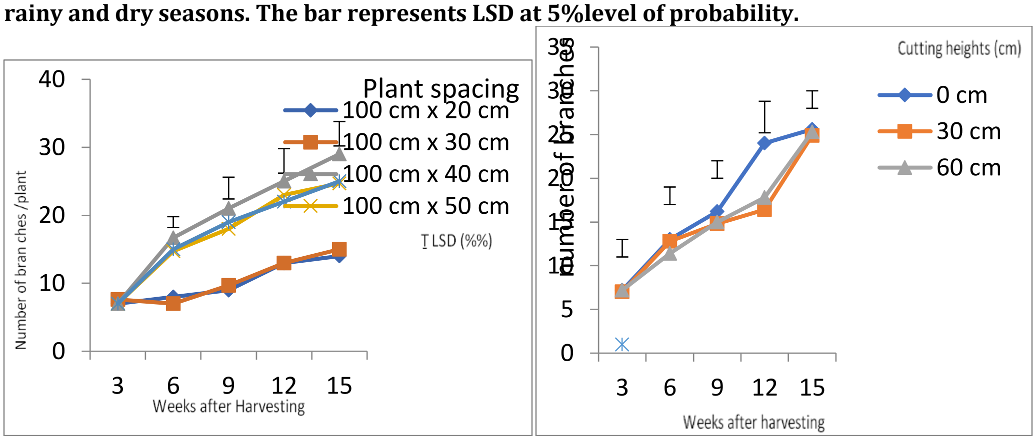


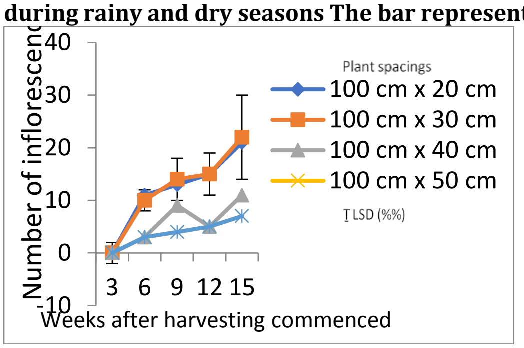
Figs. 1 and 2 Effects of different plant spacingsand pruning heights on plant height (cm) of *O. gratissimum* during rainyand dry seasons. The bar represents LSD at 5% level of probability.

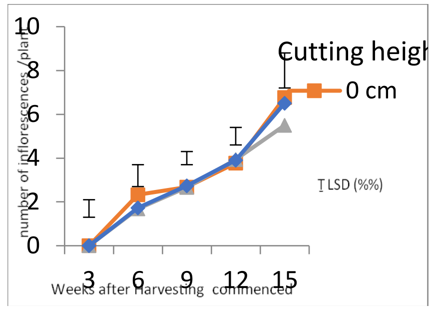


Figs.3 and 4.Effects of different plant spacings and pruning heights on number of leaves of *O. gratissimum* during rainy and dry seasons. The bar represents LSD at 5%level of probability.

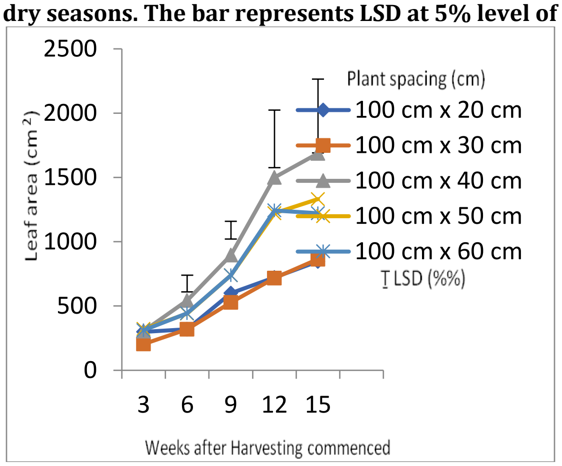


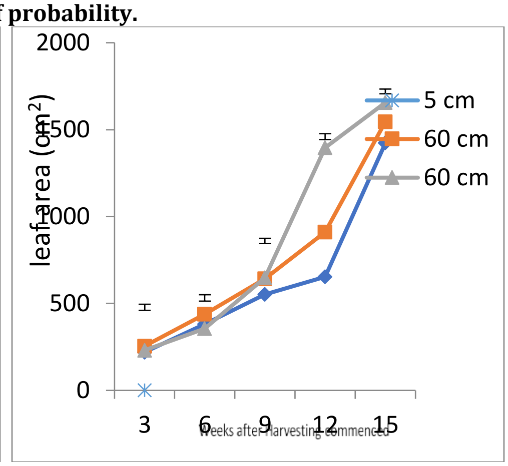
Figs.5 and 6 Effects of different plant spacings and pruning heights on number of branches of *O. gratissimum* during rainy and dry seasons The bar represents LSD at 5% level of probability.



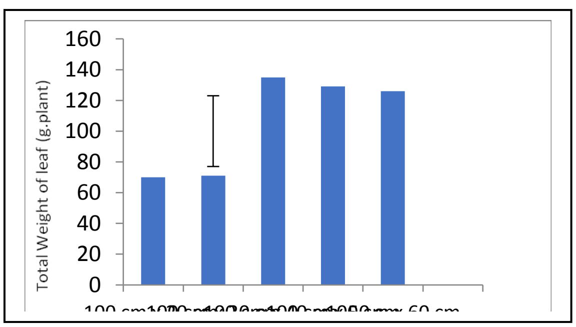


Figs. 7 and 8.Effects of different plant spacings on nu[illegible]g rainy and dry seasons. The bar represents LSD at 5% level of probability.





Figs.9 and10.Effects of different plant spacings on leaf area (cm²) of *O. gratissimum* grown during the rainy dry seasons. The bar represents LSD at 5% level of probability



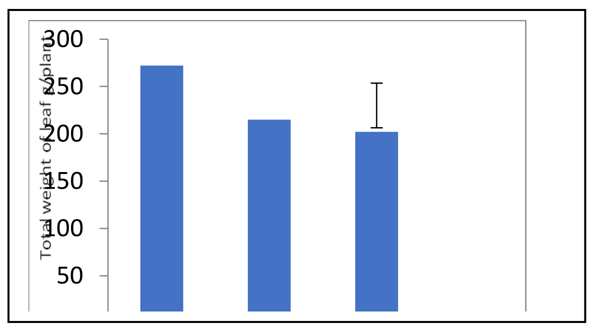
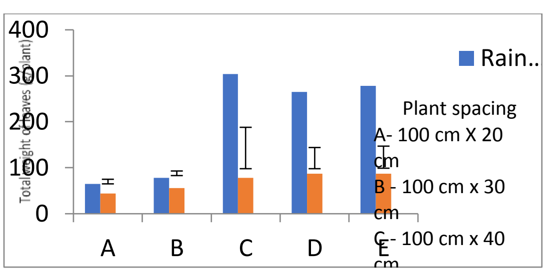
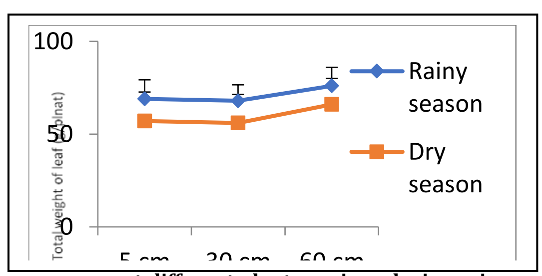


Fig. 11 and 12.Effects of different plant spacings on the total weight of leaves of *O. gratissimum* grown during rainy and dry seasons. The bar represent LSD at 5% level of probability





Figs. 13 and 14 Effects of season on growth and yield of *O. gratissimum* grown at different plant spacings during rainy and dry seasons The bar represents LSD at 5% level of probability

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Review of Soil Contamination and Uptake of Heavy Metals by Plants

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Abstract
Heavy metals are among the most important sorts of contaminant in the environment. Several methods already used to clean up the environment from these kinds of contaminants, but most of them are costly and difficult to get optimum results. Currently, phytoremediation is an effective and affordable technological solution used to extract or remove inactive metals and metal pollutants from contaminated soil and water. This technology is environmental friendly and potentially cost effective. This paper aims to review soil contamination and heavy metal uptake by plants. It also reviewed phytoremediation technology and heavy metal uptake mechanisms. According to previous studies, several plants have high potentials as heavy metal bioaccumulation and can be used for phytoremediation process of heavy metals. Remediation of heavy metal contaminated soils is necessary to reduce the associated risks, make the land resource available for agricultural production, enhance food security and scale down land tenure problems arising from changes in the land use pattern. The paper recommended proper waste disposal, collection of reliable data on heavy metals concentration in soils and crops and proper soil testing for agricultural lands.

Keywords: Soil contamination, soil contaminants, heavy metals, uptake mechanism

Introduction
Soil is a mixture of organic matter, minerals, gases, liquids and organisms that together support life. According to Voroncy and Heck (2007), soils are complex mixture of minerals, water, air, organic matter, and countless organism that are decaying remains of once living things. It forms at the surface of the land. It is the "skin of the earth". Soil is capable of supporting plant and is vital to life on earth.
Soil may become contaminated by the accumulation heavy metals and metalloids through emissions from the rapidly expanding industrials areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, waste water, irrigation coal combustion residues, spillage of petrochemicals and atmosphere deposition (Khan et al, 2008). Heavy metals constitute of an ill defined group of inorganic chemical hazards, and those most commonly found at contaminated sites are lead (Pb) chromium (Cr), arsenic (As), Zinc (Zn), Cadmium (Cd), Copper (Cu), Mercury (Hg) and Nicked (Ni), (WRTAC, 1997).
Soil Contamination and Contaminants: Soil contamination is defined as the buildup in soils of persistent toxic compounds, chemicals, salts, radioactive materials or disease causing agents, which have adverse effects on plant growth and animal health. (Okrent, 2000). Soil contaminant is any substance in the soil that exceeds naturally - occurring levels and poses human health risks. Soil contamination is the occurrence of contaminants in soil above a certain level causing decoration or loss or more soil function (JRC, 2014).
It occurs in two forms according to Mirsal, (2008). "Point pollution" caused by a specific event or series of events to a particular place such as a former factory site. This is relatively well mapped and understood. "Diffuse pollution", this involves low levels of contaminants spread over very wide areas that become lodged in the soil as it acts as a sink. This is difficult to analyze and track. Examples of such contaminants would be heavy metals or herbicides or pesticides used in agriculture.
Soil contamination could be through one of the following:

- Biological Agents: They work inside the soil to introduce manures and digested sludge (coming from human, bird and animal excreta) into the soil.
- Agricultural Practices: The soil is polluted to a large extent with pesticides, fertilizers, herbicides, slurry, debris and manure.
- Radioactive Pollutant: Radioactive substances can infiltrate the soil and create toxic effects.
- Urban Waste: Consists of garbage and rubbish materials, dried sludge and sewage from domestic and commercial waste.
- Industrial Waste: Pesticides.

Soil contaminants are those substances like lead (Pb), cadmium (Cd), nickel (Ni), arsenic (As), chromium (Cr), zinc (Zn), copper (Cu), mercury (Hg). Some of these heavy metals are Bioaccumulative. They do not break down in the environment and they are not easily metabolized, which is the main reason for their accumulation in food chain at primary producers (through the uptake of plants) and at consumer levels (through consumption) (Mirsal,2008).

Causes and Effects of Soil Contamination: Soil contamination is a result of many activities in the soil by mankind which contaminates the soil. It is often associated with indiscriminate use of farming chemicals such as pesticides, fertilizers etc. pesticides applied to plants can also leak into the ground, leaving long lasting effects. In turn, some of the harmful chemicals found in fertilizers (e.g. cadmium) may accumulate above their toxic levels, ironically leading to the poisoning of crops (JRC,2014). Acid rain caused by industrial toxic fumes mixing in rainfalls on the land, and could dissolve away some of the important nutrients found in the soil, as such change the structure of the soil. Accidental oil spills can happen during storage and transport of chemicals. Fuel leakages from automobiles which get washed by rain can seep into the nearby soil to pollute it. Waste disposal from a personal waste product by human in form of urine or feaces. Unhealthy waste management techniques release sewage into dumping grounds and nearby water bodies (JRC,2014). Soil contamination causes huge disturbances in the ecological balance and health of living organisms at an alarming rate. Crops and plants that are green on contaminated soil absorb much of the pollutants and pass on to human. It has effects on plants by decreasing the soil fertility thereby making land unsuitable for agriculture. The emission of toxic and foul gases from land fill pollutes the environment and causes serious effects on the health of people. More so, the death of many soil organisms (e.g. earthworms) in the soil can lead to alteration in soil structure (JRC,2014).

Mechanism of Heavy Metal Uptake in Plants

According to Sinha et al, (2004), contaminants uptake by plants and its mechanisms have been explored by several researchers. Plants act both as “accumulators” and “excluders”. Accumulators survive despite concentrating contaminants in their aerial tissues. They bio-degrade or bio-transform the contaminant into inert forms in their tissues. Excluders restrict contaminant uptake into their biomass (Sinha et al, 2007).

Plants have evolved highly specific and very efficient mechanism to obtain essential micro nutrient from the environment, even when present at low ppm levels. Plants have also evolved highly specific mechanisms to translocation and store micro nutrients. These same mechanisms are involved in the uptake, translocation and storage of toxic elements, whose chemical properties stimulate those of essential elements thus, micronutrients uptake mechanism are of great interest to phytoremediation (Sinha et al, 2004).

Plant uptake-translocation mechanisms are likely to be closely regulated. Plants generally do not accumulate trace elements beyond near term metabolic needs. And these requirements are small ranging from 10-15 ppm of most trace elements suffice for most needs (Sinha et al, 2004). Plant roots take up nutrients from growth substrates through rhizofiltration (root) process (Moreno et al, 2008).

Water evaporating from plant leaves, serves as a pump to absorb nutrients and other soil substances into plant roots. This process termed evapotranspiration is responsible for moving contaminants into plants shoot as well. Since contamination is translocated from roots to shoots, which are harvested, contamination is removed while leaving the original soil undisturbed. Some plants that are used in phytoextraction strategies are termed “Hyper accumulators” (Salido, 2003).

Implication of heavy metal uptake by plants: Heavy metals are important environmental pollutants and their toxicity is a problem of great concern for environmental, ecological, nutritional and toxicological reasons. Some of these heavy metals i.e., As, Cd, Hg, Pb or Se are not essential for plants growth, since they do not perform any known physiological function in plants. Others i.e. Co, Cu, Fe, Mn, Mo, Ni and Zn essential elements required for normal growth and metabolism of plants but these elements can easily lead to poisoning when their concentration greater than optimal values (Rascio and Izzo, 2011). Uptake of heavy metals by plants and subsequent accumulation along the food chains a potential threat to animal and human health (Sprynsky et al 2007).

Phytoremediation for Contaminated Soils: Phytoremediation can be understood as the use of plants (trees, shrubs, grasses and aquatic plants) and associated micro organism in order to remove degrade or isolate toxic substances form the environment. (Dickinson et al, 2009). The word "phytoremediation" derives from the Greek "phyton" meaning "plant" and latin "remedium" which means "to remedy" or to correct substances that maybe subjected to phytoremediation include metals (Pb, Zn, Cd, Cu, Ni, Hg) metalloids (As, Sb), organic compounds (NO^3, NH^{4+}, PO_4^{3-}), pesticides and herbicides, chlorinated wastes (Ensley, 2000). Phytoremediation techniques include different modalities, depending on the chemical nature and properties of the contaminant (if at is inert, volatile or subject to degradation in the plant or in the soil) and the plant characteristics.

Thus phytoremediation essentially consist of six different strategies:

- **Phytodegradation (Phytotransformation):** Organic contaminants are degraded (metabolizedints or mineralize inside plant cells by specific enzymes that include nitroreductases (degradation of nitro aromatic compounds), dehalogenases (degradation of chlorinated solvents and pesticides) and lactases (degradation of anilines). (Rylott and Bruce 2008).
- **Phytostablilization (Phytoimmobilization):** Contaminant organic or inorganic, are incorporated into the lignin of the cell wall of root cells or into humus. Metals are precipitated as insoluble forms by direct actions of root exudates and subsequently trapped in the oil matrix (Ali et al 2013).
- **Phytovolatilization:** This technique relies on the ability of some plants to absorb and volatilize certain metals/metalloids. Some element ions specifically, Hg, Se and As are absorbed by the roots, converted into non-toxic forms, and then released into the atmosphere. For example the species Astragalus bisulacatus and Stanleya Pinnata (Ali, 2013).
- **Phytoextraction (Phytoaccumiulation):** This involves the absorption of contaminants by roots followed by translocation and accumulation in the aerial parts.
- **Phytofiltration:** This uses plants to absorb, concentrate and/or precipitate contaminants, particularly heavy metals or radioactive elements, from an aqueous medium through root system or other submerged organs.
- **Rhizodegration (Phytostimulation):** Growing roots promote the proliferation of degrading rhizosphere micro organism which utilizes exudates and metabolites of plants as a source of carbon and energy. In addition, plants may exude biodegrading enzymes themselves (Ali et al, 2013).

Conclusion and Recommendation

Several researches have established heavy metals concentrations in plants and plant products. This is due to the capacity of plants to absorb heavy metals from their environment, especially soil.

The following recommendations are made:

- Clean Up**:** Environmental remediation consists of removing pollution from the soil, groundwater or surface water. Bioremediation (microbes) and phytoremediation (plants) can be used to convert the pollutants into harmless products. These are natural solutions that need to be supported by in depth actions.
- Proper Waste Disposal**,** be it for industrial or household waste, efficient waste disposal is one of the most effective ways of curbing land pollution. This especially applied to toxic and hazardous waste disposal.
- The collection of reliable data on heavy metals concentrations in soils and crops must be given utmost importance.
- Variety of useful information and methodologies can be developed towards achieving the ultimate goals of providing safe and quality foods.
- Proper soil testing/analysis should be done before using farm lands for growing crops.

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ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Soil fertility indices, growth and yield properties of groundnut (*Arachis hypogaea*) as influenced by termite mounds and urea in Unwana, Southeastern Nigeria.

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Abstract
This study was aimed at determining the effects of termite mound (TM) and urea on selected soil chemical properties, growth and yield of groundnut in the Green House, Department of Horticulture and Landscape Technology, AkanuIbiamFederalPolytechnic, Southeastern Nigeria. The treatments comprised of three rates (0, 1 and 2 ton ha^{-1}) TM and three rates (0, 1 and 2 ton ha^{-1}) urea arranged in Complete Randomized Design (CRD) in a factorial pattern. Selected soil nutrient properties (pH, organic carbon, total nitrogen, available phosphorus, exchangeable bases and acidity, effective cation exchange capacity and base saturation) and plant growth indices (plant height, number of branches, number of leaves and number of pods) were analyzed and collected according to standard methods. Results obtained showed significant higher proportions of all soil chemical properties studied in soils modified with TM as lone treatment and in combination with urea. However, the lone application of urea had consistent reductive effect on pH, organic carbon, available P and exchangeable bases. Similarly, all the growth parameters were highly improved by the addition of the two treatment material.The treatment combination of 2 ton ha^{-1} TM and 1 ton ha^{-1} urea gave the best appreciable improvements on both soil fertility properties and plant growth indices. Therefore, TM if combined with urea in the ratio of 2:1 ton ha^{-1} as fertilizer could improve the properties of the soil and growth of groundnut in areas where termites occur in large numbers.
Keywords: Termite mound, Urea, Groundnut and Soil fertility

Introduction

Groundnut is one of the most versatile legumes in the tropical and sub-tropical regions because of its drought tolerant characters, soil restoring properties, weeds smothering, multi-purpose confectionary and dilatory uses. Nigeria is the fourth largest producer of groundnut after China, India and USA (USDA, 2009). Recently, total groundnut production has declined to yield loss as high as 51 % in Nigeria (Etejere*et al*., 2013).Diseases and poor soils are considered to be the main causes of losses in the groundnut production (Uzunov, 1988; Savary, 1991).Groundnut is called a self-fertilising crop, but it is very exhaustive compared to other legumes as very little portion of the plant is left in the soil after harvesting (Savary, 1991).Soil application of nutrients leads to losses of nutrients in the form of leaching, volatilisation and fixation affecting the nutrient use efficiency. Hence, an attempt has been made to increase the crop yield through fertiliser application. Termite mound or nest is the aboveground or underground part of termites dwelling place. Termites have peculiar activities in the soil, inducing significant changes in the soil properties including enriching the mound with clay and its associated minerals (exchangeable basic cations) that results in a higher pH and cation exchange capacity (CEC). Furthermore, the centralized decomposition of organic matter in the termite nest results in an accumulation zone of nitrogen and in some cases phosphorus in the centre of the mound. Termite mound are therefore considered as fertile islands in a bare landscape (Jouquet*et al*., 2011). It has recently become a common practice to bulldoze the termite mounds to develop large-scale mechanized agriculture.The application of mound material as a natural fertilizer could improve crop growth and yield, creating an alternative fertilizer for farmers especially when drainage and other physical conditions of the soil are properly managed. However little is known about the effect of mixing mound material with mineral fertilizers on soil fertility and crop performance. The present investigation was carried out to compare and evaluate the effects of termite mound and urea on soil fertility properties, growth and yield properties of groundnut (*Arachis hypogaea* L.) in Unwana.

Materials and Method
The study was carried out in the Green House of AkanuIbiam Federal Polytechnic, Unwana(latitudes 5° 48N and longitude 7 ° 55E) The climate and vegetation types are generally humid tropical rainforest with mean annual rainfall of about 3,500mm and mean daily temperature range of 27°C to 38°C (Njoku 1996). Thereare several termites' mounds in the area.Soil samples for the experiment were collected from the Research Farm of Horticulture and Landscape Technology Department using soil auger at 0 – 20cm. 5Kg of each was weighed into 27 polyethylene bags perforated at the bottom.

Termite Mounds: Samples were taken from the termite mounds (top, center, and base) and these were air dried at room temperature, crushed, sieved using 2mm sieve, and subjected to routine analysis.

Pot Experiment The Termite Mounds and Urea were added to each polyethylene bag (plant pot) using appropriate weight. The treatments comprised of three rates (0, 1 and 2 t/ha) Termite Mounds and three rates (0, 1 and 2 t/ha) Urea arranged factorially in Complete Randomised Design in three replications. Two Groundnut (*Arachis hypogaea*) seeds were sown in each of the polyethylene bag (planting pot) and later thinned down to one seedling per pot after germination.

Data collection: At twelve weeks of planting the following agronomic parameter were measured: Plant height, numbers of leaves, numbers of branches per plant and numbers of pods.Post-harvest soil samples were collected from each pot and the following chemical analysis were carried out: soil pH was determined in soil to water and soil to $CaCl_2$ at a ratio 1:2 soil water and soil $CaCl_2$ respectively using glass electrode P^H meter (Udo*et al*; 2009).Organic carbon was determined by the wet oxidation method according to Pansu and Gautheyrous (2006) and converted to organic matter by multiplying by 1.792. The total nitrogen determination was done by the macro Kjeidahl digestion method (Simmone*et al.,* 1994). Available P was determined using the Bray II method as described by Udo*et al*; (2009). Exchangeable acidity was determined by the nikel extraction procedure as described by Udo*et al*., (2009). Exchangeable basic cations(K^+, Ca^{2+}, Mg^{2+}, Na^+) were determined by the ammonium acetate method (Carter and Gregoich, 2008). Ca and Mg in the extract were determined using the atomic absorption spectrophotometer, while K and Na were determined using the flame photometer. Effective cation exchange capacity **(**ECEC) was obtained by summation of all the exchangeable cations and exchangeable acidity as described by Udo, *et al*; (2009). The base saturation was obtained mathematically with

$$BS (\%) = \frac{\text{Total cation}}{\text{ECEC}} \times \frac{100}{1}$$

Statistical Analysis Data from agronomic parameters and soil chemical properties were subjected to analysis of variance (ANOVA) and the means separated using FLSDO 0.005

Results and discussion
The physical and chemical properties of the soil used for the study is presented in Table 1. The texture of the soil was clayey-loam. The soil was acidic; this is one of the major characteristics of soils of southeastern Nigeria (Osodeke, 2005; Azu*et al*., 2017). The organic carbon and total nitrogen were moderately high, being above the critical level set by Adeoye and Agboola (1981) for soils of the humid tropics. The soil had available P below the critical level of 15mg/kg (Enwezor*et al*.,1989; Marno and Haque1991)for crop production in tropical soils. The low available P has been related to high P fixation by sexquoxides and 1:1 clay minerals which are abundant in soils of high clay content (Nitzsche*et al*., 2008; Azu*et al*., 2017).The exchangeable bases were relatively high, but ECEC was low due to high concentration of exchangeable acidity. However, the base saturation was high.

Chemical Properties of the Termite Mound Used for the Study
The termite mound was alkaline (Table 1) which validated previous reports (Dhembare, 2013; Asawalam*et al*., 2008).Organic carbon and organic matter were high which may be attributed to the fact that mounds are composed of majorly organic matter derived from various sources such as plant materials feacal materials which are mixed with soil and saliva and covered with a dark substance secreted by termites (Brady and Weil, 2008). The nitrogen, available P and the basic cationswere highindicating the potentials of termite mound as soil improvers when properly used.

Mean effect of urea and termite mound on selected soil fertility properties.

Table 2 depicts the mean effect of termite mound and urea on some chemical properties of the soil study. Generally, the application of TM and urea relative to control improved all the soil fertility indices studied. Significantly ($p < 0.05$) effect on pH when the materials were applied both singly and interactively was observed. While TM as lone treatment consistently increased the pH, urea on the other hand, had a declining effect on pH. Recent studies have shown that mineral fertilizers induce soil acidity (Awodum, 2007; Azu*et al.,* 2018). The main effect of the treatments on organic carbon were statistically significant ($p<0.05$), however, their interactive effect was not significant. Similarly, organic carbon increased with TM addition, while the reverse trend was observed with urea. The high concentration of organic matter coupled with the abundance of basic cations in TM as reported by Donagema *et al*, (2011), must have influenced this result

Nitrogen content was significantly ($p<0.05$) improved by the addition of TM and urea both as lone and combined treatments. The mean value of N was higher than critical value of 0.15% proposed by Adeoye and Agboola (1984) for humid tropical soils. Available P was significantly ($p<0.5$) influenced by the addition of both TM and urea as lone treatments. While P consistently increased with TM, increased rate of urea application led to decline in P content. High organic matter and basic cations content in TM may have been responsible to this observation as earlier reported by Asawalam *et al*., (2007).Lone application of 2tonsha^{-1} TM gave the highest amount of P (8.73mg/kg) which was higher than the critical value of 8mg/kg set for soils of southeastern Nigeria (Enwezor, 1989).Organic matter not only releases P through mineralization by microbes, but also reduces acidity and competes with P at the adsorption sites of soil minerals, thereby reducing P fixation (Azu*et al*., 2017; Cessa *et al*., 2009; Nitzsche *et al*., 2008).With regard to P availability as related to TM, several studies have reported high P content in the termite mound (Lopez-Hermandez *et al*., 2006; Ruckamp*et al*., 2010; Oliveira *et al*., 2012) and they attributed this result to the incorporation of feces in the mound material. Significant effects ($p < 0.05$) on exchangeable bases by the application of the treatment materials as lone and combined were observed. Relative to control, TM application as lone treatment showed higher increase on total exchangeable bases (TEB) which is justified by the high cation content in TM (Ackerman *et al*., 2007 andAsawalam *et al*., 2008). However, a consistent reductive effect on the TEB was observed when urea was applied as lone treatment. The termite mound lowered the exchangeable acidity and therefore improved the percent base saturation as earlier reported by Sarcinelli *et al*., (2009).

In summary, results indicated that the addition of TM and urea singly and interactively relative to control increased the growth and yield parameters of groundnut and these increases were proportional to the application rate. Treatment combination of 2 ton ha^{-1} TM and 1 ton ha^{-1} urea proved to be superior in increasing the plant parameters than other treatment combination. Other studies have reported superior effect when organic and mineral fertilizers are integrated than their lone applications (Ano and Asumugha,2000; Azu*et al*., 2017).

CONCLUSION

Profitable and sustained groundnut production in Southeastern Nigeria is very limited in the absence of external fertilizer input due to the inherent low soil fertility status. Therefore, identifying sustainable ecological practice to enhance soil fertility is one of the surest ways of promoting food security and national integrity. Generally, the application of TM as organic ameliorant and urea improved the soil fertility properties of ultisols of Southeastern Nigeria and the agronomic parameters of groundnut. The treatment combination of 2 ton ha^{-1} termite mound and 1 ton ha^{-1} urea gave the best appreciable results in terms of soil nutrient properties, growth and yield parameters of groundnut and is therefore recommended.

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Table 1: Some properties of the Soil and Termite Mound used for the Study

Properties	**Soil**	**Termite Mound**
Sand %	39.98	-
Silt %	16.35	-
Clay %	43.67	-
Texture	Clayey-loam	-
pH (H_2O)	5.14	7.72
pH ($CaCl_2$)	4.08	6.81
Organic Carbon %	2.55	8.46
Organic Matter %	4.42	14.65
Total Nitrogen %	0.23	0.08
Available Phosphorus mg/kg	7.53	12.54
Ca^{2+}Cmol/Kg	3.21	4.02
K^{+}Cmol/Kg	0.16	1.70
Mg^{2+}Cmol/Kg	1.94	1.63
Na^{+}Cmol/Kg	0.01	1.33
TEACmol/Kg	3.04	-
ECECCmol/Kg	8.36	-
BS %	63.64	-

TEA = Total Exchangeable Acidity, ECEC = Effective Cation Exchange Capacity, BS = Base Saturation.

TEA = Total Exchangeable Acidity, ECEC = Effective Cation Exchange Capacity, BS = Base Saturation.

Table 2.**Mean effect of urea and termite mound on seleceted soil fertility properties.**

Treatments TM + UREA	pH H_2O	pH Cacl$_2$	OC %	OM %	TN %	AP mg/kg	TEB	TEA Cmol/kg	ECEC	BS %	
0 + 0	4.95	3.87	2.20	3.82	0.18	6.03	4.94	3.14	8.07	61.00	
0 + 1	4.55	3.46	2.07	3.60	0.20	5.91	4.30	3.23	7.52	48.70	
0 + 2	4.06	3.46	1.90	3.30	0.25	5.26	4.12	3.38	7.37	54.10	1 +
0	5.22	4.14	2.27	4.12	0.20	6.45	5.28	2.93	8.21	64.30	
1 + 1	5.66	4.99	2.38	4.13	0.27	6.14	5.45	2.75	8.20	66.50	
1 + 2	5.19	4.89	2.11	3.66	0.30	5.90	5.05	3.30	8.25	60.50	
2 + 0	6.40	6.02	3.07	5.33	0.25	8.73	6.10	2.57	8.68	70.40	
2 + 1	6.54	6.09	3.11	5.40	0.26	7.76	6.39	2.69	9.08	70.40	
2 + 2	6.11	5.92	2.84	4.92	0.34	7.15	5.74	3.34	9.08	63.20	
Mean	5.41	4.82	2.45	4.25	0.25	6.60	5.26	3.04	8.29	62.10	
LSD(0.05)TM	0.178	0.088	0.119	0.206	0.03	0.662	0.208	0.109	0.222	5.26	
LSD(0.05)U	0.178	0.088	0.119	0.206	0.03	0.662	0.208	0.109	NS	NS	
(TM X U)	0.121	0.103	NS	NS	0.125	NS	0.724	NS	NS	NS	

Where TM is termite mound, U is urea, OC is organic carbon, OM is organic matter, TN is total nitrogen, AP is available phosphorus, TEB is total exchangeable bases, TEA is total exchangeable acidity, ECEC is effective cation exchange capacity and BS is base saturation.

Effect of TM and Urea on Plant Height, Number of Branches, Leaves and Number of Pods of groundnut

The effect of different rates of TM and urea on height, number of branches, number of leaves and number of pods of groundnut is depicted in figure 1. Results showed that these growth and yield parameters were significantly ($p < 0.05$) influenced by the application of TM and urea.

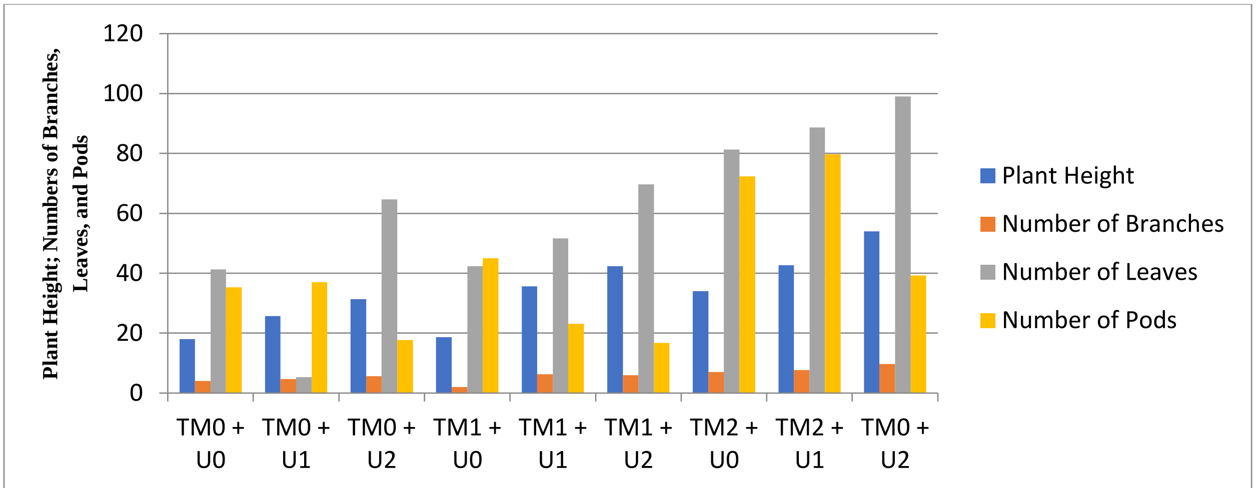

Figure 4.4.1: Effect of Termite Mound and Urea on Plant Height, Number of Branches, Number of Leaves and Number of Pods. TM = Termite Mound, U = Urea.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Soybean Production in a Varied Nigerian Soil, A Critical Review

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Abstract
Soybean growth is infuenced by climate and soil characteristics. It performs well in the southern and northern Guinea savannas of Nigeria where rainfall is more than 700 mm; soybean growth is influenced by climate and soil characteristics. Soybean is among the major industrial and food crops grown in every continent. The crop is known to be grown in virtually every state in Nigeria using low agricultural input. Soybean cultivation in Nigeria has expanded in the recent times as a result of its nutritive, economic importance and diverse domestic use. Though Soybean growth is greatly influenced by soil characteristics (different soil types), the time for planting soybean depends on the temperature and day length, and it is grown on a wide range of soils with pH ranging from 4.5 to 8.5. However, literatures have shown that Soybean should not be planted in sandy or shallow soils to avoid drought stress from increased temperatures (high evapotranspiration); it also should not be grown in waterlogged soils or soils with surface that can crust, The best soil for soybean cultivation is shown to be soils with high organic content and moisture content, and it important that the soil status of area to be used for planting soybean should be characterized before planting to guide fertilizer augmentations.
Keywords: **Nigerian soil, Production, Soybean**

Introduction

Soybean (*Glycine max* L. Merr.) is the world most important grain legume in terms of consumption, production and trade. Soybean stands out as the most popular grain legume in the world; it's frequently the most cultivated crops across a wide range of agro-geographical regions from China to Brazil and from Oceania to Canada and even in Nigeria, because of its nutritional, industrial and economic importance (Giller and Dashiell, 2007). Nigeria is the largest producers of soybean in Africa. Soybean was first introduced into Nigeria in 1908 (fennel, 1966). Its popularity is attributed to a number of factors related to its composition and productivity. Soybean has an average protein content of 40% and is richer in protein than any of the common vegetable or animal feed sources in Nigeria. Over the years, several species of legumes were screened and adopted for inclusion into the farming systems for soil fertility improvement and restoration, but none has received the expected acceptance and inclusion like soybean by the smallholder farmers as it meets the food, fodder and fertilizer needs of the farmers (Misiko, 2007). Soybean seeds also contain about 20% oil on a dry matter basis with 85% unsaturated fatty acid that is cholesterol-free (IITA, 2009). Soybean is a source of the most consumed edible oil and protein source for livestock feeds (Myaka F. A., Kirenga G., Malema B. 2005). Commercial production of soybean is concentrated in the Savanna ecology of Nigeria, particularly the southern Guinea Savanna, which comprises of Kaduna, Benue, Kwara and Kogi state. (Akande *et al*., 2007; Ojo *et al*., 2010), where low levels of phosphorus militate against its optimal yield. Soybean products are directly used for human consumption including soymilk, soya sauce, protein extracts and concentrates. Apart from nutritional qualities, soybean yield is higher than other common grain legumes, has relatively few field and storage pests and diseases and has a high nitrogen fixing ability. (Vanlauwe) B., Mukalama J., Abaidoo R., Sanginga N. 2003). Its cultivation is gaining interest in Africa following high demand from the booming livestock feed industry (which consumes about 70–80% of soybean produced per year) and need to improve nitrogen uptake by the crops which is obtained from biological nitrogen fixation.

Salvagiotti *et al*. (2008). Chianu *et al*. (2009), Mahasi *et al*. (2011). Reports dealing with soil fertility, in sub-Saharan Africa indicate an alarming negative nutrient balance (De Jagar *et al*., 1998, Roy *et al*., 2003). In respect with soil classification, the following varieties are distinguished: fluvisols; regosols; gleysols; acrisols; ferrazoles; alisols; lixisols; cambisols; luvisols; nitosols; arenosols; vertisols. The most fertile ones are the ferrazoles, which can be found in the dry northern territories and it's recommended for growing soybean. Improvement of farmers adoption of new technologies including acceptance of new high yielding varieties and for the purpose of making recommendation based on their knowledge, skills and experience, on-farm experiments are conducted (Saleh *et al*., 2004). This calls for preliminary studies of the status of the soil within such areas before research can be conducted. Cultivars are broadly grouped into three according to the number of days to maturity (early maturing), medium maturing and late maturing cultivars as shown in Table 1, which increases with increase in latitude, day light and cool conditions.

Agro-Ecologies, Soil Types and Soybean Production

The mangrove and coastal vegetation.

This is found in places near the coast that is under the influence of brackish water commonly found in the Niger Delta. Soil in the mangrove area is poorly aerated with water logged mud and is high in salt content due to the constant flooding by the sea. Mangrove soils are of marine alluvium, transported as sediments. With respect to crop production, the coastal swamp area is not widely cultivated except for swamp rice in places where they are stabilized and non-saline.

The fresh water swamp forest.

The fresh water swamp forest of the country under this agro ecological zone, are Ogun, Benin, Imo, Niger Delta and Cross River. The type of soil in this agro ecological zone is fertile alluvial soil. The high influx of water deposit vast quantities of silt, mud and sandy materials into this area. It is a low-lying region, with hardly any part rising over 30m above sea level, thus, it facilitates the development of freshwater swamps along the Niger Delta, drowned estuaries, lagoons and creeks. This zone consists of a mixture of trees. Important among the vegetation of this zone are the various Palm and Fibre plants such as *Raphia* spp., *Raphia vinifera*, the Wine Palm and *Raphia hookeri*, the Roof-mat Palm. They are used for thatching mats and for providing rafter, poles and stiff piassava fibre for the production of brooms. The better-drained areas support Oil Palm trees (*Eleais guineenais*) and big trees like Iroko (*Chlorophora exceisa*). Fishing and fibre-making are the important products of the fresh-water swamp communities.

The tropical high forest zone.

This area is characterized with a prolonged rainy season, resulting in high annual rainfall above 2000mm, thereby ensuring an adequate supply of water and promoting perennial tree growth. This luxuriant vegetation belt stretches from the western border of Nigeria to Benin Republic, through a narrow stretch on the Niger-Benue river system into the extensive area in the South-East of the country. This zone is the major source of timber for the large construction and furniture making industry. Of all the zones it contains the most valuable species of vegetation. However due to human activities, this one-time highly forested area has been drastically reduced. This zone therefore is very important in terms of food production and timber for construction and cabinet making. Oyenuga, V.A. (1967).

The derived guinea savanna

This zone is found immediately after the tropical rainforest zone. It is the transition between the tropical rainforest and guinea savannah zones. Due to bush burning, overgrazing, cultivation and hunting activities over a long period in the zone, the high forest trees were destroyed and the forest that used to exist is now replaced with a mixture of grasses and scattered trees. The zone is covered with scattered trees and tall grasses. Maize, Cassava, Yam and Rice are the major crops grown in this zone.

The guinea savanna.

The Guinea Savannah, located in the middle of the country, is the most extensive ecological zone in Nigeria, covering near half of the country. Guinea savannah zone has a unimodal rainfall distribution with the average annual temperature and rainfall of 27.3ºC and 1051.7mm respectively where the wet season lasts for 6–8 months F.A. Sowunmi and J. O. A kintola (2010). This zone consists of the larger part of the savannah zone and is sometimes divided into the Southern Guinea Savannah and Northern Guinea Savannah. It is the broadest vegetation zone in the country and it occupies almost half of its area. It extends from Ondo, Edo, Anambra and Enugu States in the South, through Oyo State to beyond Zaria in Kaduna State.

The Sahel savanna

This is the last ecological zoological zone with proximity to the fringes of the fast- encroaching Sahara desert in the northeast corner of Nigeria and is the last vegetation zone in the extreme northern part of the country, close to Lake Chad, where the dry season lasts for up to 9 months and the total average annual rainfall is hardly up to 700mm. Here the vegetation is not only sparse but the grasses are very short. As a rule this zone is not cultivated without irrigation.

Types of soil and classification

The soil covers approximately a third of the whole Earth's surface, with a thickness that ranges from tens of metres to a minimum of few centimetres, according to the intensity and duration of the rock changing processes. (Eniscoula). The factors that are responsible for soil formation create different types of soil in large geographic areas and inside small regions. The soil, in fact, is different in each area of the world: each area has its own climate, rocks and vegetation and, therefore, its own soil, with unique characteristics. There are many methods to classify the soil. They all aim at organizing the different types of soil according to determined criteria, based either on a paedogenesis factor or on another specific characteristic of the soil. Although there are many links between the different official classifications, it would be useful to have one international classification, which is valid for all countries. Among the main soil classifications, we can mention the American Agricultural Department classification (U.S.D.A.), F.A.O. (United Nations Organization for agriculture and food in the world), and U.N.E.S.C.O. (United Nations Organization for education, science and culture).

Soil classification in Nigeria

In accordance with the generally accepted classification, the following varieties are distinguished: fluvisols; regosols; gleysols; acrisols; ferrasols; alisols; lixisols; cambisols; luvisols; nitosols; arenosols; vertisols. About 48% of the soil are under 4 - 5 classes with insufficient moisture retention and low content of organic substances. The most fertile ones are the ferrazoles, which can be found in the dry northern territories. Northern zone sandy soils are formed as a result of droughts, wind impacts and sand that has undergone metamorphosis for a long time. This process began when the Sahara Desert advanced several kilometers to the south of the present border. This sandy soil is mostly found in Sokoto, Kano, Kaduna. Its lightness and looseness are well suited for planting crops. Leaching does not occur to a large extent on sandy soil, so it is ideal for growing soybean. In the south of Kaduna you will find soil formed from forest soil and granite as a result of the north wind. In fact, such mixtures are not sandy, they are loamy and perfect for cotton crop.

Development of improved soybean varieties and utilization technologies

The Malayan variety introduced to Nigeria was low yielding, susceptible to bacterial diseases and late maturing (Smith et al*.,* 1995). The latter characteristic exposes soybean to pod shattering due to the desiccating action of the seasonal Harmattan wind. Moreover, most soybean varieties could not nodulate in association with the native rhizobia indigenous to African soils and the seed quickly lost viability, which made it difficult for farmers to store it until the next cropping season (Dashiell et al., 1987). Over the last two decades, the International Institute of Tropical Agriculture (IITA) has made substantial efforts to improve the productivity of the crop by developing high yielding, early maturing varieties capable of nodulating in association with local rhizobia, and possessing other good agronomic traits (IITA, 1994). Improved soybean varieties released in Nigeria today, include TGx 849-313D, TGx 1019-2EN, TGx 1019-2EB, TGx 1447-2E, TGx 536- 02D, TGx 306-036C, TGx 1485-1ED, and TGx 1440-1E (IITA 1994); TGx1835-10E, TGx1904-6F, TGx 1987-62F and TGx1987-10F. Following the development and introduction of improved varieties, many food recipes using soybean were found to be highly acceptable to Nigerians, including their incorporation into traditional local dishes (Osho and Dashiell, 1998).

New improved varieties

In addition to improvement in agronomic traits to enhance production and consistency of production, soybean rust caused by the fungus *Phakopsora pachyrhizi* is increasingly becoming one of the most important constraints to soybean production. It has become a threat to soybean production in west, central, east and southern Africa. This foliar disease can cause 40-80% yield loss under African conditions (Tefera *et al*., 2009). IITA in collaboration with National Cereals Research Institute (NCRI) has developed resistant varieties for this disease. These varieties are high yielding, early maturing and suitable for cultivation in the rust endemic areas of Nigeria. There is need to rapidly develop improved varieties that are resistant or tolerant to biotic and abiotic stress such as rust, *cercospora* leaf spot soybean mosaic virus which are becoming production constrain in the new areas of soybean production in Nigeria

Research efforts on the improvement of soybean

In 1987, the International Institute of Tropical Agriculture (IITA), under the guidance of Principal Researcher Dr. Kenton Dashiell, launched an ambitious effort in Nigeria to combat widespread malnutrition. With support from the International Development Research Centre, IITA embarked on a project to encourage using nutritious, economical soybeans in everyday food. Soybeans are about 40% protein - more protein-rich than any of the common vegetable or animal food sources found in Africa. With the addition of maize, sorghum, wheat, rice, or any other cereal to soybeans, the resulting protein meets the standards of the United Nations Food and Agriculture Organization (FAO). Soybeans also contain about 20% oil, which is 85% unsaturated and cholesterol free. Few Nigerians knew about soybeans until the IITA initiative provided information on everything from their nutritional benefits to how to plant, harvest, store, and prepare them. Since then, soybean production and consumption has increased dramatically, improving nutrition particularly among the urban poor and middle income groups. Soybean-fortified products not only have more protein and minerals than their non-fortified counterparts, they are considerably cheaper than other sources of high-quality protein such as fish, meat, milk, and other protein-rich legumes. The cost of protein, when purchased as soybean, is only about 10-20% of the cost of protein from fish, meat, eggs, or milk. Many Nigerians now incorporate soybeans into their diets, and the Nigerian government has declared soybean production and utilization a national priority. Strict scientific standards were always observed in our research and development work, the objective was not to develop 100 new ways to use soybean. Rather, our goal was to find a few ways that it could be used every day in people's homes. This meant that participatory research methods were essential. We knew there were problems if we taught our target population how to cook 10 different soybean dishes and a week later none of the recipes were being used. This happened to us several times, but we didn't get discouraged. We would continue to interact with the people to understand why they didn't accept the new dishes. We considered a new recipe (or method) a success if 20 to 50 percent of the families were using it one week after it had been introduced. If this happened in several villages, then we started to have confidence in the method.

Conclusion

To improve the production of Soybean, with respect to the different soil types in Nigeria, it is advisable to cultivate soybean on the soil with high organic content in order to enable soybean to perform nitrogen fixation, there by establishing a symbiotic relationship with the bacterium Rhizobium japonicum in order to break down nitrogen gas from the atmosphere into ammonia which is a nitrogen product that has low availability in the soil. Soils with high content of clay are not a desirable environment to grow soybean. Soybean is grown successfully under the region with high temperature. Commercial production of soybean is concentrated in the Savanna ecology of Nigeria, particularly the southern Guinea Savanna (Akande *et al*., 2007; Ojo *et al*., 2010); where low levels of phosphorus militate against its optimal yield.

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Table 1. Recommended varieties for planting in Nigeria

Early 80-95 days	Medium 95-125 days	Late 126-145 days
TGx1485-1D	Samsoy-1	TGX923-2E
TGx1019-2EB	Samsoy-2	
TGx1835 – 10E for rust endemic areas.	TGx1448 -2E	
TGx1987-10F for rust endemic areas.	TGX1440-1E	
TGx1987-62F for rust endemic areas.	TGX1904-6F	
NCRI SOY 1E	TGX1951-3F	
NCRI SOY 2E		

Adopted from a presentation in a seminar on Good Agricultural Practices, Soybean Varieties and Maximum Yield held in NCRI. By Dr. A.B Umar and Shaahu A.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Symbiotic Effectiveness of some Nigerian Indigenous Rhizobia rhizobia strains on Samnut 24 Groundnut (*arachis hypogaea* l.) Genotype

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Abstract
Seven rhizobia isolates from root nodules of uninoculated groundnut plants in the Nigerian savanna were tested for symbiotic effectiveness on SAMNUT 24. The treatments were the isolates (GWA 194, KBU 026, MJR 530, SBG 234, SNN 343, TDW 411, TDW 414), uninoculated, positive N and a commercial inoculant strain (NC 92) as controls. These were replicated five times in a Randomized Complete Block Design (RCBD). The plants were grown under axenic N-free conditions for six weeks. Nodulation, number of flowers, shoot dry matter and N uptake of the plants were assessed. The results showed significant differences ($P < 0.01$) among the treatments in shoot dry matter and number of flowers, with R^2 values of 0.77 and 0.78, respectively. Strong positive correlation was also observed between shoot dry matter and N uptake of the plants ($R^2 = 0.94$). Indigenous rhizobia isolates SNN 343, KBU 026 and SBG 234 were most effective, having similar performance to the positive N control and NC 92, as indicated by higher shoot dry matter (55, 51, 50% higher than the uninoculated control, respectively), number of flowers and N uptake of the plants. These were followed closely by TDW 411. The rest of the isolates were next in effectiveness in the order MJR 530 > TDW 414 > GWA 194. The findings indicate hope for obtaining efficient local inoculant isolates for groundnut in Nigerian savanna.

Keywords: Groundnut, Indigenous rhizobia, N_2 fixation, Symbiosis, nitrogen

Introduction

Nitrogen (N) is the most limiting nutrient for crop production (Cummings, 2005; Gohari and Niyaki, 2010). Legumes generally require a large amount of N to produce high seed yields, because of the high protein content of their seeds (Unkovich *et al*., 2008). Mineral N-fertilizers used to supplement soil N, on the other hand, are costly, require special management strategies due to their tendency to be easily loss through processes such as leaching and volatilization (Sanginga, 2003; Yakubu *et al*., 2010). They also have a tendency to acidify the soil over time and contaminate the environment (Rao *et al*., 2014). However, leguminous plants are special for their possession of unique ability to establish symbiosis with root nodule (nodule) fixing bacteria of different genera and species (O'Hara *et al*., 2016). Their best known feature is the ability for these bacteria, collectively known as rhizobia, which invade and colonise their roots (rarely stems), forming specialized organs known as nodules (Sprent *et al*., 2013; Moróti and Kondorosi, 2014; Peix *et al*., 2015). Within the nodule, the bacteria (in form of bacteroids) reduce ("fix") atmospheric nitrogen (N_2) to ammonia (NH_3) that is directly assimilated into organic compounds such as amino acids, nucleotides and other vital organic compounds for *in situ* growth and development of the host plant (Sprent *et al*., 2013). The N_2 fixation through symbiotic association between legumes and root nodule bacteria (rhizobia) is a cheaper and environment friendly option to provide N to the crops, compared to mineral N fertilization (Nelson, 2004; Yakubu *et al.*, 2010; Rao, 2014). Therefore, inoculation of legumes with effective rhizobia is a well-established farming practice (Peix *et al*., 2015) as an alternative to the popular Herber Bosch process of forming N fertilizers, requires input of finite fossil fuel, relatively costly and leads to many environmental disadvantages (Rao, 2014). Legume inoculants are produced from effective rhizobia isolates from centres of origin of the host legumes. These are usually tested using glasshouse techniques in comparison with mineral N fertilization, uninoculated control and a standard reference strain, to arrive at the most promising candidate isolates (Woomer *et al*., 2010; Tiwari *et al*., 2012; Waswa *et al*., 2014). These are subsequently subjected to testing under target field conditions using the host legume for confirmation (Yates *et al*., 2016; Howieson *et al*., 2016). This study is therefore, designed with the objective of testing the effectiveness of some rhizobia isolated from groundnut plants in the Nigerian savanna on SAMNUT 24, in search for candidate inoculant isolates for the region.

Materials and Methods

Treatments and experimental design: The rhizobia tested for effectiveness in symbiotic N_2 fixation were isolated from root nodules of uninoculated groundnut plants growing in the Nigerian Northern Guinea and Sudan savannas by Abdullahi (2018). They were tested under axenic N-free conditions in the glasshouse. The treatments include; seven isolates (GWA 194, KBU 026, MJR 530, SBG 234, SNN 343, TDW 411, TDW 414), uninoculated control (devoid of any source of N), positive N control (1.0 mmoles N, applied weekly as KNO_3) and a standard commercial rhizobia strain (NC 92). The treatments were arranged in a Randomized Complete Block Design (RCBD), replicated five times using 10 kg pots. A commercial groundnut genotype; SAMNUT 24 obtained from the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria was used as the test crop.

Seed surface sterilization and sowing: The seeds were surface sterilized by immersing for 10 seconds in 70% (v/v) ethanol, then three minutes in 3% (v/v) hydrogen peroxide, followed six rinses of sterile deionized (DI) water. They were then pre-germinated for three days in moist paper towel placed in a sterile lunch box at 28^{o}C. Four of the pre-germinated seeds were aseptically sown into 5 cm deep holes in the pots. The plants were later thinned to two plants per pot at two weeks after sowing (WAS).

Inoculant preparation and seed inoculation: The isolates were grown from stocks of 20% glycerol at -80^{o}C on Yeast mannitol agar (YMA) media (Vincent, 1970) for seven days at 28^{o}C. Inoculants for each of the isolates was aseptically prepared by wiping pure single colonies of each strain from the plates into 25 ml of sterile 1% (w/v) sucrose solution. The optical density of the inoculants was measured at 600 nm, using spectrophotometer, and adjusted to Optical density (OD) 1 (1×10^9 rhizobia cells) to ensure uniformity in rhizobia population of each inoculant. These were stored at 4^{o}C prior to application. For the inoculated treatments, one millilitere of the relevant inoculant was drenched to each seed at sowing, while one millilitre of sterile DI water was applied to each seed in the uninoculated control and the positive N control pots.

Plant growth conditions: The plants were grown in 10 kg free draining pots, lined with absorbent paper, containing a mixture of 1:1 ratio of steam sterile coarse lawn and yellow N free sands. The pots were further flushed twice with hot, sterile DI water to leach out any trace of inorganic N and keep the soil moist, prior to sowing. Sterile polyvinyl chloride tubes (25 cm in diameter) were then inserted into the sand mixture for supply of DI water and nutrients. The surface of the soils in the pots were covered with alkathene beads at sowing. Centre for Rhizobium Studies (CRS) nutrient solution as described by Howieson *et al*. (1995) was uniformly applied to the plants throughout the experiment, based on growth requirements. The plants were grown at 28/20^{o}C day/night temperature.

Harvest and data collection: The plants were harvested at six weeks after sowing (WAS). The sand was carefully washed from the roots to assess the nodulation of the plants. The number of flowers were recorded. The plant shoots were oven dried at 60^{o}C to a constant weight and weighed. Nitrogen concentration in the plant shoots was determined using LECO TruMac N combustion N determiner (LECO, FP 528) and N uptake was calculated.

Statistical analyses: Analysis of variance (ANOVA) was conducted on the shoot dry matter and number of flowers. Where F values were significant, the means were separated using Tukey HSD. Correlation analysis were conducted between the shoot dry matter and N uptake plant^{-1}. The ANOVA was conducted using IBM SPSS Statistics 20, while the correlation and regression were conducted using Microsoft Excel 2013.

Results and Discussion

The inoculated plants were well nodulated, while the uninoculated and positive N control plants were devoid of nodules. The effect of the treatments on shoot dry matter of SAMNUT 24 is shown in Figure 1. There was significant ($P < 0.01$) difference among the treatments in influencing the shoot dry matter of the plants with high R^2 value of 0.77. The plants inoculated with the positive N and those inoculated with SNN 343, KBU 026, SBG 234 and NC 92 gave similar and significantly higher shoot dry matter of 55, 51, 50 and 49% higher than the uninoculated control. Even though, they were similar to those inoculated with those inoculated with TDW

411 (45%), MJR 530 (42%) and TDW 414 (42%) higher than the uninoculated. They were statistically similar in influencing the shoot dry matter and higher than the rest of the treatments (GWA 194 and the uninoculated control), which were similar and lowest in influencing the shoot dry matter of the plants. Similarly, there was significant ($P < 0.01$) difference among the treatments in affecting the number of flowers of the plants (Figure 2). The isolates SNN 343, KBU 026, SBG 234 and TDW 411 gave the higher number of flowers than all other treatments. The next in influencing the number of flowers were the positive N control, NC 92, MJR 530 and TDW 414, which were similar to each other and higher the all other treatments (positive N control, GWA 194 and the uninoculated control). Even though, the positive N control and GWA 194 gave similar number of flowers and higher than and the uninoculated control which recorded the lowest number of flowers. Significant positive correlation was observed between the shoot dry matter and N uptake of SAMNUT 24 on inoculation with the indigenous rhizobia isolates and high R^2 value as shown in Figures 3.

The differences among the indigenous rhizobia isolates in shoot dry matter and number of flowers are indicators of variation in effectiveness among the isolates even though inoculated to the same groundnut genotype. This could be attributed to higher symbiotic efficiency of some of the isolates over others. The more effective isolates could have been able to form root nodules earlier than the others on the tap root of the plant, an indication of early nodulation, leading to larger nodules, which corresponds with higher nodule dry matter, effectiveness in N_2 fixation and influence on the plants' development as reported by Cardoso *et al*. (2009). The strong positive correlation between shoot dry matter and N uptake of the plants indicates the observed effects to be due to N uptake due to N_2 fixation. Shoot dry matter of plants harvested at floral initiation or after significant plant biomass accumulation is the accepted criteria for assessing N_2 fixing effectiveness among rhizobia isolates under glasshouse conditions (Somasegaran and Hoben, 1985; 1994; Machido *et al*., 2011; Yates *et al*., 2016). Brockwell and Bottomly (1995), similarly identified dry matter production as an important index of inoculant performance, even though the authors also indicated the importance of other indices such as total amount of N fixed and the proportion of plant N due to N_2 fixation. Similarly, the observed variation in the influence of the indigenous rhizobia isolates on flower development of the plants is an indicator of a corresponding influence on the yield of the plants, being a key reproductive organ. This could possibly be due to higher N accumulation of the plants inoculated with the more effective over the less effective isolates as a result of higher N_2 fixation. Nitrogen is known as the most important nutrient for crop growth and yield, constituting a major limiting nutrient to global crop production (Date, 2000; Cummings, 2005; Gohari and Niyaki, 2010) and the main element in many important processes in plant metabolism, such as chlorophyll synthesis (Gohari and Niyaki, 2010; Gopalakrishnan *et al*., 2015). The N fixed by symbiotic association is directly assimilated into organic compounds such as amino acids, nucleotides, deoxy rhibonucleic acid (DNA) (Sprent *et al*., 2013). Hence, it plays a key role in metabolic reactions responsible for the observed increase in vegetative and reproductive growth of the plants in this study (Latif *et al*., 2014). Several authors, such as Elkan and Stowers (1990) and Cardoso *et al*., (2009) observed similar differences among rhizobia isolates inoculated to groundnut genotypes in these and similar parameters The findings indicate the existence of useful variation in the natural pool of rhizobia extant to the Northern Guinea and Sudan savannas of Nigeria, a glad tiding for obtaining competent local inoculant isolates for the region from its pool of rhizobia of different desired characteristics (O'Hara *et al*., 2002). Rhizobia isolates from root nodules of dark green vigorously growing, uninoculated legume plants in target area of their application have been reported to yield effective isolates for local inoculant production (Tiwari *et al*., 2012; Woomer, 2013). In addition, the isolates are usually adapted to the edaphic and soil conditions of the environment, having higher competitive ability and saprophytic survival in the intended soils (Woomer *et al*., 1988; Babalola *et al*., 2012). Hence, the achievement of significant economic and ecological benefits (Machido *et al*., 2011; Nievas *et al*., 2012). Abdullahi and Yusuf (2017), observed higher effectiveness of extant indigenous rhizobia isolates over foreign introduced rhizobia strains (AMO1 and CB756) in the Northern Guinea savanna of Nigeria an indication of hope for obtaining local inoculant isolates from within.

Conclusion

Indigenous rhizobia isolates KBU 026, SNN 343 and SBG 234 were most effective in N_2 fixation with SAMNUT 24, which are close to the performance of the positive N control and more effective than NC 92 in influencing N uptake and subsequently shoot dry matter and number of flowers of the plants. These were followed closely by TDW 411. The rest of the isolates were next in effectiveness in the order MJR 530 > TDW 414 > GWA 194. The findings indicate promise for obtaining efficient local inoculant isolates for groundnut in the Nigerian savanna.

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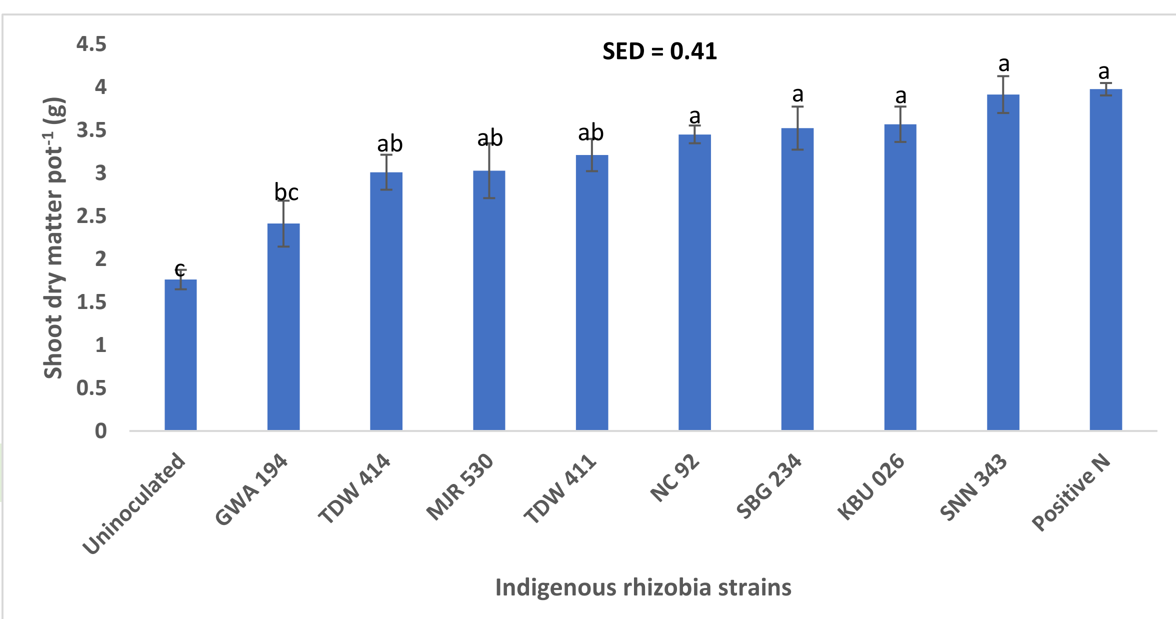

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Figure 1. Shoot dry matter of SAMNUT 24 on inoculation with indigenous rhizobia isolates. Vertical bars represent standard error (SE±), SED = Standard Error Difference. Means bars with the same letter are statistically similar.

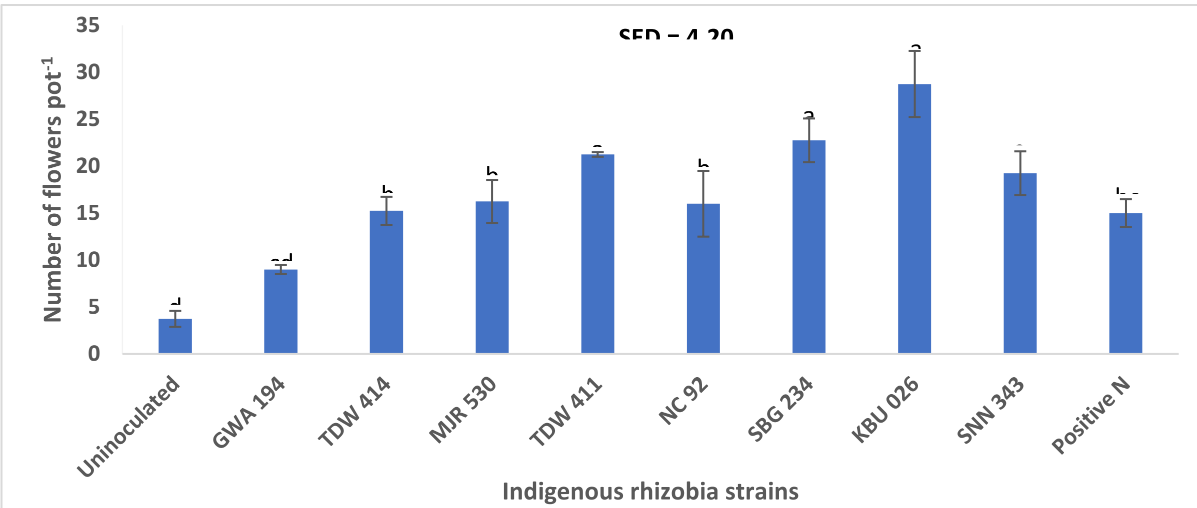

Figure 2. Number of flowers of SAMNUT 24 on inoculation with indigenous rhizobia isolates. Vertical bars represent standard error (SE±). SED = Standard Error Difference, bars with the same letter are statistically similar.

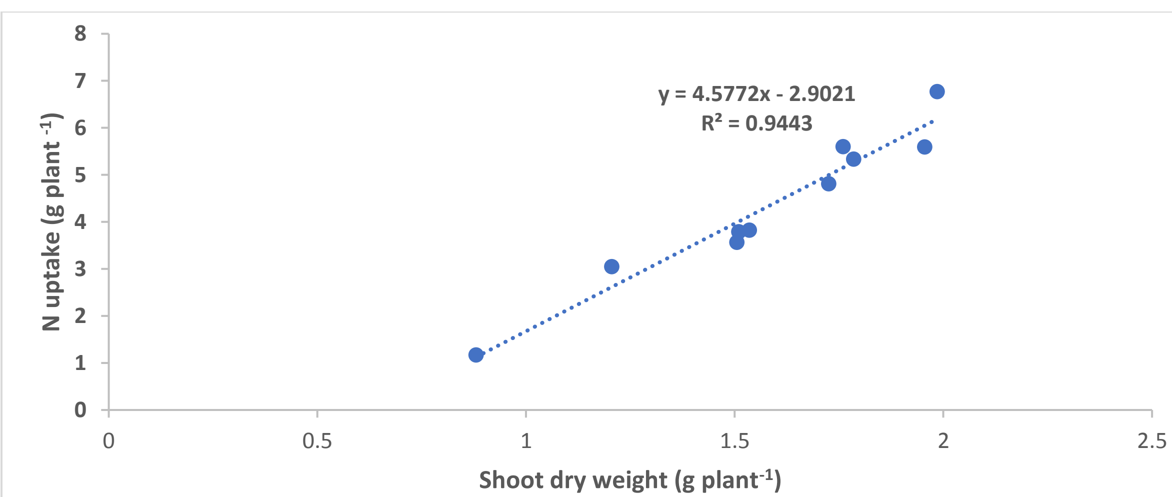

Figure 3. Strong positive correlation between shoot dry matter and N uptake of SAMNUT 24 on inoculation with the indigenous rhizobia isolates.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Tillering Dynamics of Rice under Elevated CO_2 Condition

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Abstract

An investigation was carried out to study the effect of elevated CO_2 on tillering window of rice. The experiment was conducted under ambient and elevated CO_2 condition using rice cv. CO (Coimbatore) 51 during *kharif* 2018 at Tamil Nadu Agricultural University, Tamil Nadu, India. At ambient field condition, 400±9 μmol mol^{-1} was the normal CO_2 and the open top chamber was maintained with higher level of CO_2 of 550 μmol mol^{-1} throughout the crop growth period. Tillering dynamics of plant was highly varied under elevated CO_2 condition. The production of tillers reached its peak around 60 days after transplantation, and then it was reduced. Maximum number of tillers varied from 13 to 21 per plant under elevated CO_2 and ambient condition. The reduction of 38 per cent was observed in total number of tillers plant^{-1} under elevated CO_2 condition. The maximum primary tillers per plant was recorded under ambient field condition compared to elevated CO_2 at the same time there were no tertiary tillers observed under elevated CO_2 condition.

Introduction

The global climate change due to the increase in greenhouse gases, especially the carbon dioxide (CO_2), has a direct or indirect effect on sustainable agriculture and food production. The CO_2 level was maintained up to a level below 300 μmol mol^{-1} before the beginning of industrial revolution. The industrialization changed the condition by rising global annual mean of CO_2 to reach the current level of 400 μmol mol^{-1}. The intergovernmental panel on climate change (IPCC) suggests that there will be a rise of atmospheric CO_2 to a concentration of 550 μmol mol^{-1} by 2050 due to the anthropogenic emission of greenhouse gases (IPCC 2014). Rice is a staple cereal which feeds more than half of the population at a global level. Being a C_3 crop, rice has the potential to increase the photosynthesis rate in elevated CO_2 eventually leading to better yield. But the increase in temperature associated with the increased CO_2 is leading to difficult results altering the plant growth and development. So, the combined stresses reported having a negative impact on rice yields (Jena *et al*., 2018). The increased temperature under elevated carbon dioxide (eCO_2) also found to have effects on the plant growth and development in rice (Lamichaney *et al*., 2019).

Panicle production mainly depends upon the tillering of rice plant which affects the total yield. The changing environmental condition leads to change the response of rice varieties to tiller production and its plasticity. Environmental factor plays a key role tiller production depends on the resource available for plant growth and development (Dun *et al*., 2006). Rice tiller production is response to elevated CO_2 concentration and temperatures during plant growth is based on genotypic variation in the biomass. Both the production of new tillers and the growth of individual tillers by any genotype may decrease under resource constraints or environmental stress. So, this experiment was to examine the response of elevated CO_2 on tiller production.

Materials and Methods

The field experiments were carried out in open top Chamber (OTC) with elevated CO_2 and ambient condition, established at field number A1 of wetland Farm, Department of Farm Management, Tamil Nadu Agricultural University, Coimbatore. The air enriched CO_2 is distributed through a circular tube and the uniform distribution of the carbon dioxide within the chamber was ensured by air blowers. The CO_2 analyzer established in the OTC measures the concentration of carbon dioxide within and the computer regulated inlet valves will control the flow of the gas. The recommended cultivation practices for rice seed production were adopted uniformly in both the conditions. To study the effect of elevated CO_2 on tiller production, the seeds of rice variety CO 51 were sown in a nursery bed and the seedlings were transplanted after 20 days in the open top chamber with elevated CO_2 and in ambient condition. The field trial was laid out in Randomized Block Design.

The details of the treatments are as follows; E_1 -Ambient condition (400±9 CO_2), E_2 -Open Top Chamber + Ambient CO_2 (400±9 CO_2) and E_3 -Open Top Chamber + Elevated CO_2 (550 µmol mol^{-1}). The following observations were recorded at three stages of crop growth and development viz., i) Active tillering stage (24 to 42 DAT), ii) Heading stage (55 to 60 DAT) and iii) Grain filling stage (80 to 85 DAT) in the plants raised in the open top chamber as well as under ambient conditions. A total number of tillers, primary, secondary and tertiary tillers of 50 plants were counted and recorded at three stages of crop growth and development.

Result and Discussion

The elevated carbon dioxide and associated temperature rise found to have a great influence in the growth of the plant. Even though the increase in CO_2 can positively influence the tillering ability by varying the source sink traits (Fabre et al., 2019), there was a negative impact visible in this experiment. The reason could be the associated temperature stress which reduced the tillering capacity (Fahad *et al.,* 2019). The variation in the total number of tillers was significant due to different environmental conditions at tillering, heading and grain filling stages. Among the environmental conditions, a higher number of tillers (21) were recorded in ambient condition followed by OTC+ambient CO_2 (15) and the lowest in OTC+elevated CO_2 (13) (Fig. 1a). Elevated CO_2 had resulted in 38 % reduction in total number of tiller per plant followed by OTC+ambient CO_2 when compared to ambient condition (Fig. 1a).

Tillering is an *important* agronomic trait for *rice* population, yield, seed quality, and grain *production.* Plants grown under elevated CO_2 exhibited a low number of tiller production $plant^{-1}$. The prominent morphological change evident in the plants grown under elevated CO_2 was decreased tiller production and seed yield when compared to plants grown under ambient condition. Plants grown under elevated CO_2 associated with high temperature exhibited a low number of tiller production $plant^{-1}$. This result is in agreement with Mitra and Bhatia (2008) who reported that the reduction in number of tillers in rice cultivar in response to elevated CO_2 associated with high-temperature stress. Geethalakshmi *et al*. (2007) reported that doubling of CO_2 concentration alone markedly enhanced crop dry matter production; however, increase in CO_2 concentration coupled with increase in temperature resulted in reduction of panicle dry weight and grain yield. The reduction in straw yield under modified environmental condition might be due to reduction in the number of tillers and dry matter production.

The primary, secondary and tertiary tillers per plant showed highly significant differences in ambient and elevated CO_2 condition. The result revealed that lowest number of primary tillers per plant was recorded in elevated CO_2. Among the environmental conditions, the highest number of primary tillers was recorded in ambient condition. Maximum number of secondary and tertiary tillers was observed under ambient condition followed by OTC+ambient CO_2. Under elevated CO_2 condition, there was no tertiary tillers production.

Conclusion

The elevated carbon dioxide has a negative impact on tillering mainly due to the rise of temperature with the increase in CO_2 concentrations. This will induce the oxidative stress mainly due to reactive oxygen species (ROS) production. Lower grain and straw yields under elevated CO_2 condition could be due to lesser number of tillers. Elevated temperature would nullify the enhanced CO_2 positive effect on rice growth and yield, and negatively impact the crop productivity. Global warming is likely to cause increasing environmental stresses, making it necessary to favor tillering plasticity that allow the plants to respond to a changing climate.

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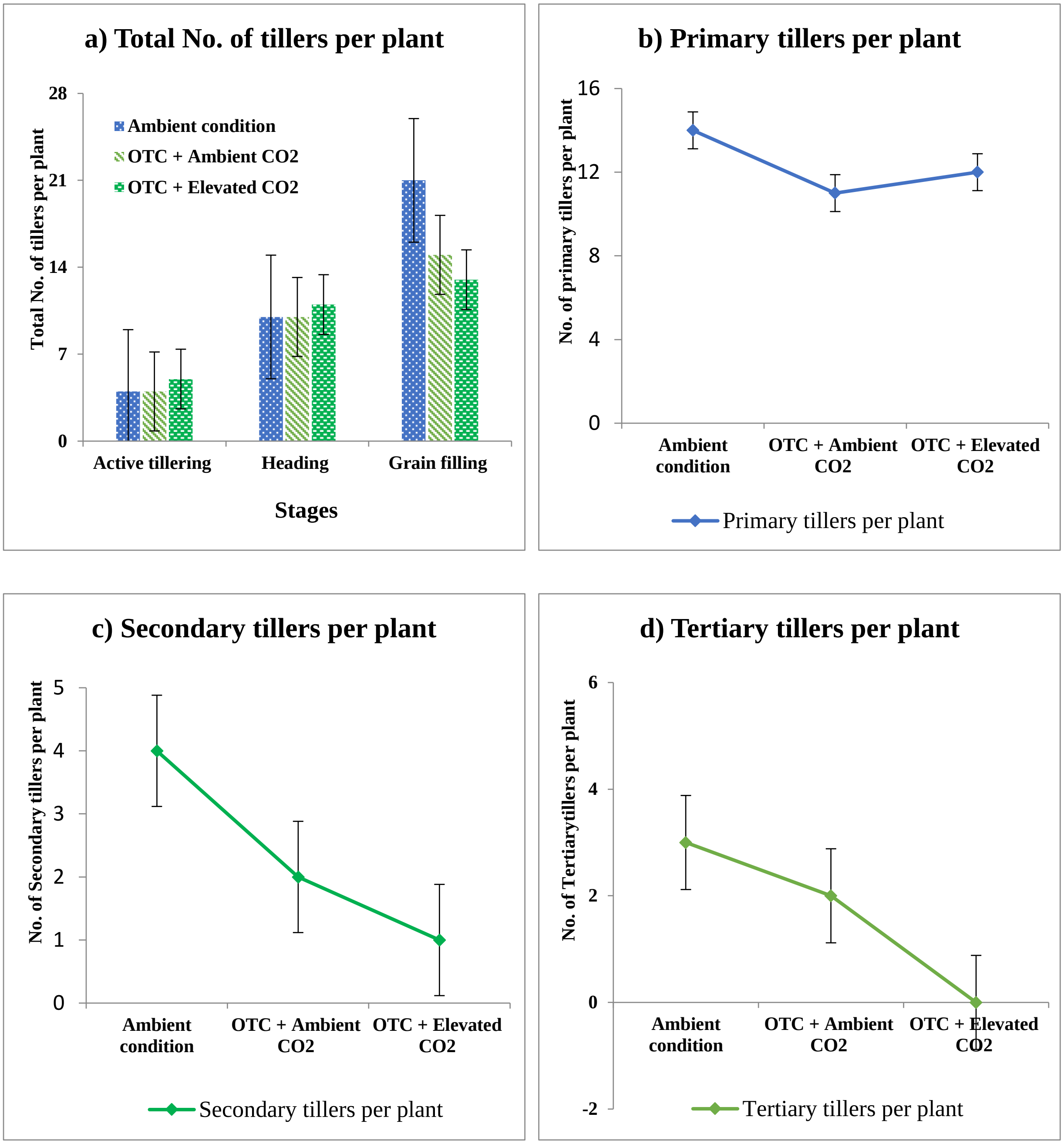
Table 1. Variations in the weather parameters during the period of field experiment

Month and year	Relative humidity (%)		Wind speed (km hr^{-1})	Rain fall (mm)	Sun shine hours
	Morn.	Even.			
June, 2018	84	67	10.5	1.80	4.1
July, 2018	84	64	11.5	2.30	4.4
Aug, 2018	85	64	9.9	1.90	4.4
Sep, 2018	87	53	5.6	3.90	7.9

Fig. 1. Effect of elevated CO_2 on (a) total number of tillers plant^{-1} (b) primary tillers plant^{-1} (c) secondary tillers plant^{-1} and (d) tertiary tillers plant^{-1} of rice cv. CO 51

Total number of tillers plant^{-1} and number of tillers plant^{-1} (Mean ± SE, n = 4) of different treatments (E) (E_1- Ambient condition, E_2- Open Top Chamber (OTC) + Ambient CO_2, E_3- Open Top Chamber (OTC) + Elevated CO_2. The analysis of



variance was carried out and comparison was done by Duncan's multiple range test (DMRT) at 5% level of significance.

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Yield and Yield Component of Tomato as Influenced By NPK Fertilizer and Farm Yard Manure Rate in the Nigerian Savannah

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Abstract
Field experiment were conducted in 2017/18 dry seasons at Research Farm of the Institute for Agricultural Research, Samaru and Irrigation research station Kadawa to study the yield and yield component of tomato to NPK fertilizer and farmyard manure rates. The treatments consisted four rate of NPK 15-15-15 fertilizer (0, 200, 400 and 600 kg ha^{-1}) and four farmyard manure rates (0, 4, 8 and 12 t ha^{-1}) which were factorially combined and laid in a Randomized Complete Block Design (RCBD) with three replications. Parameters measured include fruit diameter, number of fruit per plant, average fruit weight, and fruit yield. Yield and yield components of tomato showed significant increase as compared to the untreated control, and the highest obtained when 600 kg ha^{-1} of NPK fertilizer for tomato. Farmyard manure application at 8 t ha^{-1} resulted to significant increase in growth parameters and yield attributes such as fruit weight per plant, and fruit yield in both locations. Based on the result obtained in this study, farmers in the savanna can adopt the application of 600 kg ha^{-1} NPK fertilizer and 8.0 t ha^{-1} of farmyard manure which gave the maximum yield.
Keywords: NPK fertilizer, farmyard manure, Tomato

Introduction

Tomato (*Lycopersicon lycorpersicum* L.) belongs to the family *Solanaceae*. The family also includes other important vegetable crops such as potato (*Solanum tuberosum* L.), pepper (*Capsicum spp*. L.), eggplant (*Solanum melongena* L.) and tobacco (*Nicotiana tabacum* L). It is believed to have its origin in the Andes area of South America in the area now cover by Bolivia, Ecuador, Colombia, and Peru.

Tomato (*Lycopersicon lycorpersicum*L.) is one of the stable vegetables in Nigeria and is rich source of vitamins A, B and C with acidic properties that bring out other flavor (Rakesh and Adarsh, 2010).Tomato is one of the main vegetable crops and is the highest valuehorticultural crop (Nuez, Llacer, and Ruiz 2002).In the recent decades the consumption of tomatoes has been associated with prevention of several diseases (Wilcox *et al.,* 2003) mainly due to its content of antioxidants including carotenes, (Lycopene and β-carotene), ascorbic acid and phenolic compounds.

The world production of tomatoin 2017 was 182,301,395 metric tonnes with China leading with 59,626,900 metric tonnes followed by USA recording 10,910,990 metric tonnes. Africa produced 21,486,541 metric tonnes of world production and Nigeria is the fourth in Africa and leads in West Africa sub region with an estimated output of 4,100,000 metric tonnes (FAO, 2017).

Tomato is grown in most parts of Nigeria, and it by far dominates the largest area under production among vegetable crops (Ramalan *et al.,* 1998). Its major area of production is the less humid Northern Savanna zones where the low humid reduces the incidence of tomato disease. In this zone, it is grown during both rainy and dry seasons. The best period of production however, is the dry season when the weather is relatively cooler and the incidence of pest and disease are minimal. Dry season growing, however, has to be fully supported by irrigation (Anon, 2000).

Materials and Methods

Field experiment was conducted at two locations during the 2017-2018 dry seasons at the Research farm of Institute for Agricultural Research, Samaru ($11^0$11'N, $07^0$38'E, 686m above sea level) in the Northern Guinea Savanna and at Irrigation Research Station Kadawa ($11^0$39',$08^0$02'E, 500m above sea level) in the Sudan savanna agro ecological zone of Nigeria. The soils of the experimental fields were collected randomly from three points at the depth of 0-30cm prior to land preparation for laboratory analysis on soil physiochemical properties. The experiment consisted of factorial combinations of four levels of NPK 15:15:15 fertilizer (0, 200, 400, and 600 kg ha^{-1}) and four rates of farmyard manure (0, 4, 8, 12 t ha^{-1}) laid in a randomized complete block (RCBD) and replicated three times. Data was collected on fruit diameter, number of fruit, average fruit weight, and total fruit yield. Metrological data were also collected from the two locations. The data collected were subjected to statistical analysis of variance (F-test) as described by Snedecor and Cochran (1967) to test significance of treatment effects. The treatment means were compared using the Duncan's Multiple Range (DMR) test (Duncan, 1955).

For this experiment, UC82-B varieties were used, which is a semi determinant, short or medium in height with few numbers of branches. It matures in 60-70 days with potential yield of about 35 ton ha^{-1}. The fruits are medium – small in size, round and red. It is a processing type with excellent storability when harvested green, less heat tolerant and resistant to cracking.

RESULTS

The analytical results of the soil before transplanting at the experimental sites are shown in Table 1. The soil at Samaru was loam and slightly acidic 6.01. The soil nutrient status total nitrogen which is low, 3.70mg $kg^{-1}$of available phosphorus (low) and K was 0.18 Cmol kg^{-1}. At Kadawa, the soil was characterized as loam and slightly acidic 6.14, total nitrogen 1.10 g kg^{-1} (low), available phosphorus 5.5mg kg^{-1}(low),potassium 0.14 Cmol kg^{-1}.

At both locations, fruit diameter was significantly influenced by NPK fertilizer application (Table 2). In both location, application of 600 kg ha^{-1} produced fruits with the widest diameter than the lower applied rates, though at par with that of 400 kg NPK ha^{-1} at Kadawa. The control had the least value for fruit diameter in both locations.

Application of farmyard manure significantly influenced fruit diameter at both locations. The highest FYM rate of 12 t ha^{-1} gave the largest fruit size statistically similar to that of 8 t ha^{-1} FYM. The least fruit size was generally from the control. The interaction between the factors on fruits diameter during the period of study was not significant in both locations.

The number of fruits per plant increased with increase in NPK fertilizer applied rate at both locations (Table 2). At Samaru, applied 600 kg ha^{-1} NPK fertilizer significantly resulted to more number of fruits per plant than the lower rates, however, 200 and 400 kg were statistically similar. While at Kadawa, application of 600 kg ha^{-1} NPK fertilizer significantly resulted to more number of fruits per plant than the lower rates applied, although 400 and 600 kg ha^{-1} were similar. However, 200 kg ha^{-1} is similar to control treatment.

Varying farmyard manure rate significantly increased number of fruits per plant at both location. At both locations, application of 12 t ha^{-1} of farmyard manure resulted in significant more number of fruits per plant than the lower rates applied, however 0, 4, and 8 t ha^{-1} were similar. Although at Samaru, 8 and 12 t ha^{-1} were at par. The interaction between the factors on number of fruits per plant during the period of study was not significant in both locations.

The significant influence of treatment on average fruit weight at both location is presented on Table 3. At both location, application of NPK fertilizer at 600 kg ha^{-1} produced significantly heavier weight per fruit than the lower rates applied. In both location, fruit yield per plant recorded by 200 and 400 kg ha^{-1} NPK are statistically similar. Likewise, the difference in fruit yield between 0, 200 and 400 kg ha^{-1} NPK in Kadawa was also statistically similar. The control consistently had the least values for fruit weight per plant.

Farmyard manure application significant influenced weight per fruit at both locations. In both locations, application of 12 t ha^{-1} farmyard manure produced the heavier fruits weight per plant that was at par with that of 8 t ha^{-1} only in Samaru. There was no significant difference between 4 and 8 t ha^{-1} farmyard manure as well as between 0 and 4 t ha-1 farmyard manure in both locations. Plot that did not receive FYM had the least values for fruit weight per plant in both locations. None of the factor interaction on fruit weight per plant was significant in each of the locations.

Application of NPK fertilizer and farmyard manure significantly influenced total fruit yield ha^{-1} at both locations (Table 3). In both location, application of 600 kg ha^{-1} produced significantly higher total fruit yield ha^{-1} than the lower applied rates while the control had the least value. However at Samaru and Kadawa yield from application, 200 and 400 kg ha^{-1} NPK were similar so also were 0, 200 and 400 kg ha^{-1} NPK in Kadawa only.

Application of farmyard manure significantly influenced total fruit yield ha^{-1} at both locations. At Samaru and Kadawa application of 8 and 12 t ha^{-1} farmyard manure had resulted to statistically similar and higher than for lower rates. Also the difference in yield between 0 and 4 t ha^{-1} in both location and as well as that between 4 and 8 t ha^{-1} farmyard manure in Kadawa only were not significant. The least value for fruit yield was from plots that did not receive FYM.

Discussion

The highest values for yield and yield attributes at the highest NPK rate of 600 kg ha^{-1} also revealed the fact that higher values could be obtained at higher NPK rate. This is in line with the findings of Manoj kumar *et al.,* (2013) who reported revealed that the tallest plants and highest value for yield and yield attributing characters of tomato were recorded with the application of 100% NPK i.e.180 kg N/ha along with 80 kg P/ha and 75 kg K/ha. The low inherent soil fertility of experimental field could be another reason for positive response of the crop to applied NPK fertilizer. Significant improvement of such tomato plant characters such as average fruit weight, fruit diameter and total yield as a result of application of farmyard manure is expected due to low soil fertility statues of the two experimental sited. It could also be attributed to the fact that manures contain organic matter, macro nutrients, essential micro nutrients, growth promoting factors like IAA, GA and beneficial microorganisms, which are essential for proper growth and yield (Sreenivasa *et al*., 2010). Optimum value of these parameters either in both or one of the locations were attained at 8 t ha^{-1} FYM indicating the requirements of these parameters being satisfy at that rate. Further increase in farmyard manure up to 12 t ha^{-1} only increased fruit diameter and fruit weight only in Kadawa, thus indicating probability of achieving higher values for these parameters at higher rates. This findings, is in agreement with the findings of Ahmed et al (2014) who reported that application farmyard manure (FYM) at 20 t ha^{-1} significantly increased the growth of carrot (*Daucus Carota* L.).

Significant NPK fertilizer by farmyard manure interaction on height of tomato confirms the importance and synergistic benefit of the combined application of NPK fertilizer and Farmyard manure in crop growth and development. The results showed that the combination of 600 kg ha^{-1} NPK fertilizer and 8.0 t ha^{-1} of farmyard manure resulted in the highest values for this parameter. Ayoola and Adeniyan (2006) reported that nutrients from mineral fertilizers enhance the establishment of crops, while those from mineralization of organic manure promoted yield when both fertilizers were combined. The combined application of pig manure and NPK fertilizer also increased tomato fruit yield compared with pig manure or NPK fertilizer treatments alone (Giwa, 2004).

Conclusion

In conclusion the present study has shown that the possibility of achieving a productive tomato in the Savannah is the combine application of 600 kg ha^{-1} NPK fertilizer and 8.0 t ha^{-1} of farmyard manure.

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Table 1: Physical and chemical properties of soils at experimental locations in Samaru and Kadawa during 2017-18 dry season.

	Samaru	**Kadawa**
Physical properties (g kg^{-1})		
Sandy	420	520
Silt	356	330
Clay	224	150
Textural class	Loam	Loam
Chemical properties		
pH in water	6.01	6.14
pH ($CaCl_2$)	5.48	5.46
Organic carbon (g kg^{-1})	11.98	12.60
Available phosphorus (mg kg^{-1})	3.70	5.5
Total Nitrogen (g kg^{-1})	0.70	1.10
Exchangeable bases (cmol kg^{-1})		
Ca^{++}	3.70	3.12
Mg^{++}	0.52	0.49
K^{+}	0.18	0.14
Na^{+}	0.13	0.17
$Al^{+++} + H^{+}$	0.23	0.21
Exchangeable acidity		
CEC	4.76	4.13

Soil samples analyzed at Agronomy Department I.A.R/ABU, Zaria

Table 2:, Fruit diameter and Number of fruit of tomato varieties as influenced by NPK fertilizer and farmyard manure during 2017/2018 dry season at Samaru and Kadawa

	Fruit diameter (cm)	**Number of fruits plant^{-1}**	**Fruit diameter (cm)**	**Number of fruits plant^{-1}**
Treatment	SAMARU		KADAWA	
NPK Fertilizer (kgha^{-1}) (N)				
0	3.48c	16.1c	3.9c	15.0c
200	3.85b	25.4b	4.2b	16.6bc
400	3.92b	25.1b	4.4ab	19.6ab
600	4.12a	32.0a	4.5a	23.5a
SE±	0.07	1.50	0.08	1.46

Farmyard Manure (t) (F)				
0	3.5c	21.3b	3.9c	15.5b
4	3.7b	22.7b	4.0c	16.1b
8	4.1a	25.6ab	4.3b	18.6b
12	4.0a	29.0a	4.6a	24.5a
SE±	0.07	1.50	0.08	1.46
Interaction				
N*F	NS	NS	NS	NS

Mean followed by the same letter(s) in the same column within the same treatment group are statistically similar (p> 0.05) using Duncan Multiple Range Test (DMRT). NS= Not significant

Table 3:, Average fruit weight and Total fruit yield of tomato varieties as influenced by NPK fertilizer and farmyard manure during 2017/2018 dry season at Samaru and Kadawa

	Average fruit weight $^{-1}$	**Total fruit yield (t ha^{-1})**	**Average fruit weight $^{-1}$**	**Total fruit yield (t ha^{-1})**
Treatment	**SAMARU**		**KADAWA**	
NPK Fertilizer (kgha^{-1}) (N)				
0	77.2c	18.2c	112.7b	19.8b
200	118.3b	26.3b	123.5b	21.4b
400	123.2b	28.3b	145.0b	25.6b
600	156.8a	34.1a	199.8a	31.3a
SE±	7.96	1.49	12.49	1.77
Farmyard Manure (t) (F)				
0	91.6c	20.3b	116.3b	17.1c
4	107.8bc	22.2b	128.8b	22.7bc
8	127.6ab	29.0a	143.9b	25.4ab
12	147.5a	33.5a	192.0a	31.0a
SE±	7.96	1.49	12.49	1.77
Interaction				
N*F	NS	NS	NS	NS

Mean followed by the same letter(s) in the same column within the same treatment group are statistically similar (p> 0.05) using Duncan Multiple Range Test (DMRT). NS= Not significant

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Yield and Yield Components of Okra as Influenced by Nutrient Composition of Soil after Harvest of Different Legumes

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Abstract
An experiment was conducted at the Vegetable Research Farm of National Horticultural Research Institute, Ibadan, Oyo state, Nigeria between June and November 2018 to determine the influence of the contributions of varying population of legumes harvested on soil nutrient composition and yield of okra. The experiment comprised of thirteen (13) treatments laid out in a randomized complete block design (RCBD) replicated three times. The legumes which comprised of cowpea (Ife brown), soybean, bambara nut and groundnut (Kampala) were planted each at 55,555 plats/ha, 37,037 plants/ha, and 27, 777 plants/ha on a plot size of 3.6 m x 1.5 m (5.4 m^2). Seeds of okra variety (NHAe 47-4) was planted after harvesting of the leguminous plants at a spacing of 50 cm x 50 cm, giving rise to 40,000 plants/ha. The results showed that okra cropped on previously cropped cowpea field at the spacing of 45 x 30cm with the population of 37,037 plant/ha significantly ($p < 0.05$) increased the yield of okra. The cowpea also significantly ($p < 0.05$) contributed the highest amount of Nitrogen (0.32mg/kg) and Phosphorus (7.5mg/kg) to the soil. Although Bambara significantly ($p < 0.05$) produced the highest amount of dry matter accumulation at flowering (34.86g) and maturity (70.0g) this did not translate or have significant effect on the yield of okra.
Keywords: Okra, cowpea, peanut, bambara, population

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench), is a widely cultivated vegetable crop and very important in the diet of Africans (Omotoso and Shittu, 2008). It is one of the important nutritional vegetable crops cultivated in Nigeria, covering an estimated land area of 1-2 million hectares (FMAWR&RD, 1989). Fresh edible pods provide human supplementary vitamins such as Vitamins C, A, B-Complex, iron and calcium (Chutichudet *et al.*, 2006). Many countries in Asia and Africa have increased their land areas for the cultivation of this economic crop. In Nigeria the limiting factors in okra production and other vegetables among others include weed management, poor soil fertility, tillage practices, low yielding varieties and sub-optimal planting density (Dikwahal *et al.* 2006; Adeyemi *et al*., 2008; Iyagba *et al*., 2012). The problems of diseases and in particular poor soil fertility has an important role in production of the crop, as poor soil fertility has significant impact in producing high quality yield of the okra plants, thus the problem of poor soil fertility should receive priority if both high edible pod yield and quality are to be expected. The ability of legumes to fix atmospheric nitrogen is perhaps the most notable aspect that sets them apart from other plants. Legume has the ability to supply most of its own nitrogen needs with the help of symbiotic Rhizobia bacteria living in their roots. Inoculated with the proper strain of Rhizobia bacteria, legumes can supply up to 90% of their own nitrogen (N). Usually about two-thirds of the nitrogen fixed by a legume becomes available the next growing season after a legume in a rotation. Objective of this study was to determine the optimum population of legumes for improved soil fertility and consequently the yield of okra.

Materials and methods

The experiment was conducted at the Vegetable Research Farm of National Horticultural Research Institute (NIHORT), Ibadan, Oyo state located in the rain-forest agro-ecological zone ($7^0 33^1$N and $3^0 56^1$E 168 m above sea level) between June and November 2018. The soil of the site is dominated by Alfisols (Soil Survey Staff, 1999), it belongs to Egbeda soil series which is derived from fine-grained biotitesgnesis (Smith and Montgomery, 1962). The experimental site has been under continuous cultivation for more than 15 years. Pre-cropping soil sampling was done randomly at the depth of 0-15 cm for the analysis of physical and chemical properties of the soil using a soil auger and mixed together to get homogenous soil sample. The soil sample was air dried and sieved through a 2mm mesh. The experiment comprised of thirteen (13) treatments laid out in a randomized complete block design (RCBD) replicated three times. The field was disc-ploughed twice, harrowed and sprayed with systemic herbicide (force-up a.i glyphosate) at the rate of 250 ml to 18 litres of water using a knapsack sprayer before planting. The legumes which comprised of cowpea (Ife brown), soybean, bambara nut and groundnut (Kampala) were planted each at 60 cm x 30 cm (55,555 plats/ha), 60 cm x 45 cm (37,037 plants/ha), and 60 cm x 60 cm (27, 777 plants/ha) on a plot size of 3.6 m x 1.5 m (5.4 m^2). Seeds of okra variety (NHAe 47-4) obtained from NIHORT was planted after the harvesting of the leguminous plants at a spacing of 50 cm x 50 cm in giving rise to 40,000 plants/ha. Weeding was carried out manually with hoe at 4 and 6 weeks after sowing. Five plants within net plot were randomly selected and tagged for data collection at 4 and 6 weeks after sowing. Data collected were subjected to analysis of variance (ANOVA) and significant means were separated using the Duncan Multiple Range Test (DMRT) at 5% probability level.

Results and Discussion

Dry matter accumulation and root nodule count of legumes

The result of table 1 shows that the total dry matter accumulation of legumes planted at different population and spacing in which Bambara nut planted at the spacing of 60 x 30cm with a total population of 27,777 plants/ha significantly ($p < 0.05$) produced the highest amount of dry matter accumulation at flowering (34.8g) and at harvesting (70g) as soybean planted at the three different plant population significantly ($p < 0.05$) produced the lowest dry matter accumulation at flowering (0.77g, 0.55g and 0.59g) and at maturity (2.0g, 1.4g and 1.5g). However, these were not significantly ($p < 0.05$) different from other legumes at different planting population at flowering except Bambara at the planting spacing of 60 x 30cm and groundnut at the spacing of 30 x 30cm. Also the formation of noodles by the legumes showed that at flowering no significant ($p < 0.05$) difference was observed in their nodule formation while at maturity groundnut cropped at the spacing of 30 x 30cm and 60 x 30cm with the population of 55,555 plants/ha and 27,777 plants/ha significantly ($p < 0.05$) produced the highest number of nodules (Table 1). Soybean at the three spacing and plant population, cowpea at the spacing of 30 x 30cm with the population of 55,555 plants/ha and spacing of 45 x 30cm with the population of 37,037 plant/ha and Bambara at the spacing of 30 x 30cm with the population of 55,555 plants/ha significantly ($p < 0.05$) produced the lowest number of nodules.

Contribution of legume to the soil

The legume have contributed positively to the soil as the results showed that soybean, cowpea, Bambara and groundnut significantly ($p < 0.05$) increased the organic carbon of the soil (Table 2). However, Bambara at the spacing of 45 x 30cm with the population of 37,777 plant/ha significantly ($p < 0.05$) had the least contribution to the soil as the soil organic carbon was not significantly ($p < 0.05$) different from the control plots (2.79mg/kg). The total nitrogen also was significantly ($p < 0.05$) influenced by the legumes as soybean at the three planting spacing and populations evaluated significantly ($p < 0.05$) had the highest contribution in the soil. Also, cowpea and Bambara cropped at the spacing of 60 x 30cm and groundnut cropped at the spacing of 45 x 30cm significantly ($p < 0.05$) produced the highest total nitrogen in the soil. The available P in the soil was significantly ($p < 0.05$) increased (2.5mg/kg) at cowpea cropped at 45 x 30cm with the population of 37,777 plant/ha while Bambara cropped at 45 x 30cm with the population of 37,777 significantly ($p < 0.05$) produced the lowest P (Table 2). Dick *et al.* (2000) reported that the availability of Phosphate in the soil is an indicator of good soil fertility.

Influence of previously cropped legume on the yield of okra

The result in the table 3 showed that okra planted on previously cropped cowpea at the spacing of 45 x 30cm with the population of 37,777 plants/ha significantly ($p < 0.05$) increased the yield of okra (1.08 t/ha), while soybean cropped at the spacing of 30 x 30cm with the population of 55,555 plants/ha significantly (p <0.05) had the lowest okra yield (0.17t/ha). The increase in the yield of okra by previously cropped cowpea has been reported by Ghanbari and Lee (2003) who reported that legume supplies nitrogen for the following cereal crop. The result of this trial is also in agreement with the findings of Okonji *et al.* (2011) that there was an increase in the yield of rice as a result of cowpea residue being incorporated into the soil. Also, groundnut cropped at the spacing of 45 x 30cm with the population of 37,777 plants/ha significantly (p <0.05) increased the fruit length of okra (6.73cm). however, no significant (p <0.05) difference was observed between the control plot (4.43cm) and the soybean plots cropped at the spacing of 30 x 30cm with the population of 55,555 plant/ha (5cm), cowpea at 45 x 30cm with the population of 37,777 plant/ha (5.4cm) and 60 x 30cm with the population of 27,777 plants/ha (4.8cm). However, it was observed that previously cropped groundnut plots with the spacing of 30 x 30cm with the population of 55,555 plant/ha significantly (p <0.05) increased the fruit girth of okra (21.1cm) though this was not significantly (p <0.05) different from the other previously cropped legumes fields at different spacing and population except for previously cropped groundnut plots at the spacing of 45 x 30cm with the population of 37,777 plants/ha and 60 x 30cm with the population of 27,777 plants/ha. Also these were not significantly (p <0.05) different from the control plot (11.6cm). Ekhlas *et al.* (2012) has also reported that the N transfer from legume to cereal increased the cropping system's yield and efficiency of N uses. This could be attributed to the better yield of okra on previously cropped legume field as against the control plot.

Conclusion

From this study it can be concluded that the growing of okra on a field previously incorporated with legumes had an advantage over when no legume is used.

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Table 1: Dry matter accumulation parameters of the legumes evaluated

Treatments	Dry weight at flowering	Dry weight at harvest	Number of noodles at flowering	Number of noodles at harvesting
Soybean				
30 x30 (55,555plant/ha)	0.77c	2.00e	1.67	4.0c
45 x 30 (37,037 plant/ha)	0.35c	1.40e	1.67	2.33c
60 x 30 (27,777 plant/ha)	0.59c	1.53e	1.00	2.0c
Cowpea				
30 x30 (55,555plant/ha)	16.79bc	51.67ab	4.33	0.0c
45 x 30 (37,037 plant/ha)	18.07abc	36.0bcd	1.67	2.0c
60 x 30 (27,777 plant/ha)	12.67bc	47.67abc	1.00	6.67bc
Bambara				
30 x30 (55,555plant/ha)	13.92bc	40.33abcd	5.67	4.67c
45 x 30 (37,037 plant/ha)	14.45bc	51.33ab	7.67	18.67abc
60 x 30 (27,777 plant/ha)	34.86a	70.0a	40.67	10.0bc
Groundnut				
30 x30 (55,555plant/ha)	18.91ab	18.33cde	29.67	33.33a
45 x 30 (37,037 plant/ha)	8.37bc	14.0de	13.67	2667ab
60 x 30 (27,777 plant/ha)	7.73bc	21.0bcde	11.33	40.0a
LSD	17.85	31.39	Ns	21.72

Means followed by the same letters are not significantly different at $p < 0.05$.

Table 2: Contribution of legume to the soil properties

Treatments	pH H20	Organic carbon (mg/kg)	Total Nitrogen (mg/kg)	Available phosphourus (mg/kg)	Potassium (mg/kg)
Soybean					
30 x30 (55,555 plant/ha)	4.30d	3.57a	0.30a	3.5cde	0.08e
45 x 30 (37,037 plant/ha)	4.30d	3.75a	0.31a	4.0cd	0.14a
60 x 30 (27,777 plant/ha)	4.30d	3.89a	0.32a	4.5bc	0.10c
Cowpea					
30 x30 (55,555 plant/ha)	4.30d	3.61a	0.20b	4.0cd	0.08e
45 x 30 (37,037 plant/ha)	4.60ab	3.64a	0.20b	7.5a	0.13b
60 x 30 (27,777 plant/ha)	4.60ab	3.86a	0.32a	5.5b	0.09d
Bambara					
30 x30 (55,555 plant/ha)	4.30d	3.57a	0.20b	3.0de	0.09d
45 x 30 (37,037 plant/ha)	4.40cd	2.86c	0.24ab	2.5e	0.09d
60 x 30 (27,777 plant/ha)	4.60ab	3.89a	0.32a	3.0de	0.09d

Groundnut					
30 x30 (55,555 plant/ha)	4.50bc	3.04bc	0.25ab	4.0cd	0.07f
45 x 30 (37,037 plant/ha)	4.10e	3.71a	0.31a	4.5bc	0.09d
60 x 30 (27,777 plant/ha)	4.10e	3.46ab	0.29ab	5.5b	0.10c
Control	4.70a	2.99c	0.25ab	3.0de	0.08e
LSD	0.15	0.47	0.09	1.16	0.01

Means followed by the same letters are not significantly different at p <0.05.

Table 3: Yield and yield attributes of okra as influenced by previously cropped legume

Treatments	Average fruit length (cm)	Average girth length (cm)	Fruit yield (t/ha)
Soybean			
30 x30 (55,555 plant/ha)	5.00cde	20.17ab	0.17f
45 x 30 (37,037 plant/ha)	5.47bcde	19.33abc	0.46cde
60 x 30 (27,777 plant/ha)	5.60bcd	19.07abc	0.40def
Cowpea			
30 x30 (55,555 plant/ha)	6.21ab	19.52abc	0.81ab
45 x 30 (37,037 plant/ha)	5.51bcde	18.53abc	1.08a
60 x 30 (27,777 plant/ha)	4.85de	17.33abc	0.72bc
Bambara			
30 x30 (55,555 plant/ha)	5.83abcd	18.70abc	0.43def
45 x 30 (37,037 plant/ha)	5.73abcd	17.00abc	0.22ef
60 x 30 (27,777 plant/ha)	5.99abc	17.69abc	0.58bcd
Groundnut			
30 x30 (55,555 plant/ha)	6.49ab	21.15a	0.78b
45 x 30 (37,037 plant/ha)	6.73a	15.32cd	0.66bcd
60 x 30 (27,777 plant/ha)	5.77abcd	15.92bcd	0.55bcd
Control	4.43e	11.64d	0.20ef
LSD	1.11	4.63	0.28

Means followed by the same letters are not significantly different at p <0.05.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Yield Performance of Component Crops as Influenced by Groundnut Variety and Plant Arrangement in Groundnut Maize Mixture at Samaru, Nigeria

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Abstract
An experiment was conducted during 2005 wet season at the research farm of the Institute for Agricultural Research, Samaru (11^0 1l' N, 07^0 38' E, 686 m above sea level) located in the Northern Guinea Savanna ecological Zone of Nigeria to study effect of groundnut variety and plant arrangement on groundnut/maize mixture. Treatments consisted of two groundnut varieties (SAMNUT 22 and SAMNUT 23) and three row arrangements (1:1 alternate row, 2:1 alternate row and 2:1 alternate stand) groundnut: maize in addition to sole plots of each crop and variety. These were combined and laid out in a randomized complete block design and replicated four times. Results revealed that groundnut variety SAMNUT 23 recorded higher kernel and pod yields per hectare, and shelling percentage than SAMNUT 22, which excelled in haulm yield. It also recorded higher but non significant values of pods per plant, pod weight per plant and 100-kernel weight. The effect of plant arrangement showed that 1:1 alternate groundnut/maize rows recorded lower values of pod and kernel yields per hectare than other plant arrangements assessed. Also, the 1:1 alternate rows with SAMNUT 23 recorded heavier cobs per plant than either 1:1 rows with SAMNUT 22 and sole maize only. The 2:1 alternate rows of maize and groundnut variety SAMNUT 23 recorded higher maize 100-seed weight than other combinations and the sole maize. It could be concluded that SAMNUT 23 excelled SAMNUT 22 in yield attributes and 2:1 alternate groundnut/maize row arrangement is better for optimum yield of both crops in the study area
Keywords: Yield, Groundnut, Variety, Plant, Arrangement, Maize, Mixture

Introduction

Mixed cropping is a common practice among small scale farmers. It is the growing of two or more crops such that they compete with each other for growth factors like light, water, nutrients etc during their growing period. Mixed cropping gives higher total yield and provides insurance against total crop failure. It also limits spread of diseases and pests (Anomymous, 19). The most popular form of mixed cropping is the cereal legume form of mixed cropping. Ground nut is an important source of oil (44-56%) and protein (25-34%) while maize is a major staple crop in Nigeria. Yield potential of mixed cropping system could be increased through improved management practices using high yielding varieties (Elemo, *et. al*., 1988). In view of the importance of ground nut and maize crops and predominance of cereal: legume mixture, this study was proposed to study the yield performance of component crops and determine suitable groundnut variety and plant arrangement for optimum yield in mixture.

Materials and Methods

An experiment was conducted during 2005 wet season at the research farm of the Institute for Agricultural Research, Samaru, Zaria (11^0 1l' N, 07^0 38' E, 686 m above sea level) located in the Northern Guinea Savanna ecological Zone of Nigeria to study the effect of groundnut variety and plant arrangement on groundnut/maize mixture. Treatments consisted of two groundnut varieties (SAMNUT 22 and SAMNUT 23) and three row arrangements (1:1 alternate row, 2:1 alternate row and 2:1 alternate stands of groundnut/maize in addition to sole plots of each crop and variety. These were combined and laid out in a randomized complete block design and replicated four times. The gross size was five ridges with a length of 6 m and a breadth of 4 m giving an area of 24 m^2. The net plot was 12 m^2 (3 m x 4m) or four ridges 3m long. Groundnut varieties used were

-SAMNUT 22 (it has a potential pod yield of 2,400 kg/ha, medium maturing (110-120 days) with tan seed colour and adapted to Sudan guinea savanna).

SAMNUT 23 (potential yield of 2,000 kg/ha, early maturing (90-100 days), seed colour is red and adapted to Sudan and Sahel savannah).

maize (TZE-COM3). It has a potential yield of 5.5-7.7 t/ha, early maturing; adapted forest zone, white seeds

The field was ploughed, harrowed and ridged. It was marked into thirty-six plots. The seeds of both crops were sown simultaneously. The seeds were dressed with Apron star. Two seeds of the groundnut were planted and three seeds of maize were planted per hole. .Groundnut and maize plants were thinned to two plants per stand at 3 WAS. The weeding was done manually at 3WAS and 6WAS. Recommended rates of fertilizer was applied at 30-60-60 kg/ha for groundnut and 120-60-60 for maize in two equal split doses at 3 and 9WAS, Sources of fertilizer were NPK and SSP. Both crops were harvested manually, sun-dried before shelling and threshed. Groundnut yield data were collected on number of pods per plant (g), pod weight per plant (g), seed weight per plant (g), 100 hundred kernel weight (g), pod yield (kg/ha), haulm yield (kg/ha) and shelling percentage (%). Maize yield data were collected on cob weight per plant (g), weight of grains per plant (g), Grain yield (kg//ha) and 100-hundred grain weight (g). The data collected were subjected to statistical analysis of variance (ANOVA) using SAS software to test for significant effects of treatments as described by Gomez and Gomez (1984). The means were compared using Duncan Multiple Range Test (DMRT) to establish superiority (Duncan 1955)

Results and Discussions

Table 1 presents data on groundnuts as influenced by variety and plant arrangement in groundnut/maize. SAMNUT 23 recorded higher kernel yield per hectare, pod yield per hectare and shelling percentage than SAMNUT 22, which excelled in haulm yield. Other parameters assessed were not significant although SAMNNUT 23 recorded higher values of pod per plant, pod weight per plant and 100 kernel weights. SAMNUT 23 excelled in yield attributes except haulm yield. This is logical because maturity differences exert great influence on performance of component crops in mixture (Raw and Willy, 1983). The superior yield performance of 2:1 alternate groundnut/maize rows and stands respectively could be explained by the higher groundnut populations in both arrangements. This is in conformity with studies by Gehomoon and Bamiduno (1971) who opined that 2:1 arrangement was better suited for erect groundnut varieties in mixtures. The effect of plant arrangement was significant on kernel yield per hectare and pod yield per hectare only. The 1:1 alternate groundnut maize rows recorded lower values of these parameters than other plant arrangements assessed. Table 2 presents maize yield parameters as affected by groundnut varieties and plant arrangements in groundnut/maize mixtures. Cob weight per plant, grain yield and 100seed weight were significantly affected. The 1:1 alternate row with SAMNUT 23 recorded heavier cobs per plant than either 1:1 rows with SAMNUT 22 and sole maize only. However , it was at par with all other combination of groundnut variety and row arrangements. Likewise, 2:1 alternate rows of maize and groundnut variety SAMNUT 23 recorded higher 100 pod weight though at par with 2:1 alternate stands (same variety) than other combinations and the sole. This could be attributed to higher maize population density compared to groundnut. Similar results were reported by Shebayan and Katung (1991) reported that 2:1 maize/cowpea planting pattern was most productive and gave highest maize yield without much reduction in cowpea yield

Conclusion

Based on the findings of this study, it could be concluded that It could be concluded that SAMNUT 23 excelled SAMNUT 22 in yield attributes and 2;1 alternate groundnut/maize row arrangement is better for optimum yield of both crops in the study area

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Table 1. Yield parameters of groundnut as influenced by variety and plant arrangement in groundnut/maize mixture during 2005 wet season in Samaru

Treatment	Pod number plant^{-1}	Pod weight plant^{-1} (g)	Kernel weight plant^{-1} (kg ha^{-1})	Kernel yield (kg ha^{-1})	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Shelling (%)	100-kernel weight (g)
Sole crop								
Samnut 22	50.25	38.33	23.4b	152.78b	268.86b	1,546.9a	58.00b	39.33
Samnut 23	67.83	46.6	32.42a	267.01a	447.92a	1,224.0b	68.89a	29.08
SE (±)	4.43	3.18	2.79	33.62	51.38	155.85	2.87	1.11
Plant arrangement (groungnut/maize)								
1:1 alternate row	56.62	37.50	23.38	90.67b	100.26b	997.0	60.13	36.25
2:1 alternate row	58.25	45.00	30.63	182.73a	315.08a	979.7	67.33	39.63
2:1 alternate stand	60.75	45.00	29.75	146.60a	267.50a	795.5	62.88	38.75
SE(±)	5.42	3.89	3.42	13.72	41.53	125.98	3.52	1.92
Interaction								
VXP.A	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT).
WAS = Weeks after sowing; NS[1] = Not significant; * and ** are significant at 5 and 1% level respectively.

Table 2. Yield parameters of maize as influenced by groundnut variety and plant arrangement in ground/maize mixture during 2005 wet season in Samaru

Treatment	Cob weight/plant (g)	Grain weight/plants (g)	Grain yield (kg/ha)	100- seed weight (g)
Sole maize	60.50b	42.50b	25.21a	22.50f
Plant arrangement				
Samnut 22				
1:1 alternative row	40.00b	20.00	20.50b	73.43bc
2:1 alternative row	42.00ab	20.50	19.75b	71.43bcd
2:1 alternative stand	42.50ab	20.00	21.00b	64.61b-e
Samnut 23				
1:1 alternative row	72.50a	42.50	22.75ab	52.61b-f
2:1 alternative row	57.50ab	40.00	20.00b	104.21a
2:1 alternative stand	43.50ab	27.50	21.50ab	75.73ab
SE(±)	9.49	7.13	1.17	10.13

Means followed by the same letter(s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT).
WAS = Weeks after sowing; NS[1] = Not significant; * and ** are significant at 5 and 1% level respectively.

ASN 53rd Annual Conference Proceedings (Sub-Theme: Agronomy)

Diversification of the Economy through Cassava Production: Prospects and challenges in Nigeria

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Abstract
This article focused on the diversification of the economy through cassava production: prospects and challenges in Nigeria. It aimed to analyse the determinant variables of cassava enterprise, determine the profitability level, and examine the challenges associated with cassava production. Multi stage sampling procedure was used in the selection of the respondents. The data were collected with the aid of structured questionnaire and personal interview. Data were analysed using descriptive statistics, regression model and budgetary analysis. The result of the regression analysis indicated that all the variables used were significant except fungicides application. The result also reveals that the gross margin per hectare for cassava production in the study area was ₦24,749.28 with a gross benefit ratio of 2.3. This shows that for every ₦1 invested in the business of cassava production, there is a corresponding profit of ₦2.3 kobo. The major challenges identified in cassava enterprise are huge transportation cost, lack of improved cassava cultivars, and lack of market linkages. The study concluded that cassava production is profitable and can serve as a panacea for economic diversification. Therefore, the research recommends basic inputs such as improved cassava varieties and fertilizer should be made available at affordable price. Also, infrastructural facilities that improve marketing channels and extension services should be promoted in order to sustain current production rate and economic diversification.
Keywords: Economic diversification, cassava production, regression model and Nigeria

Introduction

Nigeria dependent on crude oil as a major source of revenue is mainly due to the fact that over 90% of its income is derived from oil and gas exploration (Ikelegbe, 2005).. Ever since the discovery of the crude oil, it has weakened the development and growth of other sector in the economy particularly agricultural production. This situation as lead to over reliance on oil which can no longer sustain the growing population and the needed infrastructural facilities required to bring the nation to the level expected by her citizens and other nations around the world. Hence, it is critical for the national to diversify into agricultural business and harness the opportunity for feeding her fast growing population as well as enjoyed the financial returns from the food markets (Byerlee, Garcia, Giertz, & Palmade, 2013). Nigeria is an agrarian society with about 70% of her over 180 million population engaged in agricultural production (Adewuyi et al, 2014). Hence, it is currently the largest producer of cassava in the world though with fragmented industry structure and with an annual production of over 34 million tons of tuberous roots (Adenle et al., 2017).

Cassava is important not only as a food crop but even more so a major source of income for rural households. As an income crop, cassava generates cash income for the largest number of households' comparison with other staples in the same category. As a food crop, cassava has some inherent characteristics which make it attractive especially to the smallholder farmers in Nigeria. First, it is rich carbohydrates especially starch and consequently has a multiplicity of end uses. Secondly, it is available all year round, making it preferable to other more seasonal crops such as grains, peas, beans, and other crops for food security, energy security, poverty reduction and has economic importance for millions of smallholders in developing countries including Nigeria (OECD-FAO, 2015)..

Apart from considering the fact that rapid population growth tends to increase market demand, it would be justifiable to have adequate understanding of the operations surrounding cassava production being one of the most important crops in the country. The research work is expected to enhance farmers' resource allocation so as to achieve optimal goal within the limited available resources. The outcome of the research will also be of immense benefit to stakeholders in agricultural industry particularly policy and decision makers in order to achieve the target of the agricultural revolution and food security that are key for successful diversification of the economy. The significant role play by agriculture particularly cassava production in the process of economic growth and development cannot be over emphasized. However, the myriad of problems confronting rural farmers that engaged in the cultivation of cassava to meet the rising level of local population and demand (Alamu, 2013) as well as challenges faces by medium and large scale entrepreneur in the enterprise targeting export and international markets laid credence for concern in order to meet up with current diversification motive of the nation. Therefore the main purpose of this research is to analyse diversification of the economy through cassava production: prospects and challenges. The specific objectives are to:

i. analyse the determinant variables in cassava enterprise
ii. determine the profitability level of production
iii. examine the challenges associated with cassava production.

Materials and Method

The study area of research is Irepodun Local Government Area (LGA), Kwara State. It shares boundary with Ifelodun LGA to the North, Osun State to the South, Ekiti and Offa Local Government to the East and West respectively. It has a population of 148,610 people and a landmass of 1,095 square kilometers (NPC, 2006). It is endowed with Svannah and Rain forest vegetation on a plain terrain with patches of rivers and streams. The people of the area are predominantly farmers and speak Yoruba language.

Multi-stage random sampling technique was employed in the study. A total of one hundred cassava farmers were randomly selected from the numerous towns and villages in the study area. Primary data were obtained by the use of interview schedule and structured questionnaires administered to the respondents. Data were analysed using descriptive statistics such as frequency, percentage and tables, budgetary techniques (cost and return/ gross margin analysis) and multiple regression model. The gross margin model states as follows:

GMc = GIc - TVCc …………………………………………………….. (i)

GMc = GIc – TVCc (₦/ha) ……………………………………………….. (ii)

BCR = GMc/ TVCc ……………………………………………………… (iii)

Where;

GMc = Gross Margin of cassava (₦/ha)

GIc = Gross income of cassava (₦/ha) = the product of the total output and the unit price of output.

TVCc = Total Variable Cost (₦/ha) = cost of variable inputs.

BCR = Benefit Cost ratio

Multiple regression analysis was used to analyse the effect of inputs on cassava output. Three functional forms of linear, semi-log and double-log were fitted for the regression analysis. The significant t-values, magnitude of the coefficient of determination (R^2) and the significant values of the estimators were the criteria used in the selection of the lead equation. The regression equation was specified explicitly following the ordinary least square approach and is stated thus;

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \mu$$

Where:

Y = Output of cassava production (kg)

X_1 = Quantity of inorganic fertilizer (kg/ha)

X_2 = Quantity of herbicides/ha (litres)

X_3 = Quantity of fungicides/ha (litres)

X_4 = Farm size (ha)

X_5 = Hired labour in mandays

X_6 = Family labour in manday

β_0 = Intercept or constant term
β_1- β_6 = Coefficients of the parameters estimate
μ = Error term

Results and Discussion

Determinants of cassava production

Multiple regression analysis was used to determine the variables affecting cassava production in the study area. Cassava output was regressed on fertilizer quantity, farm size, herbicide applications, fungicides, hired labour, and family labour. The linear functional form was chosen of the three forms fitted for the analysis. The significant t-values, magnitude of the coefficient of determination (R^2) and the significant values of the estimators were the criteria used in the selection. All variable inputs used except fungicide were significant at different levels of significance between 1% and 10% (Table 1). The coefficient of fungicide was not significant probably due to the fact that it had a negligible impact on output produced hence many farmers deemed it unnecessary to use in most of the farm. The findings of this research is similar to that of Chikezie et al (2012) that emphasized that fertilizer application and household size are significant factors for cassava enterprise thereby improving rural livelihood and food security of the nation.

Table 1: Regression Analysis for Cassava Production

Variable	Coefficient	Standard Error	T value
Constant	5.230577	1.372048	3.81
Fertilizer	9.793542	1.858399	5.27**
Herbicide	0.4488473	0.2422905	1.85*
Fungicide	0.1771383	0.1547023	1.15
Farm Size	0.7918113	0.1100063	7.20***
Hired labour	1.393661	0.2703595	5.15***
Family labour	0.3947081	0.2212705	1.78*
R^2	0.8509		
Adjusted R^2	0.7614		

Source: Computed from field Survey, 2017.
Note: *** 1% level of significance, ** 5% level, * 10%.

Profitability analysis

Budgetary analysis (Gross margin) was used to determine the profitability level of the cassava farmers in the study area as presented in Table 2. The result showed that the total variable cost per hectare by cassava farmers was ₦17,980.66 and total revenue was ₦42,729.94. Thus, the gross margin obtained was ₦106,443.89 per hectare. It implies that average rice farmer in the study area earned gross profit of ₦24,749.28 per hectare at the end of the season. On the other hand, the Benefit Cost Ratio was of 2.38. It implies that for every ₦1 invested by the farmers in cassava production, ₦2.38k was realized in return. It can therefore be concluded that cassava production in Kwara State, Nigeria was profitable. The result is in consonant with Zaknayiba et al (2014) that established that cassava production in Nasarawa State was profitable when the rate of return was found to be 153%.

Table 2: Result of Gross margin analysis (Profitability level)

Items	Cost (₦)	Total Return (TR) (₦)
Yield (Total value of cassava produced)		42,729.94
Variable items		
Planting operations	4,510.76	
Herbicide used	1,490.62	
Fertilizer	5,932.49	
Fungicide used	1,021.00	
Hired labour	3,070.66	
Family labour	954.05	
Transportation	1,001.08	
Total Variable Cost (TVC)	17,980.66	
Gross margin (GM) = (TR – TVC)	24,749.28	
Benefit Cost Ratio = (GM/TVC)	2.38	

Source: Field Survey, 2017

Constraints Analysis

Problems and constraints faced by cassava farmers and militating against the increase in production are presented (Table 3). The results gathered were ranked and it revealed that high cost of transportation (89.4%), cost of production (42.3%), lack of linkages with agro-markets (34.6%), non-availability of improved cultivars (24%) and inadequate investment capital (15.4%) are the major factors hindering investors in cassava business enterprise. Corroborating this finding, Godfray et al (2010) asserted that enabling production facilities, viable markrt channels and favourable working capital should be provided to stakeholders in tropical agricultural industry in order to maximize its growth potential, human and animal food enrichment, economic and industrial benefits.

Table 3: Farmers Constraints on Cassava Production

Major Constraints	Frequency	Percentage (%)	Rank
Expensive Transportation	93	89.4	1
High cost of production	39	37.5	2
Market linkages hindrance	36	34.6	3
Lack of improved cultivars	25	24	4
Lack of capital	16	15.4	5

Source: Field Survey, 2017

Note: Multiple responses allowed.

Conclusion and Recommendations

It has becomes imperative for Nigeria economy to be diversify because mono-economy that has been in operation since the discovery of crude oil has cripple the growth and development of other sectors particularly agriculture. Cassava production has the potential to stabilize the rural economy, increase household income and boost foreign exchange earning of the nation when fully utilize. The research concluded that cassava enterprise is profitable and capable of providing the necessary impetus for the current agricultural revolution strategy aimed at diversifying the economy. Based on the challenges identified, the study recommends as follows:

i. Infrastructural facilities such as good road network, water supply and market linkages should be provided through public- private interventions and concessions in order to reduce hardship of investors in cassava enterprise arising from high cost of transportation due to bad road network.

ii. Universities and research institutes should collaborate and intensify efforts in the development of improved varieties. The outcomes of their research should be made available and accessible through visible extension specialist in the agricultural value chain.

iii. Flexible loan and grant should be provided to small and medium enterprises (SMEs) in the cassava revolution industry so as to boost production for export thereby curbing negative effect of low capital. The current anchor borrow scheme by Central Bank of Nigeria should sustain and other related windows should be set up.

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Environmental and Social Benefits Of Urban Greening

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Abstract
Urban greening has become a contemporary issue, gaining prominence especially in developing economies because it has been discovered to be a viable poverty intervention strategy for the urban poor. However, policy makers and government have deliberately neglected this veritable sector and have failed to acknowledge it and channel attention to it. This paper examines the benefits of urban greening as well as the types of the benefits which included the environmental and social benefits of urban greening. The paper suggested that urban greening should be integrated into the land use planning of all urban centers in Nigeria amongst the recommendations suggested.

Keywords: Environmental benefits, social benefits, challenges, urban greening

Introduction

Poverty alleviation dominates the international development agenda of the 21st century, and one of the primary concerns of the Millennium Development Goals is to improve the health and living conditions of at least 100 million slum dwellers around the world by the year 2020. (UN-Habitat, 2003). Up to the 1980 poverty was largely associated with the rural areas in developing countries; but the situation has changed with the dramatic increase in the numbers and proportion of the population living in urban areas, and a corresponding increase in the level of urban poverty. The International Labour Organization (ILO) estimates that the proportion of the urban work force engaged in the informal sector is highest in sub-Saharan Africa, and accounts for more than 50 per cent of urban employment in two-thirds of the countries surveyed in 1999 (Population Reports, 2002).

The increasing concentration of human populations in cities presents urban planners with enormous challenges in meeting the demand for infrastructure. Population growth and high human densities can exact a heavy toll on a city's fragile natural and environmental resources, particularly in developing countries where squatter communities are prevalent and resources are scarce. Nevertheless, the preservation of a system of vegetated areas, or green spaces, can improve the quality of life by providing people with natural settings for leisure and recreation, and by safeguarding the qualityof precious life-giving resourcessuch as air and water. Green areas also have the potential for affording citizens the opportunity to get direct economic benefits through urban agriculture or forestry. Yet none of these amenities occurs accidentally.

As more people leave rural environments for the steel and concrete surroundings of cities, there is a growing recognition that they will need and want some form of vegetation present in their daily lives. Whether it is a shady city park for recreation, a tree border for noise reduction or a wetland area for flood control, the concept of urban greeningis fast becoming a reality. The term evolved from Miller's (1993) definition to mean an integrated, citywide approach to theplanting, care and management of all vegetation in a city to secure multiple environmental and social benefits for urban dwellers. While urban forestrytypically refers to the planting and maintenance of groups of trees and urban agriculture means food grown by city and suburban dwellers, urban greening is a more general term. For the purposes of this paper, urban greening refers to any re-vegetation effort including the planting of trees, shrubs, grass, or agricultural plots whose design is intended to improve the environmental quality, economic opportunity, or aesthetic value associated with a city's landscape.

Urban Growth

United Nations figures indicate that in 1990 only 37 percent of the total population of developing countries lived in urban areas. By the year 2025, it is estimated that 61 percent of the population will be urbanized There are many reasons to explain this rapid urban growth, including falling death rates, industrialization (which concentrates job opportunities in urban areas), high fertility rates, a popular perception of greater opportunities in urban areas, and political and economic problems in rural areas (UNDP 1996). Urban greening must not only serve the needs of all urban residents, but they must also participate fully in it. There are numerous subgroups that compose the population of urban dwellers in Latin America, including recently arrived poor migrants, migrants that are beginning to settle, well-established urban dwellers, single workers, families, people from various economic strata, groups with varied educational levels, those with and without rural links, and those with and without tenure to their residence, among others.

The accelerating rate of urbanization is exacerbating the serious environmental problems already found in the cities in Nigeria. The urban poor, usually residing on marginal, environmentally sensitive land, often face the greatest exposure to urban environmental hazards. Despite the fact that the poor are most often the hardest hit by these hazards, air, water and noise pollution affect people of every economic stratum. The social and ecological costs of urban pollution will continue to affect the growing urban populations in theregion unless the cycle of degradation and poverty can be broken.

Benefits of Urban Greening

Urban greening offers improvements in air,water, and land resources by absorbing airpollutants, increasing water catchment andfloodplain surfaces, and stabilizing soils.Urban forests act as temperaturebuffersproviding shade in the summer, andwind break in the winterin addition toreducing noise pollution and CO2 levels, andproviding a habitat for wildlife. Theeconomic benefits include marketable timberand agricultural products, as well as a variety of non-timber forest products such as artisanwares and honey. Lastly, the overall benefitsto society, particularly to low-income residents, are significant. They include thecontribution of trees and vegetation to themental and physical health of the populace,and the provision of recreationalopportunities and an outdoor classroom forenvironmental education. In addition, theyprovide aesthetic improvements to anenvironment otherwise dominated by asphaltand concrete. Furthermore, the benefits of urban greening can be classified into three classes; this includes environmental benefits, material benefits and social benefits.However, for this study, two benefits will be discussed. They are the environmental and the social benefits

Environmental Benefits

Air Quality Improvement

Air pollution indices in many cities in more developed countries have dropped over the last ten to twenty-five years while air pollution levels have been rising in cities throughout much of the African continent. Suspended particulate matter, carbon dioxide and ozone layer destruction are also serious problems in the continent. Those most affected by such detrimental air contaminants are children, the elderly and people with respiratory problems. Therefore, in these cities an aggressive and multifaceted approach to combating pollution is all the more urgent. Using vegetation to reduce air pollution is an effective technique that also provides other benefits such as city beautification. Urban greening can reduce air pollutants to varying degrees. Air pollution is directly reduced when dust and smoke particles are trapped by the vegetation. In addition, plants absorb toxic gases, especially those from vehicle exhausts, which are a major component of urban smog (Nowak *et al*, 1996).

Climate Improvement: One of the most important benefits of urban vegetation is its impact on the climate. Two distinct influences can be identified. First, there is a direct effect on human comfort. Secondly, there is an effect on the energy budget of buildings in cities where air-conditioning is used. Both of these effects can be significant, or negligible, depending on the size, spacing and design of vegetated areas. The direct impact on human comfort is one that every person is familiar with, although it is hard to quantify. Anyone who has walked on a city street on a rainy, hot, or windy day knows from personal experience that trees can significantly increase human comfort by influencing the degree of solar radiation, air movement, humidity and air temperature and providing protection from heavy rains. Wind speeds 2 meters above the ground in a residential neighborhood were shown to decrease by 60 percent or more in areas of moderate tree cover compared to open areas (Heisler 1990).

Trees and other vegetation can also have an important impact on the energy budgets of buildings and, in turn, of entire cities. This effect is most noticeable in urban centers with little or no vegetation and extensive paved areas. Large areas of paved surfaces dissipate the heat of the sun only very slowly. This results in the urban heat island effect where a city heats up rapidly and then maintains a high temperature. Furthermore, as city temperatures increase, so too do airborne pollutants and smog (Kuchelmeister, 1991). A research in Sao Paulo showed that the temperature in a concrete-covered center of the city is consistently several degrees warmer than in more open and vegetated outlying areas. Akbari *et al*. (1992) found that tree shade could reduce the average air temperature in buildings by as much as five degrees Celsius.

Flood Control: Floods cause considerable damage in Nigeria and other African. The damage included destruction of roads, bridges, canals, drainage networks, dikes, water and sewage networks, electric power systems, factories, residences and commercial establishments. Most of the time the flood affected predominantly low-income population, with limited access to schools, health facilities and basic sanitation. Using wetlands and parks as important components of a city's flood control system is not only recommended but is quite feasible. By locating city parks and green spaces in the flood plains of rivers, streams or other drainage systems, planners can increase the permeable surface area available for catchment, reduce flow rates (compared to non vegetated surfaces such as asphalt), and avoid damage to buildings or settlements that might have otherwise been constructed in the area.

Furthermore, some cities, such as Durban, South Africa,have pioneered urban greening flood control.The Durban park system is used to retainstorm runoff waters in upland ponds andmarshes and in downstream wetlands (ICLEI1995). In Tulsa, Oklahoma (USA), the parkservice has selected certain tree species thatcan survive standing water for up to a weekor more and has planted them in parksdesigned for flood control. The city ofCuritiba, Brazil, which in the pastexperienced frequent flood damage, has usedurban greening to reverse that trend. Almostall of Curitiba's city parks created since the1980s have a lake in the middle for flood control purposes, and old sand and claymines have likewise been turned into lakes and parks.

Noise Abatement: Noise often reaches consistently unhealthy levels in large cities in Latin America. Poor populations living close to heavy industry, commercial and traffic corridors often get exposed to the highest levels. To make matters worse, the building materials used in low-income neighborhoods do not insulate the residents from noise as well as the more substantial materials frequently used in wealthier neighborhoods. Trees and vegetation can help reduce noise pollution in five important ways. By:

(1) Sound absorption (sound is transferred to some other object),
(2) deflection (the direction of sound is altered),
(3) reflection (sound is bounced back to its source),
(4) refraction (sound waves bend around an object) and
(5) masking (unwanted sound is covered up with more pleasing sounds).

Thus, leaves, twigs and branches will *absorb* sound, as will grasses and other herbaceous plants. Tree or plant barriers will *deflect* sound away from listeners and, if at right angles to the source, will *reflect* it back to that source. If the noise passes through and around the vegetation, it is being *refracted* and thereby dissipated. Vegetation can also *mask* sounds to the extent that people will filter out unwanted noise by selectively listening to the sounds of nature (bird songs, leaves rustling, etc.) over the sounds of the city (Miller 1988).

Erosion Control

Many large cities in the region are located below, on or above steep hills and mountains, or on coastal slopes. Given the general lack of vegetative cover and the hard seasonal rains most of these cities experience, erosion predominantly do occur in most of Nigerian cities and landslides and earth quakes have become common occurrences in developed cities. Informal settlements are hit especially hard by landslides, as they are most often built on marginal slopes. Because of the potential for loss of life and property that eroded embankments represent, many countries enacted legislation long ago to prevent urban development on excessively steep hills.

Wildlife Habitat and Biodiversity

Urban green areas have been found to provide habitats for a surprising number of species and for large populations of birds and animals. Most urban residents are familiar with at least some local species of birds and animals that have adjusted to urban conditions. Where more parks and vegetation exist, local and migrating species can find suitable habitats. In particular, suburban wetlands may offer some of the world's most productive natural ecosystems as transitional areas between terrestrial and aquatic environments (Bernstein 1994). Wetlands that are incorporated into urban greening projects, including those designed or maintained for flood control and wastewater treatment settling ponds, provide particularly important habitats for local and migrating fauna contributing to maintaining a healthy biodiversity in the area.

On a larger scale, urban greening can create or restore biological diversity that will reconnect a city to its surrounding bioregion. Cities are built in an existing ecosystem and often destroy it. The flora and fauna that once lived in that system are either destroyed, displaced or have to adapt to the new urban environment. This process seriously depletes a region's genetic diversity (both plant and animal) and can threaten with extinction some species that are essential to the area's natural ecosystem and consequently to the resident human population.

Social Benefits

Health

Although they may be difficult to quantify, the benefits of urban greening to human health can be considerable. Certainly, improvements in air quality due to vegetation have positive impacts on physical health with such obvious benefits as decreases in respiratory illnesses. Perhaps less obvious, however, is the fact that urban forests also reduce stress and improve health by contributing to an aesthetically pleasing and relaxing environment (Nowak *et al*. 1996). According to Ulrich (1990) found that convalescing hospital patients recuperated significantly faster when placed in rooms with views of trees and outdoor settings than patients without such views. Urban forests provide a connection between people and their natural environment that would otherwise be missing in a city. This connection is important for everyday enjoyment, worker productivity and general mental health (Nowak *et al,* 1996).

Employment

Another important aspect of urban greening is the jobs provided for poor, skilled and unskilled laborers. Urban greening projects are often labor-intensive and provide both initial start-up jobs (soil preparation, planting, etc.) as well as more permanent employment (maintenance, management, etc.).

Recreation

Green areas provide recreational sites, especially for lower income residents who tend to frequent city parks more than wealthier citizens because of financial constraints and restrictions on leisure time. This, of course, depends on two conditions: first, the park must be within an affordable traveling distance for the individual or family; and second, it must have the amenities those people prefer.

Aesthetic Values

Cities with enough greenery are always aesthetically pleasing, are attractive to residents and investors alike. Advantage of aesthetically pleasing green areas is their positive effect on property values. When unsightly vacant lots or garbage dumps are replaced by attractive parks, not only does the residents' quality of life improve, but the value of their property increases. In addition, rehabilitating lands with vegetation is often more attractive and cost-effective than constructing new buildings on them.

Education

Parks and other green areas also provide educational opportunities for urban residents. Many cities in Latin America boast botanical gardens, zoos, nature trails and even visitor information centers that can inform residents and tourists alike about the area's flora and fauna. Individuals, families and school groups can take advantage of a city's green areas to learn about the environment and natural processes. For urban children, as well as adult students, the learning experiences available in urban parks may be some of the few opportunities they have to learn about nature through first-hand experience. Moreover, by getting the public involved in educational activities associated with urban green spaces, planners can raise the consciousness of the public concerning the importance of these spaces. Another way to educate the public on the importance and benefits of urban greening is to involve people in the greening process itself. Example includes the tree planting campaign being done every year in Nigeria.

Conclusion and Recommendations

Sustainable urbanization is a global challenge. The contribution of urban greening to the development of urban centres cannot be underestimated as it goes a long way in improving their livelihood. The increasing concentration of human populations in cities presents urban planners with enormous challenges in meeting the demand for infrastructure. Population growth and high human densities can exact a heavy toll on a city's fragile natural and environmental resources, particularly in developing countries where squatter communities are prevalent and resources are scarce. However, careful planning and forethoughtare the keys to ensuring that a city will have healthy natural resources for both today and the future generation in perpetuity.

However, the following recommendations are imperative:

1. Urban greening should be integrated into land use planning of all urban centers in Nigeria. This can be achieved by establishing a greenbelt zone in all major cities to halt urban development
2. Academia and stakeholders should design programmes to cover urban greening
3. Urban greening experts should be mobilized to form associations/cooperatives so as to help in inputs supply and mobilization of credit.
4. Urban greening should be integrated into our national agricultural and forestry research agenda soas to evolve:
    - Environment friendly technologies for commercial production;
    - Small-plot agronomic requirements, and;
    - Intensified sustainable cropping system.

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