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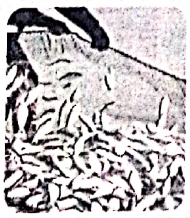

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EFFECTS OF DIFFERENT NITROGEN SOURCES ON THE GROWTH OF MAIZE AND SOYBEAN IN AN INTERCROPPED SYSTEM

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ABSTRACT

A pot experiment was conducted at the screen house of Federal University of Technology, Minna in the cropping season of 2019. The experimental soil was obtained from a location within Gidan Kwano campus with GPS coordinates of latitude 9° 31' N and longitude 6° 26' E. Maize variety Sammaz 27 and soybean variety TSB 4810 were intercropped per pot containing 14 kg of soil. A week after planting, they were thinned to one maize and one soybean seedling per pot, prior to the application of 4 nitrogen treatment sources. Treatments were then arranged in a Completely Randomized Design and replicated thrice. Basal applications of NPK and other micronutrients were supplied. Data collected were analyzed using ANOVA. Results showed that the different Nitrogen sources did not significantly affect the growth and leaf damage of maize. Excluding shoot biomass, nitrogen sources significantly affected all the growth parameters of soybean. Inoculated soybean nodulated significantly compared to soybeans treated with other nitrogen sources.

Key words: Growth, Intercrop, Maize, Nitrogen, Soybean.

INTRODUCTION

Maize is a cereal crop that is grown widely throughout the world in a range of agro-ecological habitat. More maize is produced annually than any other grain. The grains are rich in vitamin A, C and E, carbohydrates and essential minerals and contain 9% protein. They are also rich in dietary fiber and calories which are good source of energy (Shiferaw *et al., 2011*).

Maize is the most widely and popular cereal in Nigeria that is found in usage in almost every home either as food for humans or feed for animals and of utmost importance, it serves as raw materials for industries. 8% of the world's total 34.7million hectare of maize is produced by Africa. Nigeria which comes second after South Africa in Africa produced 8.7 million tonnes per hectare from 5.7 million tonnes per hectare which represents 1% of the world's total production in 2012. Nigeria's production is very low compared to the 273.8 million tonnes per hectare produced by USA in 2012. This study was conducted in the savanna zone of Nigeria which accounts for over 70% of maize production in Nigeria (Uyovbisere *et al., 2001*).

The explanation for this cannot be farfetched because the average yield per hectare in Nigeria is still very low to the tune of 1500kgha^{-1} in 2012 as stated by FAO. Low crop yield in sub Saharan

African countries have been attributed to challenges such as low soil fertility and change in climate (Ibeawuchi *et al., 2009*). Most maize production in Africa is rain fed. Anomalous rainfall can activate occasional drought which impacts yield negatively and in some cases total crop failure. On the other hand, a lack of nitrogen can reduce the production potential of maize (Chaudhary *et al., 2014*). As important as nitrogen is in plant life, it is low in soils of Nigerian Guinea Savanna, hence the need to supplement through mineral and biological sources. Abuse of the mineral source has dire environmental consequence. The most promising biological source with more economic returns is intercropping maize with soybean, such that the soybean can supply the needed amount of nitrogen for both plants. However, soybean unlike cowpea will need an initial supply of nitrogen within the range of 20-30 Kg N ha^{-1}. Thereafter, depending on the symbiotic effectiveness of the associating rhizobia, the soybeans can fix as much as 80 - 350 Kg N ha^{-1} (Mobasser et al., 2014). Intercropping is an age long practice that has so many advantages and few disadvantages if crops are incompatible. This intercrop system is nitrogen demanding hence the need to investigate the effect of different nitrogen sources on maize and soybean in an intercropped system at Gidan Kwano, Minna.

The objectives of the study are to:

1. Assess growth characteristics of intercropped soybean as affected by different nitrogen sources.
2. Estimate growth characteristics of intercropped maize as affected by different nitrogen sources

MATERIALS AND METHODS

Description of Study Area

The experiment was conducted at the screen house, School of Agriculture and Agricultural Technology, Federal University of Technology, Gidan Kwano, Minna which is within the Southern Guinea Savanna agro-ecological zone of Nigeria. The climate of Minna is sub-humid with a mean annual rainfall of 1248mm and distinct dry season from November to March . The mean maximum temperature remains high throughout, about 32^{0}C particularly in March and June *(Ojanuga, 2006)* .

Treatments and Experimental Design

The treatments consist of: Control (0 Kg N ha^{-1}), NPK 15:15:15 (20 Kg N ha^{-1}), Poultry Manure

(20 Kg N ha^{-1}) and USDA 110 as Rhizobium Inoculants at the rate of 2ml per plant. The treatments were arranged in a Completely Randomized Design (CRD) and replicated three times giving a total of twelve pots.

Soil Sampling amd Analysis

Soils were taken from the field at Gidan Kwano at a depth of 0-15cm with sterilized soil auger. A smaller portion of the soil sample collected (representative) was taken and sieved through a 2mm sieve in preparation for routine analysis of soil according to methods of International Soil Reference and Information Centre and Food and Agricultural organization (ISRIC/FAO, 2002). Thereafter, the poly pots were filled with 14 kg of soil and arranged as appropriate in the screen house.

Planting and Crop Management

Two seeds of each crop genotype were sown per poly pot containing 14 kg of soil. Thereafter, seeds were thinned to one plant per poly pot one week after planting (WAP). Fertilizer application was basal and as follows; 30 Kg P ha^{-1}, 60 Kg K ha^{-1}, 20 Kg N ha^{-1} and $ZnSO_4$ and $MgSO_4$. Thereafter, the pots were weeded and watered till harvest at 6 WAP. Growth data were obtained at harvest and also Percentage Leaf Damage as $\frac{\text{number of damaged leaves}}{\text{total number of leaves}} \times 100$

$$\frac{\text{number of damaged leaves}}{\text{total number of leaves}} \times 100$$

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using SAS. Mean differences was separated using Duncan Multiple Range Test (DMRT) where the effects of treatments were significant

RESULTS

Table 1 shows the results obtained from the chemical properties of Gidan Kwano soil. Table 2 shows the growth parameter of intercrop maize and table 3 shows the growth parameter of intercrop soybean.

Table 1:Chemical properties of the soil of experimental location

Soil Parameters	Gidan Kwano
Sand (g Kg^{-1})	798

Silt (g Kg^{-1})	80
Clay (g Kg^{-1})	122
Textural class	Sandy Loam
pH in $CaCl_2$	4.45
Total Nitrogen (g Kg^{-1})	1.04
Organic Carbon (g Kg^{-1})	1.36
Available P (mg Kg^{-1})	13.87
Exchangeable bases (CmolKg-^{1})	
Mg^{2+}	0.45
Ca^{2+}	2.08
Na^{+}	0.27
K^{+}	0.09
Exchangeable Acidity (CmolKg-^{1})	
H^{+} and Al^{3+}	0.11

Table 2: Growth parameters of intercrop maize as affected by different Nitrogen sources

Nitrogen source	Plant height (cm)	Shoot biomass (gplant^{-1})	Root biomass (gplant^{-1})	Leaf Damage (%)
- N	64.9^{a}	7.2^{a}	2.5^{a}	0^{a}
+ Inorganic N	67.9^{a}	10^{a}	1.9^{a}	0^{a}
+ Organic N	71^{a}	8^{a}	2.3^{a}	0^{a}
+ USDA 110	66.1^{a}	10.6^{a}	2.4^{a}	0^{a}
SE±	2.1^{NS}	0.9^{NS}	0.3^{NS}	0^{NS}

Means with the same letter(s) indicated in the columns are not significantly different ($p \leq 0.05$).

** = Highly Significant

NS = Not Significant

* = Significant

Table 3: Growth, nodulation and percentage leaf damage parameters of intercrop soybean as affected by different Nitrogen sources.

Nitrogen source	Plant height (cm)	Shoot biomass (gplant^{-1})	Root biomass (gplant^{-1})	Nodule number (plant^{-1})	Nodule weight (gplant^{-1})	Leaf Damage(%)
- N	35.4^{b}	0.8^{b}	0.6^{c}	1^{b}	0.04^{b}	45.6^{bc}
+ Inorganic N	38.9^{b}	1.4^{ab}	2.9^{a}	2.0^{b}	0.04^{b}	68.9^{a}
+ Organic N	41.9^{ab}	1.3^{ab}	0.6^{c}	2.0^{b}	0.02^{b}	59.8^{ab}
+USDA 110	48.9^{a}	1.5^{a}	1.5^{b}	10.0^{a}	0.2^{a}	37.2^{c}
SE±	1.9*	0.1^{NS}	0.3**	1.2**	0.02*	4.3**

Means with different letter(s) indicated in the columns are significantly different ($p \leq 0.05$).

NS = Not Significant ** = Highly Significant

* = Significant

Discussion

The result of chemical properties of Gidan Kwano soil (Table 1) shows that the soil had an extremely acidic reaction and low exchangeable acidity thus implying that the soil might have fertility problem (Adeboye *et al.,2009)*. The organic carbon content of the soil was very low which is typical of cultivated soils of the Nigerian savanna (Adeboye *et al.,2009*). The soil N was low and this may be attributed to low organic matter content which is the major reservoir of soil N. The low exchangeable bases may be due to very low clay and organic carbon content of the soils as suggested by Onyekwere and Ezenwa *(2009)*.

The effects of Nitrogen sources on-the growth and percentage leaf damage of intercrop maize (Sammaz 27) were not significant (Table 2) signifying that 20 Kg N ha^{-1} would not be enough for significant growth change because Maize as a cereal crop requires an appreciable amount of nitrogen (90 – 120 Kg N ha^{-1}) (Adesoji *et al., 2015*). The application of 20 Kg N ha^{-1} of any form may just not be enough for maize alone, how much more the intercrop maize. The result of Table 2 shows that plant height and shoot biomass performance of maize plants were the poorest in control pots implying that nitrogen was low and poorly supplied to maize plants.

Root biomass of intercrop soybean (TSB 4810) was significantly affected by Nitrogen sources (Table 3) implying that nitrogen application, regardless of source can significantly affect root weight as far as the root aids uptake of nutrient and does not compete with the Leaf for carbohydrates.

Application of 20 Kg N ha^{-1} as inorganic fertilizer to intercrop soybean and its inoculation with USDA110 produced root biomass that was significantly superior to the root biomass of control plants (Table 3) reflecting the role nitrogen plays in the overall growth of the plant (Shiferaw *et al., 2011*). and also suggesting that biological nitrogen supply was significantly higher than nitrogen in the control pots. Conversely, application of organic nitrogen (20 Kg N ha^{-1}) produced root biomass that was the same and not statistically different from the root biomass of control plants implying that the organic N was probably not mineralized and available to the intercrops (Dobermann and Gassmann, *2004*). Nodule number and weight were significantly affected by Nitrogen sources (Table 3). Nodule number was significantly improved as a result of inoculation with USDA 110 compared to control and other Nitrogen sources implying that USDA 110 strain was quite infective compared to the exotic strains in control pot (Sanjay *et al., 2017*).

The reverse was the case under inoculated treatment.

Conclusion.

Although there was no significant evidence that showed that the intercrop maize benefited from the different Nitrogen sources applied, the study has however shown that the growth and nodulation characteristics of intercrop soybean was significantly affected by the supply of 20 Kg N ha^{-1} from different Nitrogen sources.

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