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EFFECTS OF NPK FERTILIZER APPLICATION ON THE GROWTH AND SEED YIELD OF COWPEA IN ILORIN, SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT

To forestall wastage and determine the optimum level of complete fertilizer needed for better production of cowpea, the application of NPK 16:16:16 fertilizer on the growth and yield of the crop was investigated. The field experiment was conducted on the Teaching and Research Farm of the Faculty of Agriculture, University of Ilorin. A medium-maturing cowpea variety IAR- 48 was tested with five NPK fertilizer rates viz: 200kgNPK/ha, 400kgNPK/ha, 600kgNPK/ha, 800kgNPK/ha and 0kgNPK/ha as the control. The experiment was laid out in a randomized complete block design, replicated twice. Data were collected on plant height, number of leaves, leaf area, number of branches, number of pods per plant, number of seeds per pod, weight of 100seeds and grain yield per treatment. All data were subjected to Analysis of Variance (ANOVA) using GENSTAT package while separation of significant means was done using Least Significance Difference (LSD) at 5% probability level. Results showed that NPK fertilizer at the rate of 200kg/ha improved pod production, weight of 100seeds, pod weight and final grain yield per hectare. It could, therefore, be inferred that, subject to further research, if NPK 16:16:16 is applied at rate of 200kgNPK/ha or less, better yield and reduction in the cost of production will be achieved with cowpea variety IAR- 48 in Ilorin, a location in the Northern Guinea Savanna Zone of Nigeria.

Keywords: Complete fertilizer, cowpea, vegetative growth, yield potential and yield improvement

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most adapting, versatile and nutritious grain legumes found mostly in drier regions and marginal areas of the tropics and subtropics. The crop is particularly important in West Africa with over 9.3 million tones annual production (Ortiz, 1998). The grains are a good source of human protein, while the

Pods are a valuable source of livestock feed (Fatokun, 2004). Cowpea is also important because it fixes atmospheric nitrogen (Asiwe *et al.*, 2009) and excess of its nitrogen requirements are available for subsequent crop uptake thereby reducing the cost of nitrogen fertilization. In Nigeria, 80% of the cowpea produced is mainly in the savanna zone of the country. The main cowpea producing states in Nigeria are in the north, mainly Kano, Kaduna, Katsina, Bauchi, Borno, Adamawa, and Taraba (Ayinde *et al.*, 2006).

Cowpea is a warmth-loving, herbaceous annual legume that is cold sensitive and killed by frost. Hence, it is less prone to diseases and insect pests in the drier areas of the Sudan zone than the wetter areas. The crop dries well before and after harvesting, thereby making storage relatively easy to organize. The plant is deep-rooted and mature in about 60-90 days. For better production and good yield, the crop should be planted at the appropriate time as planting too early results in luxuriant vegetative growth at the expense of pod yields, while late planting makes the pods fail to mature well before dry season commences.

Compared with many other crops, cowpea has received little attention from plant breeders for yield improvement and so efforts need to be made to achieve satisfying yield increase through exploring its yield potential. It has been observed that if cowpea production is to keep pace with the other crops, especially cereals such as sorghum and millet, its yield potential must be improved (Anonymous, 2004). Among factors responsible for the low yields is soil fertility because most tropical soils are deficient in essential nutrients, particularly Nitrogen (N) and Phosphorous (P).

The use of fertilizers as a yield booster has been reported by Kutu *et al.*, (2009). At present, most cultivated land in Southern Guinea Savannah ecological region loses more N, P, and K as a result of continuous cultivation which has led to nutrient mining and loss of topsoil by wind and/or water erosion. Under these conditions, productivity level of both cereals and legumes are too low to sustain food production, meet food requirement of the fast growing human population and ensure food security. Although organic amendment such as crop residue, manure or compost is essential in the sustainability of the cropping systems, they are incapable of preventing nutrient mining. The addition of organic amendments corresponds in most cases to a recycling process, which cannot compensate for nutrient exported through crop production and removal of its residue from the producing soil. As a result, the use of external inputs such as inorganic plant nutrients or local sources of NPK is essential requirement for soil nutrient sustainability and the consequential better yield improvement.

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There are many reported studies on the effects of N and P application on growth and yield of cowpea (Owolade *et al.*, 2006; Kolawole *et al.*, 2002; Okeleye and Okelana, 1997) but there is paucity of information on the effects of combination of NPK fertilizer on growth and yield of cowpea in Ilorin, which is in a savannah ecological zone in Nigeria. Since it has been reported that the main limiting nutrients for legume production in the tropics are N and P (Fox and Kang, 1997), therefore, the present work was carried out to evaluate the effects of NPK 16:16:16 fertilizer on the growth and yield of cowpea in Ilorin, Kwara State.

MATERIALS AND METHODS

The field experiment was conducted on the Teaching and Research Farm of the Faculty of Agriculture, University of Ilorin. The University is located in Southern Guinea savanna ecological zone of Nigeria (Long. 18°29'N; Lat. 4°35'E) and about 307m above sea level. The land was ploughed and harrowed once and was consequently ridged. Soil samples of the experimental site were randomly taken from the top 0-5 cm soil depth and a composite sample was then made out of them. It was then air-dried for 5 days and passed through a 2mm mesh for physico-chemical analysis.

- Five levels of NPK 16:16:16 fertilizer which were 0kgNPK(T₀), 200kg NPK(T₁), 400kg NPK(T₂), 600kg NPK(T₃), 800kg NPK(T₄) were tested. Each treatment was replicated three times in a randomized complete block design. There were a total of 15 plots with each plot having a dimension of 3m × 3m (9m²) which contained three ridges of 3m length. A medium-maturing variety of cowpea, IAR 48, collected from National Agricultural Seed Council (NASC), Ilorin, was sown in August, 2010, with a spacing of 30 x 100cm. Four seeds were planted per hole and the resultant seedlings were thinned to one plant per stand at 3 weeks after planting (WAP). Fertilizer was applied 3WAP using spot application method at a depth of 4cm and was buried to prevent crop injury (Fapohunda and Adekalu, 1995). The plots were manually weeded three times at three weeks interval starting from 2WAP. Insect pests were controlled using Karate 2.5EC as soon as flowers emerged until pod matured at a week interval. The application rate was 1.2kg a.i/ha. Two different forms of data were collected; the growth and yield parameters starting from 5WAP. Three representative plants were randomly selected from the middle of each plot to forestall border line effects and the data were taken every fortnight. Morphological and yield data were assessed with plant height, number of leaves, leaf area using graphical method, number of branches, pods per plant, number of seeds per pod,

weight of 100 seeds, yield per treatment, shelling percentage and grain yield per hectare. The shelling percentage was calculated as follows:

$$\text{Shelling \%} = \frac{\text{Grain weight} \times 100}{\text{Pod weight}}$$

All data collected were subjected to Analysis of Variance (ANOVA) using GENSTAT while significant means separation was done using Least Significant Difference (LSD) at 5% probability level.

RESULTS AND DISCUSSION

Fertilizer application at all levels did not statistically improve the height of the plant above the control. On the contrary, the tallest plants were found in the control plots. At 5WAP, application of 600kgNPK/ha produced plants with the highest height while at 7WAP it was 200kgNPK/ha. Other parameters were at optimum with application of no fertilizer (Table 1). All the NPK rates tested failed to produce significant height improvement above the control during the period of observation and data collection (Table 2). Plant height which is a measure of plant growth that results from mitotic cell division is nutritionally promoted by nitrogen in the soil and is normally supported by additional fertilizer added to the soil. In situations where there is nutrient imbalance and the critical level has not been reached, the differences in response resulting from different levels of applied nitrogen will show a positive correlation until the optimum requirement is fulfilled after which law of diminishing return sets in. This explains what really happened with plant height where no fertilizer treatment outperformed the other while the control plants having the highest height. The discovery of Summerfield *et al* (1994) that increased level of fertilizer application increased the growth parameters of cowpea is still maintained and sustained as long as the critical level of the nutrient requirement of the plant is not reached.

Table 1: Effects of NPK Fertilizer on Cowpea Plant Height (Cm) at Different Ages

NPK levels (kg/ha)	5WAP	7WAP	9WAP	11WAP
0	11.00	15.00	19.33	20.33
200	11.00	16.00	17.67	19.33
400	11.00	13.00	14.33	15.33
600	12.33	14.67	17.00	18.67
800	10.00	13.33	16.67	17.67
LSD (5%)	ns	ns	ns	ns

ns = not significant, WAP= weeks after planting

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Table 2: Effects of NPK Fertilizer on Cowpea Number of Branches at Different Ages

NPK levels (kg/ha)	5WAP	7WAP	9WAP	11WAP
0	1	2	2	3
200	1	2	2	3
400	2	3	3	3
600	2	2	3	3
800	1	2	3	3
LSD (5%)	Ns	ns	ns	ns

ns= not significant, WAP= weeks after planting

Leaf production in cowpea was favoured by all NPK levels applied treatments above the control. The relationship between the fertilizer levels and the leaf number increase was linear at all ages though the increases recorded were not statistically significant. The highest number of leaves was recorded from the highest application rate (800kg/ha), while the lowest was from the control throughout the period of observation (Table 3). The number of branches produced is a function of how vigorous the vegetative growth of the plant is. This is dictated by the genome and the predominant environmental factors of the plant involved. Varietal differences have got a lot to do with what happens to branch production. Abayomi *et al*, (2008) reported the highest number of branches in cowpea plant in the control contrary to what was obtained in this work.

Table 3: Effects of NPK Fertilizer on Cowpea Number of Leaves at Different Ages

NPK levels (kg/ha)	5WAP	7WAP	9WAP	11WAP
0	8	21	30	34
200	9	23	32	37
400	9	23	31	38
600	9	32	32	42
800	10	34	41	45
LSD (5%)	ns	ns	ns	ns

ns = not significant, WAP= weeks after planting

Application of NPK fertilizer at all levels during the period of the experiment resulted in insignificant increase in leaf area over the control. This is in line with the observation on the leaf number production in response to the applied treatment. However, contrary to results obtained on number of leaf production, there was a decline in leaf area after

600KgNPK/ha treatment and that led to non-sustainability of the response linearity at all ages (Table 4). Following the same pattern as that of branch production, an item of vegetative part of cowpea, leaf production also got aided by fertilizer application. The linearity of the relationship implied that as the fertilizer rate increased, the number of leaves also increased. It has been reported that vegetative production normally increases as the level of fertilizer application increases and that nitrogen application results in vigorous and luxuriant growth of cowpea till optimum level is reached and law of diminishing return sets.

Table 4: Effects of NPK on Leaf Area (Cm²) of Cowpea Plants at Different Ages

NPK levels(kg/ha)	5WAP	7WAP	7WAP	11WAP
0	30.09	31.77	34.55	34.90
200	33.88	34.31	35.06	35.15
400	34.71	35.51	35.96	36.00
600	35.30	35.80	36.03	36.12
800	34.00	34.68	34.80	34.90
LSD	Ns	ns	ns	ns

ns = not significant WAP= weeks after planting

To intercept solar radiation for photosynthetic activities, the leaf area of a plant has to be at its optimum size and its angle of inclination should be favourable for the targeted objective to be achieved. Furthermore, the absorption of nutrient and water from the soil is dependent on transpiration rate of the plant which majorly rests on the size of the leaf or the leaf area. To that end, application of fertilizer is required to boost such vegetative characteristics. This was so up to a certain degree after which the response started declining because the vegetative growth of plants as a result of fertilizer application follows the Liebig's law of optimum. This implies that increasing the amount of abundant nutrients will not increase plant growth. It is only by increasing the amount of the limiting nutrient (the scarcest one in relation to the "need") will the growth of a plant or crop be improved.

There was linear increase in pod production with age increase in all the fertilizer rates tested with inclusion of the control. At the final stage of observation (11 weeks after planting), only 200kgNPK/ha had increase in pod production after which there was a decline as the fertilizer rate increases. Both leaf area development and pod production were statistically similar at all levels of application and times of measurement (Table 5). Because there is a linear relationship between pod and grain production, pod production is,

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therefore, an index of productivity in legume plants. Aiding pod production with fertilizer application was not a success in the work because none of the treatments stood out when compared with the control. It could be said that at the time of pod initiation and development, more of the assimilates were partitioned to the growing regions of the plant vegetative parts to fuel the cell division and development and so a greater sink than the that of the pod development has to be catered for according to the priority of their needs. Study carried out at Varanasi, India also exhibited the same effects when NPK fertilizer was used to aid pod production in cowpea (Raj *et al.*, 1991).

Table 5: Effects of NPK on cowpea pod production at different ages

NPK levels(kg/ha)	7WAP	9WAP	11WAP
0	5	14	14
200	9	14	17
400	10	14	16
600	10	13	15
800	8	12	13
LSD	ns	ns	ns

ns = not significant

WAP = weeks after planting

Seed production per pod was only improved by application of 400kg NPK/ha while the rest were the same in terms of their output though none was statistically better than the other (Table 6). 200kgNPK/ha had the highest value for weight of 100 seeds while 800kgNPK/ha showed some weight increase with no significant difference at all the levels of application (Table 6). Highest pod weight was recorded from 200kgNPK/ha with the least resulting from 600kgNPK/ha. Though clear differences were evident, statistically, they were not recognized (Table 6). 200kgNPK/ha produced the highest grain yield per hectare while 600kgNPK/ha had the least among the tested treatments (Table 6). The carrying capacity of the pods is dependent upon the length of the pod as well as the number of ovules that got fertilized. The linearity of the relationship between the pod length and the number of seeds is a viable index to exhibit how helpful the treatment was in improving the length of the pods. It could be inferred that the length of the pods as well as the number of seeds produced were only enhanced at a minimum degree above the control which was 200KgNPK and further increase in the application resulted in production retardation instead of acceleration. Poisoning resulted in further addition of the nutrient with

consequence of lower production than the control. This is still in line with Liebig's law (Van der Ploeg *et al.*, 1999).

Table 6: Effect of Application of NPK Fertilizer on Seed Parameters and Yield of Cowpea

Treatments (NPK levels- kg/ha)	No of seeds/pod s	Weight of 100 seeds (g)	Pod weight/plant (g)	Grain yield (kg/ha)
0	7	15.79	0.700	156
200	8	16.65	0.867	200
400	7	16.01	0.567	133
600	7	15.33	0.533	122
800	7	15.20	0.500	115
LSD (5%)	ns	ns	ns	Ns

In the same vein, the amount of assimilate contained in the seeds of plants that received 200kgNPK/ha was the highest and that resulted in the highest weight of 100 seeds. This weight increase or decrease was a result of the enhancement given by the fertilizer to mitotic cell division that succeeded the meiotic division which brought about seed production after fertilization. It is, therefore, evident that an appreciable level of nitrogen up to 200KgNPK can be used in enhancing the seed weight as well as the quality of the seeds in cowpea. This rate is chosen because further increase leads to decline in production. Also, it could be said that partitioning of assimilate was effective and that led to increase in dry matter accumulation in the seeds which was evident in the weight of 100 seeds. The partitioning effectiveness could be said to be supported by potassium nutrition which is very essential in grain filling of both grain legumes and cereals. This is a constituent of NPK fertilizer applied.

Heavy seeds of legumes require firm support to be held intact and such was provided by the pods. So, if the seeds are heavy, the required pods for proper housing of such seeds must be heavy and firm to provide the expected support. This was the case of the present research finding in which the pod weight of the treatment that produced the highest grain weight (200kgNPK/ha) was the highest. Positive linear relationship between fertilizer application and pod weight was also reported by Owolade *et al.*, (2006) who used fertilizer rates below 200kgNPK/ha throughout his experiment.

The trend of yield parameter response was still maintained in the overall grain (yield) production. The result of weight of 100seeds was in consonance with the overall yield in

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which highest weight or yield was recorded from 200kgNPK/ha. This showed that weight of 100 or 1000 seeds could be used to determine which treatment would give the highest yield weight provided there was an attack of pests and diseases as well as environmental hazards so as to know the best treatment although the exact yield cannot be determined, still we can forestall repeating the experiment and the scarce resources could be judiciously used for further discoveries. From the on-going, it is crystal clear that there was a positive correlation between morphological parameters and yield. Also, there was progressive decrease in grain yield above certain critical level which was 200kgNPK/ha in this experiment. This conclusion was also corroborated by Abayomi *et al.* (2008).

CONCLUSION AND RECOMMENDATION

From the foregoing, it could be safely concluded that NPK 16:16:16 fertilizer should be applied at the rate of 200NPK/ha or less for judicious production of cowpea variety IAR-48 with advantage of reduction in cost of production in Ilorin, a location in the Northern Guinea Savannah of Nigeria. It is suggested that interested scientists should carry out further research on this work in order to better harness its import for the end users.

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