

Effect of NPK (12:12:17) Fertilizer Rates on the Growth and Yield of Cowpea (*Vigna unguiculata*) Varieties

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Abstract

Field experiments were carried out as 3 x 4 factorial at the faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki in 2016 and 2017 cropping seasons to study the effect of NPK (12:12:17) fertilizer rates on the growth and yield of cowpea varieties (*Vigna unguiculata*). Results revealed that fertilizer application resulted in significant improvement in plant height, number of leaves per plant, leave area index and reduced days to flowering. Yield components and grain yield were significantly enhanced by the application of fertilizer at 150 kg ha⁻¹ but varietal effect indicated differential varietal responses to fertilizer application which had significantly practical implications for field production. It was therefore concluded that the application of fertilizer to cowpea is beneficial although in small quantity and genotype dependent. There were positive and significant correlation among growth and yield characters except days to 50% flowering that was negatively correlated.

Keywords: Cowpea, Fertilizer, Growth, NPK, Varieties, Yield.

DOI: 10.7176/JBAH/10-2-03

Publication date: January 31st 2020

Introduction

Cowpea (*Vigna unguiculata* L walp) is a tropical annual herbaceous legume which belong to the family papilionaceae (Fabaceae) order Leguminosae and genus Vigna (Singh et al., 1997). The genus Vigna consist of over hundred different species widely found in the tropical and subtropical regions and has great morphological and ecological diversity. It is an important food grain legume for over 200 million people in the dry savanna of tropical Africa. It is particularly important in West Africa with over 9.3 million metric tons of annual production (Ortiz, 1998). The grain is a good source of human protein, while the haulms are valuable source of livestock protein (Fatokun, 2002). It is also a source of income for many smallholder farmers in sub-Saharan Africa and contributes to the sustainability of cropping systems and soil fertility improvement in marginal lands through provision of ground cover and plant residue, nitrogen fixation and suppressing weed. However, despite its great importance, grain yield of cowpea crop is low, around 300 kg ha⁻¹ compared with many other crops, the cowpea has received little attention from plant breeders and a large efforts needs to be made to break the yield barriers and if cowpea production is to keep pace with the other crops, especially cereals, its yield potential must be improved (Anonymous, 2004).

In Nigeria, 80% of the cowpea produced is mainly in the savanna zone of the country (FAO, 1999). A wide range of seed yields have been recorded for cowpeas but are generally low.

Among factors responsible for the low yields are low soil fertility, as most tropical soils are deficient in essential nutrients particularly N and P (Jones and Wild, 1975). Traditionally, soil fertility in West Africa have been maintained through fallow. However, in Nigeria, intensive cropping and high population pressure are gradually replacing the traditional shifting cultivation that is associated with long fallow and hence low crop yield. The steady decline in food production due to reduced length of fallow on land has prompt farmers to amend soil with different materials such as organic and inorganic in order to enhance plant growth and increase yield (Adepetu, 1997). It has been suggested that organic manure should be used in place of chemical fertilizer to avoid long-term negative effects of chemical fertilizer on the soil (Parr et al., 1990). However, organic manure is usually required in large quantity to sustain crop production and may not be available to the small scale farmers (Nyathi and Campbell, 1995), hence, the need for inorganic fertilizer. The positive effect of the application of inorganic fertilizers on crop yields and yield improvement have been reported (Carsky and Iwuafor, 1999). Although, cowpea symbiotically fixes nitrogen, plant dependent on symbiotically fixed N may well suffer from temporary N deficiency during the seedling growth once the cotyledonary reserves have been exhausted.

Materials and Methods

The field experiments were conducted during 2016 and 2017 cropping seasons at the Research field of the Faculty of Agriculture and Natural Resources Management, Ebonyi State University Abakaliki. The experimental design was 3x 4 factorial laid out in a randomized complete block design (RCDB). The treatments comprised of three cowpea varieties (Sampea 5, 6 and 13) and four rates of NPK 12:12:17 (0, 50, 100 and 150kg ha⁻¹ and was replicated three times. The land was cleared and cultivated manually and the plot measured out and

pegged. Each plot measured 2m x2m (4 m²) with 0.5m between adjacent plot and 1m between replicates. The seeds were sown two seeds per hill at the depth of 2cm with the planting distance of 50cm x 50cm. Data were collected on the growth and yield parameters and were analysed with a General Linear Model in Minitab and where there were significant differences Turkey's test was used to separate the means. The residuals were tested for normality with the Anderson-Darling test, and where appropriate a transformation was used to improve the fit of the residuals to the normal distribution. Also correlations of the growth and yield parameters were determined in Minitab.

Result and Discussions

Soils of the area varied in their chemical properties with the Ferric Luvisol having a P value higher than that of the Ferric Lixisol. Soil nutrients deficiency is wide spread and is a major constraint to crop production (Nwoke *et al.*, 2005; Kisinyo *et al.*, 2011). The P value for the Ferric Luvisol could be attributed to the spatial variation of soil properties which is common. The inability of soils to supply adequate amounts of soil nutrients for plant growth is partly due to extensive losses due to long periods of intense weathering and strong fixation by Al and Fe oxides prevalent in many tropical soils (Doe, 2006). Organic matter levels of both soils were below the critical value (<1.7%) while the exchangeable calcium, sodium and magnesium levels were moderate for cowpea production (Landon, 1996). Fosu and Tetteh (2008) reported soil organic matter level of 0.48% for soils and soil nitrogen level of between 0.02 and 0.07% for savanna soils. The soils low organic carbon and total nitrogen contents could be attributed to the high temperatures resulting in high rate of decomposition. It can also be attributed to overgrazing as the farmers release their animals to feed on crop residues soon after harvest making residue incorporation unlikely. Soil organic matter is a major contributor to agricultural production in Africa and it influences soil properties and consequently plant growth.

Growth attributes such as plant height, leaf area index, number of leaves and Days to 50% flowering were significantly increased by the application of NPK fertilizer. This result is in conformity to the results observed by Krasilnikoff *et al.* (2003) and Nyoki *et al.* (2013). This could be attributed to the fact that NPK is required in large quantities in shoot and root tips where metabolism is high and cell division is rapid (Ndakidemi and Dakora, 2007). Thus, an indication that the cowpea varieties utilized the NPK fertilizer applied judiciously in growth and development processes. NPK application also improved all yield attributes taken into consideration in this study: number of pod, pod weight, pod length, seed weight, number of seeds and seed yield. These were found to be significantly different at 0.05 level of significance and this is in conformity with the findings of other workers (Okeleye and Okelana, 2000; Haruna and Usman, 2013; Odundo *et al.*, 2001; Ntare and Bationo, 2002; Nyoki *et al.*, 2013; Singh *et al.*, 2011 and Ndor *et al.*, 2012) who also discovered significant increase in yield of cowpea in response to phosphorus application. However, Agboola and Obigbesan (2001) reported that phosphorus application did not significantly increase cowpea yield but rather enhanced nodulation and phosphorus content of leaf and stem. Highest value in all the yield characters measured was observed in variety sampea 5 or 13 at NPK fertilizer rate of 150kg ha⁻¹, this contradicts the findings of Haruna and Usman (2013) who recorded highest yield at 30 kg ha⁻¹ in their experiment and Singh *et al.*, (2011) who reported highest yield at 60kg ha⁻¹ and suggested that that may be the optimum as further application of phosphorus may or may not increase yield of cowpea. The significant response of the measured yield characters of cowpea to phosphorus application could be attributed to the role of phosphorus in seed formation and grain filling (Haruna, 2011).

Table 1: Physcial and chemical properties of soil (0-30) from the experimental site

Soil Properties	Quantity
Sand (g/kg)	112
Silt (g/kg)	273
Clay (g/kg)	152
Textural Class	Loam
Chemical Properties	
ph in 0.01M CaCl ₂	3.21
Organic Carbon (g/kg)	10.3
Total Nitrogen (g/kg)	0.5
Available P (mg/kg)	2.02
Exchangeable Cation (cmol/kg)	
K	0.11
Mg	0.42
Ca	50
Na	5.3
CEC	2.34

Table 2: Effect of NPK 12:12:17 Fertilizer rates on the growth and yield characters of cowpea varieties

Treatments	Height (Cm)	No of leaves	Leave area index	Days 50% flowering	No of Pod	Pod Length	Pod weight (kg)	No of Seeds	Seed Weight (g)	Yield (Kg ha ¹)
NPK rates (kg ha¹)										
0	34.29d	17.02c	3.30d	42.78a	5.33d	4.44c	0.42d	4.22d	0.31d	4.48d
50	40.20c	29.97b	4.07c	32.22b	7.00c	5.11b	0.61c	5.44c	0.57c	5.70c
100	44.53b	30.39b	4.5b	32.33b	7.89b	5.33b	0.77b	7.11b	0.63b	6.76b
150	50.49a	38.37a	5.40a	30.89c	11.0a	8.67a	1.32a	9.11a	1.03a	7.54a
SE ±	0.95	1.08	0.24	0.48	0.28	0.27	0.03	0.13	0.06	0.59
Varieties										
Sampea 5	42.73a	28.75b	4.28a	33.83c	7.08c	5.42c	0.77a	6.25c	0.68a	6.57a
Sampea 6	42.14a	29.72a	4.41a	34.17b	8.00b	6.00b	0.78a	6.67a	0.60b	5.22b
Sampea 13	42.27a	28.35b	4.28a	35.67a	8.33a	6.25a	0.80a	6.50b	0.62b	6.58a
SE ±	0.83	0.94	0.21	0.41	0.24	0.23	0.03	0.11	0.05	0.51

Means followed by same letter (s) within same column and treatment group are not statistically different at 5% level of probability using Turkey's test.

Table 3 shows the relationship that exist in growth, yield and yield components of cowpea varieties. The significant and highly positive correlation between yield characters and its growth characters signified the importance of these characters in assimilate production. Larger canopy cover means greater interception of light energy and higher rate of photosynthesis. The parameter with the strongest relationship with yield was pod weight followed by number of seed while the weakest association with yield was days to 50% flowering that was negative, though was significant. The positive association of plant height via some growth and yield characters indicate a sort of source –sink relationship because assimilates produced had to be shared between the foliage, root and seeds hence the reason for weaker relationship because of competition for assimilates. These factors determine the vegetative photosynthetic surface area for the manufacture and translocation of assimilates to seeds which constitute yield. The positive and highly relationship between one character and other indicated interdependency between the characters, Lawa (2000) reported a significant inter-relationship among growth and yield attributes. The negative and significant association observed in days to 50% flowering suggest that the character was not the main component of seed yield due to combination of the treatments such as NPK rates which resulted in competition for limited resources.

Table 3: Correlation of growth and yield components of cowpea varieties

	Height	LAI	No of leave	Days 50%F	No of pod	pod length	no of seed	seed weight	pod weight	yield
LAI	0.652 0.000									
No of leave	0.856 0.000	0.683 0.000								
Days 50%F	-0.752 0.000	-0.611 0.000	-0.794 0.000							
No of pod	0.784 0.000	0.620 0.000	0.801 0.000	-0.570 0.000						
pod length	0.735 0.000	0.668 0.000	0.686 0.000	-0.503 0.002	0.778 0.000					
No of seed	0.842 0.000	0.708 0.000	0.765 0.000	-0.694 0.000	0.840 0.000	0.810 0.000				
seed weight	0.705 0.000	0.588 0.000	0.655 0.000	-0.704 0.000	0.723 0.000	0.740 0.000	0.786 0.000			
pod weight	0.877 0.000	0.723 0.000	0.795 0.000	-0.635 0.000	0.817 0.000	0.859 0.000	0.884 0.000	0.793 0.000		
yield	0.445 0.007	0.353 0.035	0.378 0.023	-0.430 0.009	0.373 0.025	0.254 0.136	0.501 0.002	0.366 0.028	0.327 0.052	

The values below each of the means are the p- values at 5%

Conclusion

The observed variations in the performance of the cowpea varieties used could provide a basis for selecting cowpea lines with greater agronomic efficiency in deficient soil to reduce fertilizer cost. These variations could be important for selecting varieties suitable for a range of soil conditions as well as to release to farmers on large scale production. It could be concluded that Sampea 5 or 13 which were statistically similar in yield and NPK application rate of 150kg ha⁻¹ is ideal for the area and is therefore recommended for farmers in the study area for enhancement of cowpea production.

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