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EEFECT OF FERTILIZER TYPES ON NODULATION, GROWTH AND YIELD OF COWPEA IN SOUTHWESTERN NIGERIA

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ABSTRACT

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Two pot experiments were conducted in the screen-house of the Department of Biology, Adeyemi College of Education, Ondo southwestern Nigeria between May and August 2015 to determine the effect of fertilizer types on nodulation, growth and yield of cowpea. Thirty two pots of 10kg in size were filled with washed sand collected from river. The eight treatments comprised 5g/10kg soil of poultry manure (PM), manufactured organic fertilizer (MOF) and organomineral fertilizer (OMF) while 2g/10kg soil of NPK 15 15 15, single superphosphate (SSP), urea and muriate of potash (MOP) and control were used.The treatments were arranged in Completely Randomized Design (CRD) and replicated four times. Poultry manure applied at 5g/10kg soil had the highest plant height,grain yield, biomass and number of effective nodules (p> 0.05) relative to other treatments. The order of increase in effective nodules werePM>SSP>OMF>Urea>MOP MOF>Control.

Keywords*: Organomineral fertilizer, mineral fertilizers, manufactured organic fertilizer and effective nodules*

INTRODUCTION

The dwindling in the available lands required for agricultural purposes has led to various practices that cause depletion in soil nutrients. Among such practices include deforestation, nutrients mining and continuos cropping. Over population, civilization and technological advancement are also some of the major problems that cause reduction in the available lands meant for agriculture. Records have shown that most Nigerian diets are deficient in protein as a result scarcity of food (Adegeye, 2014). Among the proteinous food, cowpea is one of the most common arable crops that arerich in protein. Ddamulira *et al.* (2015) reported that the protein content in the leaves of cowpea ranges between 27 – 43% while Adegeye (2014) reported that the seed of cowpea consists of about 20%.

Cowpea serves a dual purpose. Firstly, cowpea supplies protein to human diet. In Nigeria, cowpea could be prepared as food in different forms. It could be cooked and eaten with stew, mixed with soup ingredients, prepared as bean cake or as ingredient for salad (Adegeye, 2014). Secondly, cowpea is a leguminous crop that is known to increase nitrogen content of agricultural soils through symbiotic association with *Rhizobium leguminosae*. The bacteria help to fix nitrogen in the nodules (Rachies, 1985). The number of nodules present in a given roots of the plants may affect the microbial population that will fix nitrogen. Viser and Parkinson, (1992) emphasized that some bacteria are important because of their roles in biological N2 fixation, a process that has been identified as an important indicator of soil fertility. The poor soil fertility has necessitated the use of fertilizers in increasing the growth and yield of cowpea as well as increasing its nodules. There have been little known research work the effect of mineral, organic and organomineral fertilizers on nodulation, growth and yield of cowpea in Ondo southwestern Nigeria. Hence, the objective of this study was to compare the effects of fertilizer types on nodulation, growth and yield of cowpea in Ondo Southwestern Nigeria.

MATERIALS AND METHODS

Two pot experiments were conducted in the screen-house of the Department of Biology, Adeyemi College of Education, Ondo southwestern Nigeria between May and August 2015 to determine the effect of organic, organomineral and mineral fertilizers on nodulation, growth and yield of cowpea. Thirty two pots of 10kg in size were filled with washed sand collected from river. Washed sands are low in soil organic matter and soil nutrients. Four (4) cowpea seeds of Ife brown varieties were planted per pot and were later thinned to two (2) cowpea seed per stand. The Eight Treatments used comprised 5 g per 10 kg soil of poultry manure, manufactured organic manure and organomineral fertilizer while 2 g per 10 kg soil of NPK 15:15:15, single superphosphate, urea and muriate of potash were used. There was a control experiment without treatment. Addition of 5g of poultry manure to 10 kg of soil is equivalent to 10 t ha^{-1} of poultry manure while 2g of fertilizer types added to 10 kg soil is equivalent to 400 kg ha^{-1}. Research work have shown that application of 10t/ha of organic manure and 400 kg ha^{-1} of mineral fertilizers are believed to be sufficient for optimum production of most arable crops in depleted soils of southwestern Nigeria (Ilodibia and Chukwuma, 2015; Donatus *et al*., 2014; Ndor and Dauda, 2013).

Each treatment was replicated four times and arranged in Completely Randomized Design (CRD). Equal volume of water was weekly added to each pot. Insecticide (Solitex) was applied at two (2) weeks interval to each pot. Two grams (2g) of the insecticide mixed with 2 litres of water were sprayed with knapsack to the cowpea

seedlings. The washed sand was analysed for soil chemical properties before the conduct of the experiment while the final soil chemical properties was determined. The soil pH, OC, total N, available P and cations (K, Ca, Mg and Na) and micronutrients (Iron, Mn, Cu and Zn) were anlaysed using the methods described by IITA, (1982)
Two plants per pot were used to measure root nodulation, growth, nutrient uptake and yield parameters. Data were collected on stover yield, dry root matter, leaf area, wet leaf matter at 50% flowering.
Plant nutrient analysis
The plants from each pot were uprooted and transported in a well labelled paper envelope to the laboratory. They were washed with distilled H_2O and air dried. The air dried samples were packed inside the well labelled enveloped and put inside a hot air oven, preset to a temperatures of 65 °C for about 24 hours and dried to a constant weight. The dried sample were allowed to cool inside a desiccator and grounded into powder. The grounded samples were then packed inside a cellophane nylon accordingly. The nutrients determined were N, P, K, Ca, Mg, Fe, Cu, Zn, Mn nutrient uptake was analysed from the wet digest using perchloric acid (IITA, 1982). The biomass of the cowpea was harvested and weighed. The numbers of pods/plant was counted and weighed to determine the yield. Nodulation was determined at forty five days after planting. The cowpea plants were carefully uprooted. The nodules were counted and then cut with razor blade were cut in order to determine the effective nodules. Hand lens was used to separate the nodules with pink or reddish, from the green or colourless ones. The reddish or pink colours signified effective nodules while the green or colourless nodules were ineffective. The effective nodules were the nodules that fixed N. The nodules were oven dried at 80°C for 48 hour. The leaf area was determined with the use of graph paper. Plant height was measured with meter rule. The data for the two experiments were generated and their means were computed. Data collected were subjected to Analysis of Variance (ANOVA) using the Statistical Analysis System Institute Package SAS, (2003). Means were separated using .Duncan Multiple Range Test.

RESULT AND DISCUSSION

The chemical and physical characteristics of the soil for the conduct of this research are presented in Tables 1 and 2. The chemical properties of the soil showed that the soil was slightly Acidic, the soil was sandy, Ca fairly adequate, Mg, K, EA and ECEC were low, K is low, EA is low, ECEC too low, N too low, organic carbon too low, while Mg, Fe, Zn were very high, Cu was adequate. The nutrients composition of NPK 15:15:15, organic and Organomineral fertilizers are presented in Table 3. NPK fertilizer had high N, P, K than organic and Organomineral fertilizers. The Single Super Phosphate contained only P (22%) without N and K. Muriate of Potash (MOP) had only K (60%). Urea fertilizer contained only N (46%) without P and K. The data in table 4 shows the effect of NPK 15:15:15, organic and Organomineral fertilizers on soil chemical properties. Compared with control, all the pots fertilized with OMF, PM and MOF significantly increased ($p>0.05$) the soil pH. The OC content in the soil treated with PM was significantly increased ($p>0.05$) compared to control. Compared with control, all the treatments significantly increased ($p>0.05$) available P. Only the soil samples fertilized with OMF, OMP and SSP had better significant effect on soil exchangeable K. The nutrients composition of the fertilizers used as treatments showed that OMF, MOF and SSP had reasonable amount of K which might not be totally exhausted by the cowpea plants.

Table 1: Initial soil chemical properties

Soil Properties	Value
pH	6.30
N (%)	0.04
O.C (%)	0.33
Available P mg kg^{-1}	4.21
Exchangeable Base ($Cmolkg^{-1}$)	
Ca	1.32
Mg	0.58
K	0.04
Na	0.11
Al+H	0.07
ECEC	2.23
Micro Nutrients (mg kg^{-1})	
Mn	20.85
Fe	276.98
Cu	1.19
Zn	17.98
Textural class (%)	
Sand	90.20
Silt	5.40
Clay	4.40

Table 3: Nutrient composition of organic, mineral and organomineral fertilizers (%)

Nutrients	N	P	K
Mineral Fertilizers (NPK)	15	15	15
Organomineral fertilizer (OMF)	3.5	2.5	4.0
SSP	-	22	-
MOP	-	-	60
Urea	46		
Poultry Manure	2.10	1.82	0.32

Table 4: Effect of organic, organomineral and mineral fertilizers on soil chemical properties

Treatment	pH	OC (%)	N (%)	P (mg kg^{-1})	K (Cmol kg^{-1})
Control	5.93e	0.38b	0.05b	5.84g	0.08c
MOF	7.35a	0.27cd	0.04b	43.09b	0.34b
MOP	5.29g	0.35bc	0.05b	33.42c	0.11c
NPK	6.14d	0.21d	0.02c	23.41d	0.09c
OMF	6.98c	0.33cd	0.08a	21.96d	0.83a
PM	7.08b	0.97a	0.10a	9.03f	0.09c
SSP	5.78f	0.27de	0.03bc	46.14a	0.61b
Urea	5.30g	0.22e	0.03bc	17.18e	0.11c

Means with the same letters is not significantly different according to Duncan Multiple Range Test.
MOF = Manufactured Organic fertilizer, MOP = Muriate of Potash, NPK = NPK 15:15:15 fertilizer, PM = Poultry Manure, OMF = Organomineral, SSP= Single Super Phosphate

The data in Table 5 shows the effect of NPK 15:15:15, organic and Organomineral fertilizer on yield and growth components of cowpea. Compared with control, all the treatments significantly increased plant height, number of branches, weight of pods (except MOP), weight of seeds except (MOF and MOP) and biomass except SSP. Figures 1 and 2 show the effect of fertilizer types on nodulation of cowpea. On nodulation count, all the treatments significantly increased the number of nodules compared with the control experiment.. The cowpea fertilized with poultry manure recorded the highest number of nodules. The nodules of the cowpea fertilized with OMF, SSP, NPK and urea fertilizer were not significantly different.

Table 5: Effect of fertilizers on agronomic parameters of cowpea for experiments 1 and 2

Treatment	Plant height (cm)	No. of Branches	Leaf area (cm^2)	No of Leaves	No. of Pod	Weight of Seed (g)	Weight of Husk (g)	Weight of Pod (g)	Biomass (g)
Control	90.33d	2.33c	18.06b	58.00a	3.0b	1.27c	2.8b	4.47c	39.37e
MOF(5g)	126.00a	5.00ab	22.27a	33.00c	3.67b	2.70c	2.90b	8.77b	62.20b
MOP(2g)	104.66c	4.00b	13.41c	60.66a	2.67b	1.57c	1.80b	1.47d	49.00d
NPK(2g)	117.66b	4.00b	22.60a	49.67b	4.00ab	4.57b	6.87a	11.96a	47.23d
OMF(5g)	122.33a	6.00a	21.67a	43.33b	5.33a	4.23b	7.13a	11.80a	62.93b
PM(5g)	129.00a	5.00ab	24.75a	38.33c	6.33a	5.70ab	6.00a	12.93a	72.90a
SSP(2g)	91.00dc	7.66a	19.97b	31.67 c	5.00a	4.93ab	8.40a	6.77b	18.47e
Urea(2g)	121.33a	4.66b	19.73b	47.00b	3.00b	4.70a	3.97c	10.87a	57.70c

Means with the same letters is not significantly different according to Duncan Multiple Range Test.
MOF = Manufactured Organic fertilizer, MOP = Muriate of Potash, NPK = NPK 15:15:15 fertilizer, PM = Poultry Manure, OMF = Organomineral, SSP= Single Super Phosphate

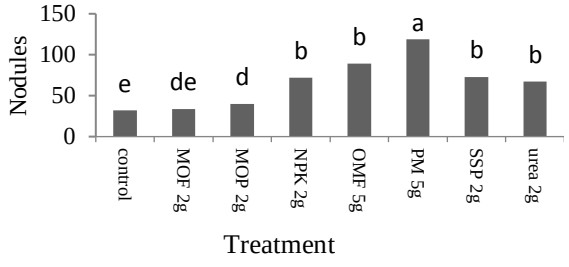

Fig. 1: Number of nodules/plant

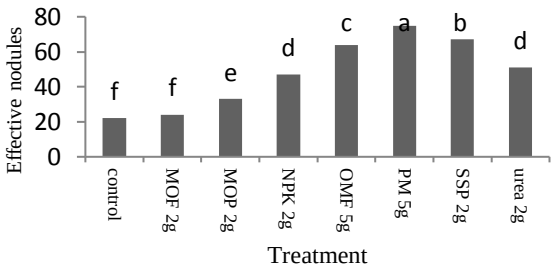

Fig 2: No of effective nodules/plant

MOF = Manufactured Organic fertilizer, MOP = Muriate of Potash, NPK = NPK 15:15:15 fertilizer, PM = Poultry Manure, OMF = Organomineral, SSP = Single Super Phosphate

DISCUSSION

It was observed that the Mn, Fe and Zn content of the soil used for the experiment was very high. Samuel *et al* (2003) reported that macro nutrient increase soil acidity and low nutrient status of the soil indicate that the soil needs fertilizer because the soil used was washed sandy soil containing low nutrient. The analysis of organic manure in this study is also in line with the work of Adeleye and Ayeni (2010), Adeniyan (1999), Adeniyan and Ojeniyi (2005 and 2006) that organic manure composed of micro nutrients with little micro nutrients.). The available P was lower than the critical recommended level of 7.0 mg kg^{-1} by Aune and Lai (1995) as the critical soil available P level required for proper growth and development of cowpea. Organomineral fertilizer had higher P and K than organic fertilizer, the Nutrient composition of organic, Organomineral and NPK fertilizer show that NPK had the highest N, P and K followed by Organomineral fertilizer. The higher N, P and K content NPK fertilizer than both organomineral fertilizer and organic manure would affect the N, P and K released to the soil for cowpea uptake.

It was observed that the N content of the soil samples fertilized with OMF and PM was significantly higher than the control and the soil fertilized with the mineral fertilizers at the end of the experiment. This showed that OMF and PM have better residual effects on soil nutrients than the mineral fertilizers. This might be as a result of higher C/N ratio in PM and OMF than the mineral fertilizers that delayed mineralization of plant nutrients. The lower N content in the soil samples fertilized with NPK, MOP, SSP and urea might be as a result of evaporation of the nutrient into the atmosphere. The highest percentage increase in N was recorded by PM. The addition of OMF and PM to the soil samples might have provided favourable conditions for the N fixing bacteria. The residual N and the other nutrients were expected to come from the treatments used for the experiment since the soil samples used was collected from the river sand which was deficient in plant nutrients. It was observed that the control experiment, the soil samples fertilized with MOP and SSP had higher number of leaves but lower leaf area. Broad leaves were expected to have more photosynthetic area than the short and thin leaves. This might be the reason why PM, NPK and OMF had better yields. Poultry manure, NPK and OMF might have enjoyed balanced plant nutrition. Analysis of poultry manure and OMF showed that they contain reasonable amount of N, P, K, Ca, Mg, S and some micronutrients that are essential for plant growth and grain formation. Poultry manure composed 11.8, 1.72, 6.9, 9.56, 3.87, 2.66, 1.09 and 2.77% for OC, N, C/N, P, K, Ca, Mg and S respectively in the experiment conducted by Ayeni (2008) on the effect of poultry manure on soil fertility management. Ayeni, *et al.*, (2008) showed that poultry manure comprised 2.44, 0.41, 1.30 and 4.20 for Fe, Zn, Cu and Mn respectively. The N, P and K present in NPK fertilizer are the most required plant nutrients for crop growth and yield.

The observation that fertilizers increased the nodulation count was in line with the finding of Singh et al. (2011) who observed that phosphorus fertilizer has influence on the yield of cowpea in the experiment performed on the influence of phosphorus on the performance of cowpea (*Vigna unguiculata* (L) Walp.) varieties in the Sudan savanna of Nigeria. The plots fertilized with the treatments that contained P were observed to increase nodulations than the treatments without P in their contents Phosphorus helps in nutrition and nodulation of cowpea (Okeleye and Okelana, 1997). Phosphorus also stimulates root growth, plant height, initiates nodule formulation and influences the general efficiency of the rhizobium – legume symbiosis thereby optimizes the biological N fixation system of legume (Normal et al., 1995 and Ankomah et al., 1995 and Nkaa et al., 2014). Phosphorus helps in producing higher nodulation count. Zahran (1999) reported that nodulation, nitrogen fixation and specific nodule activity are related to the P supply.

CONCLUSION

The experiment conducted to show the effect of organic, Organomineral and mineral fertilizers on the nodulation and agronomic parameters of cowpea showed that the soil used for the experiment was slightly acidic and deficient in organic matter N, P and K. Poultry manure applied at 5g/10kg soil had the highest plant height, biomass and number of effective nodules. NPK fertilizer applied at 2g/10kg soil recorded the highest leaf area while SSP recorded the highest number of branches, husk and pod weight. Application of manufactured organic fertilizer performed best in increasing availability of soil nutrient (P), cowpea growth and yield. Organomineral fertilizer and organic manure increase the level of N, P and K content in the soil. This experiment also shows that Organomineral fertilizer can increase the number of pods as well as nodulation in cowpea.

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