RESPONSE OF COWPEA (*Vigna unguiculata* L. Walp) TO APPLICATION OF STARTER NITROGEN IN MINNA, NIGERIA

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ABSTRACT

The experiment was conducted in the screen house of Federal University of Technology Minna, Nigeria, to determine the response of cowpea to application of starter nitrogen (N). The treatments were 0, 10, 20 and 30 kg N ha^{-1} laid down in a Completely Randomized Design (CRD) with four replications. Data collected were plant height, number of leaves, number of days to flowering, number of days to podding, grain yield and haulms yield. The results showed that the soil was sandy loam, low in organic carbon and phosphorous. At 4, 8, and 10 WAS, application of 30 kg N ha^{-1} had significantly taller plant than control, but statistically similar to 10 and 20 kg N ha^{-1}. The 10 kg N ha^{-1} had the highest grain yield and fresh haulms yield which were significantly higher than control. There was no significant effect of N on the soil chemical properties, except for total nitrogen were application of N resulted in significant increase over that of control. N application increased the growth and yield of cowpea, application of 10 kg N ha^{-1} improved the growth parameters, haulms and grain yield of cowpea assessed.

Keywords: Cowpea, Starter nitrogen, Minna

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is an important grain legume usually grown in the dry savanna of tropical Africa, Asia and South America with over 9.3 million metric tons of annual production (Oritz, 1998). Nigeria is the world's largest producer with about 2.1 million tons followed by Niger with 650,000 tones and Mali with 110,000 tones. FAO (2006) reported that 850 million people in the world with high incidence of undernourishment are in sub-Sahara Africa. Cowpea is mostly intercropped with other crops such as millet, sorghum, pigeon peas, leafy vegetables, bananas, maize and others (Bittenbender *et al., 1984;* Singh *et al.,* 1997). In intercropping system, the spreading indeterminate type of cowpea serves as a ground cover crop which helps in suppressing weeds as well as protects the soil against erosion and in addition, some varieties are suicidal germination of the seed of *Striga hermonthica*, a parasite plant that usually infests cereals with devastating effect (Quin, 1997). Cowpea grain is a rich source of protein, and its haulms, a valuable source of livestock protein (Fatokun, 2002). Both grain and leaves are edible products of cowpea that are rich in protein and cheap sources of protein. On average, cowpea grain contains 23-25 % protein, cooked leaves contain two-third the protein, seven times the calcium, three times the iron, half the phosphorus, eight times the riboflavin, five times the niacin and several hundred times the ascorbic acid and beta-carotene of the cooked seed (Bittenbender, 1990). Cowpea yield are among the lowest in the world, averaging 310 kg/ha (Ofosun-Budu *et al.,* 2007). Consequently, efforts have been made to improve cowpea production in Nigeria through various means including the introduction of new varieties (Addo-Quaye *et al.,* 2011). None of these improved varieties could achieve optimum yield without appropriate fertilizer recommendation. The positive effect on the application of inorganic fertilizer on crop yield and yield improvement has been reported (Carsky and Iwuafor, 1999).

Nitrogen (N) is the most important element needed for crop production. Although, cowpea symbiotically fixes N, plants which are dependent on symbiotically fixed N may suffer from temporary N-fixation during the seedling growth once the cotyledon reserves have been exhausted. It has thus been recognized and demonstrated that application of a small amount of nitrogen fertilizer enhances early vegetative growth (Dart *et al.,* 1977). Nitrogen fertilizer is sometimes also used as a starter doze. Cowpea responds to added fertilizer despite its capacity to fix nitrogen with *Rhizobium* (Sultana, 2003). Although there are divergent views of nitrogen application to legumes, especially cowpea, results of investigation in the tropics have indicated either no response or significant response to nitrogen fertilizer application (Akinola, 1978). It has also been reported that available nitrogenous compound allowed seedlings to make a good start before nitrogen fixation has a chance to occur. Other researchers have shown that plants given inorganic N during vegetative periods were much larger by the onset of flowering than those dependent on symbiotic N fixation (Minchin *et al.,* 1981). Such plants also had more branches and produced many peduncles resulting in greater number of pods, seeds and significantly larger yields.

Despite the importance of cowpea in human diet and animal feed, the yield obtained by most farmers in Nigeria is very low due to the rapid increase in population, there is need to increase production generally and that of cowpea in particular hence the objective of the study is to evaluate the response of cowpea to application of starter N in Minna.

MATERIALS AND METHODS

Study site: The experiment was conducted at the screen house, Federal University of Technology, Gidan Kwano, Minna, Niger State in the Southern Guinea Savanna of Nigeria. Climate of Minna is sub-humid with mean annual rainfall of about 1284 mm. The physical features around Minna consist of gently undulating high plains developed on basement complex rocks made up of granites, migmatites, gneisses and schists. Inselbergs of "Older Granites" and low hills of schists rise conspicuously above the plains. Beneath the plains, bedrock is deeply weathered and constitutes the major soil parent material. The soil has been classified as Typic plinthustalf (Lawal *et al.*, 2012)

Treatments and experimental design: The treatments consisted of four rates of N, (0, 10, 20, 30 kg N ha^{-1}). The experiment was laid out in a completely randomized design (CRD) with four replications to give a total of 16 pots.

Soil sampling and analysis: Surface soil (0-15 cm) collected from the Teaching and Research Farm of the Federal University of Technology, from different points were bulked together to give a composite sample. The soil samples were analysed according to the procedures described by Agbenin (1995). Particle size analysis was carried out by Bouyoucos hydrometer method and textural class, determined using the textural triangle. The soil pH was measured in 1:2.5 soil/$CaCl_2$ suspension with glass electrode pH meter and organic carbon by Walkley-Black method. Available phosphorus (P) was extracted by Bray P1 method. The phosphorus concentration in the extract was determined colorimetrically using the spectrophotometer. Exchangeable acidity was determined by titrimetric titration with standard NaOH. Exchangeable bases, Ca^{2+}, Mg^{2+}, K^+ and Na^+ were extracted with 1N NH_4OAc. Ca^{2+} and Mg^{2+} in the extracts were determined using atomic absorption spectrophotometer (AAS) while K^+ and Na^+ were determined by flame photometer.

Agronomic practices: Three seed of cowpea variety Sampea 15 (IT99K-573-2-1) was sown in the pot. Two weeks after sowing (WAS), the cowpea plant was thinned to one plant per pot. 10 kg ha^{-1} of phosphorous and potassium was applied at 2 WAS as basal application. Nitrogen fertilizer was applied at 2 WAS. The source of phosphorous and potassium were single super phosphate and muriate of potash respectively while urea was used to supply nitrogen and the fertilizer was applied by ring method. Weeding was also done on a weekly basis by hand pulling.

Growth and yield components: The plant height of cowpea was measured from the base of the plant to the tip of the plant using meter rule at 2, 4, 6, 8 and 10 WAS. Number of leaf was determined by numerical counting of leaves on each plant at 2, 4, 6, 8 and 10 WAS. Number of days to flowering was calculated from the date of sowing to the date when the first flower appeared on each treatment pot and recorded as days to flowering Number of flowers per pot was counted and number of pod per pot was also counted. The pods were harvested, threshed manually, and the grain yield haulms were weighed and also recorded.

Statistical analysis: Data collected were subjected to Analysis of Variance (ANOVA) using the General Linear Model Procedure of Statistical Analysis System (SAS version 9.0) 2002. Treatment means were compared using least significant difference (LSD) at 5 % Level of probability.

RESULTS AND DISCUSSION

The soil physical and chemical properties before sowing are shown in Table 1. The textural class of the soil was sandy loam. The soil was slightly acidic in water (pH 6.5) and the organic carbon (3.12 g kg^{-1}), with available phosphorus (9 mg kg^{-1}) were low and N content was high (0.58 g kg^{-1}) (Esu, 1991). The effect of N on some soil chemical properties is shown in Table 2. There was no significant effect of N on the soil chemical properties after harvest, except for total nitrogen were application of N resulted in significant increase over that of control.

The effect of nitrogen on plant height of cowpea at different growth stages is shown in Table 3. At 2 WAS, all the pots with starter N were significantly taller ($p<0.05$) than the control. At 4, 8, and 10 WAS, the treatment 30 kg N ha^{-1} had significantly taller plant than control, but statistically similar to 10 and 20 kg N ha^{-1}. The effect of starter N on number of leaves are shown in Table 4. The control had significantly higher number of leaves than other treatments at all the growth stages of the plant except at 2 WAS. There was however no significant difference amongst the other treatments at all the growth stages of the plant. The effect of N on yield components of cowpea are shown in Table 5. Application of starter N had no effect on flowering and podding of the plant. All the plants flowered and podded at the same time. Similarly, all the plants produced statistically similar number of pods. Effect of N on grain yield of cowpea was shown in Figure 1. The treatment 10 kg N ha^{-1} recorded the highest grain yield and the lowest was observed in 0 kg N ha^{-1}.

The pH of the soil which was slightly acidic and favourable for accessibility of plant nutrients as most plant nutrients are available for plant uptake at pH 5.5- 6.5 (Brady and Weil, 2002). The N content of the soil is high probably due to prior cultivation of land with fertilizer or incorporation of crop residue. Giller (2001) reported that N increases the growth of plant. The reduction of flowering and podding duration was observed, this might be due to enhanced supply of carbohydrate to active reproductive parts (Giller *et. al.,* 1991). Afolabi *et. al.,*(2013) observed an increase in plant height, shoot biomass, leaf number as result of application of nitrogenous fertilizer with phosphate fertilizer to cowpea. Sultana (2003) also reported that plant height increased due to increase in N fertilizer to cowpea.

Nitrogen application increases yield of cowpea. This increase might be due to the positive effect of N element on plant growth which leads to progressive increase in internodes length and consequently plant height. Several reports had earlier attributed significant increase in the development of vegetative plant parts and dry matter accumulation with N application, as N is an important constituent of chloropyll, amino acid and nucleic acid (Anjorin, 2013). The improvement in plant growth also corroborated the findings of Cox *et. al.,* (1993); Sumi and Ketayama, (2000) also reported that N promotes higher leaf area development and reduced rate of senescence. The application of N increased the grain yield of cowpea. This is in agreement with the findings of Minchin *et al*. (1981) who showed that cowpea plants supplied with nitrogen fertilizer had more branches, produced many peduncels and so greater number of pods, seeds, and significantly larger grain yields than those dependant on symbiotic nitrogen fixation.

CONCLUSION AND RECOMMENDATIONS

From the result of this study, N application increased the plant height, haulms and grain yield of cowpea. Application of 10 kg N ha^{-1} improved the growth parameters, haulms and grain yield of cowpea, suggesting that application of 10 kg N ha^{-1} will improve the performance of cowpea Sampea 15 (IT99K-573-2-1) assessed. A field trial should be conducted to ascertain this finding.

Table 1: Physical and chemical properties of the soil used for the experiment

Parameters	Values
Sand (g kg^{-1})	858
Silt (g kg^{-1})	40
Clay (g kg^{-1})	102
Textural class	Sandy loam
pH in water at 1:2.5	6.5
Organic Carbon (g kg^{-1})	3.12
Total Nitrogen (g kg^{-1})	0.58
Available phosphorus (mg kg^{-1})	9
Exchangeable Bases (cmol kg^{-1})	
Ca^{2+}	4.12
Mg^{2+}	1
K^{+}	0.09
Na^{+}	0.16
Exchangeable acidity (cmol kg^{-1})	0.02
ECEC	5.39

Table 2: Effect of nitrogen fertilization on some soil chemical properties after harvest

Treatment (kg N ha-1)	EK (cmol kg-1)	AP (mg kg-1)	OC (g kg-1)	TN (g kg-1)
0	0.06	5.23	9.73	0.5
10	0.06	5.53	10.4	0.66
20	0.07	5.14	6.4	0.8
30	0.06	4.74	8	0.55
LSD	0.009	0.45	2.13	0.14

EK: Exchangeable potassium AP: Available phosphorus OC: Organic Carbon TN: Total Nitrogen

Table 3: Effect of nitrogen on cowpea plant height

Treatment (kg N ha-1)	Plant height (cm)				
	2 WAS	4 WAS	6 WAS	8 WAS	10 WAS
0	18.2	24.2	31	33.6	33.6
10	27.3	29.1	38	40.2	40.3
20	25.4	30.6	37.3	40.2	40.2
30	26.2	31.1	45.1	41.8	41.8
LSD	3.81	3.15	6.67	4.49	4.83

WAS: weeks after sowing

Table 4: Effect of nitrogen on cowpea number of leaves

Treatment (kg N ha^{-1})	Number of leaves				
	2 WAS	4WAS	6WAS	8WAS	10WAS
0	7	20	26	36	37
10	11	15	21	22	24
20	8	13	17	20	22
30	9	14	19	23	23
LSD	2.19	4.43	3.93	7.30	7.13

WAS: weeks after sowing

Table 5: Effect of nitrogen on cowpea yield components

Treatment (kg N ha^{-1})	DTF	DTP	NPPP	FHY	DHY
0	46	58	2	8.59	3.36
10	47	59	3	16.77	5.08
20	44	62	3	10.78	3.46
30	51	56	3	14.95	4.03
LSD	3.57	2.56	0.54	3.89	0.85

DTF: Days to flowering, DTP: Days to podding, NPPP: Number of pods per plant
FHY: Fresh haulms yield DHY: Dry haulms yield

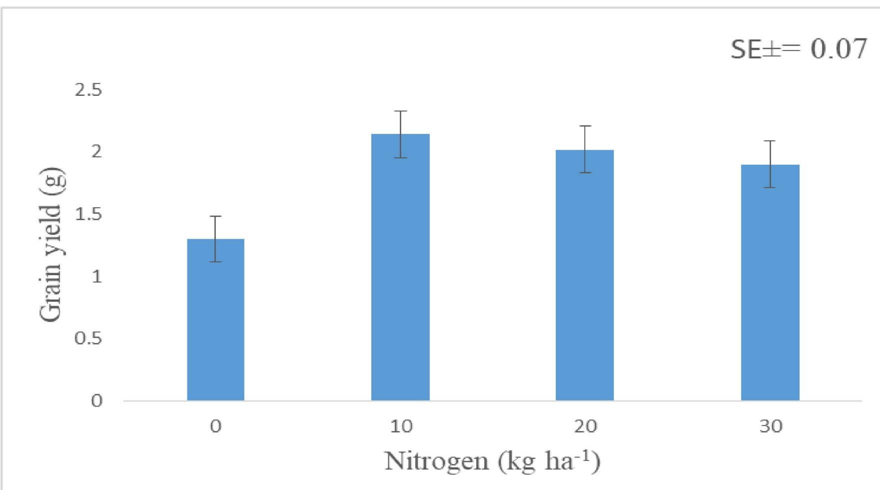

Figure1: Effect of nitrogen on cowpea grain yield

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