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Effect of NPK Fertilizer Rates and Method of Application on Growth and Yield of Okra (*Abelmoschus esculentus* (L.) Moench)

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Abstract: This study was conducted to determine the effect of NPK fertilizer application rates and method of application on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) at the Teaching and Research Farm, University of Ado-Ekiti. Okra seed variety LD88 were treated to three levels of NPK fertilizer rates (0, 150 and 450 kg NPK ha^{-1}) and 2 methods of fertilizer application (ring and band method). Treatments were arranged in a split-plot design with fertilizer application method as main plot factor and NPK rates as sub-plot factor. The treatments were replicated 3 times to give a total of eighteen experimental field plots. The result indicated that the fertilizer NPK significantly increase growth parameters (plant height, leaf area, root length, number of leaves), yield and yield components with optimum yield of okra obtained at 150 NPK kg ha^{-1} and ring method of application seems appropriate for okra production.

Key words: Placement, NPK fertilizer, application methods, plant nutrition, Okra

INTRODUCTION

Abelmoschus esculentus (L.) okra is a widely cultivated vegetable and can be found in almost every market all over Africa (Schippers, 2000). The nutritional constituents of okra include calcium, protein, oil and carbohydrates; others are iron, magnesium and phosphorus. Most okra is eaten in cooked or processed form. Young fruits may be eaten raw. The oil in the seed could be as high as in poultry eggs and soybean (Akinfasoye and Nwanguma, 2005). Nitrogen as well as Phosphorus plays an important role in fruit, seed and quality development of okra. NPK fertilizer has been reported to give a yield increase in okra Babatola (2006). Different methods of fertilizer application have been known to influence plant yields, Sweeney *et al*., 1996 reported that greater yields of early-grazing samples and higher P and K concentration was obtained by broadcasting fertilizer than was obtained for knifing (subsurface banding). This study was carried out to examine the effect of NPK fertilizer rates and the appropriate method of application on growth and yield of okra.

MATERIALS AND METHODS

Trial sites: The study was conducted at the Teaching and Research Farm, University of Ado-Ekiti between May and July 2006. Ado Ekiti is located on latitude 7.3o N and longitude 5.3° E. The area has a bimodal rainfall with mean annual rainfall of 1367mm and a daily temperature of 27°C. The area falls within the high forest zone where the rich tropical forests once thrived. The region has a tropical humid climate with distinct wet and dry seasons. The wet season is from late March to October with little dry season in July and August.

Soil preparation and analysis: Prior to planting, soil samples were collected air-dried in the laboratory, ground and sieved through a 2 mm sieve. Particle-size distribution was determined by the hydrometer method (Bouyoucos, 1951). Soil pH was measured using the pH meter at 1:1 soil to water ratio. The percentage organic carbon was determined by the Walkey Black wet oxidation method (Walkey aand Black, 1934) while percent total Nitrogen (N) was determined by the micro-kjeldahl technique (Jackson, 1962). The present organic matter was estimated by multiplying the percent organic carbon with a factor of 1.724. Available P was extracted by the Bray/method and determined colorimetrically (Bray and Kurtz, 1945). Exchangeable bases were displaced by NH_4+ from neutral/NH_4OAC solution as describe by Jackson (1958). Calcium (Ca) and Magnesium (Mg) were determined by the Atomic Absorption Spectrophotometer (AAS) and potassium (K) and sodium (Na) were determined by flame emission photometry. Cation Exchange Capacity (CEC)

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was determined by the neutral/NH_4OAC saturation method. Base saturation was calculated with reference to the NH_4OAC-CEC. Exchangeable acidity was extracted with IMKCL and determined by titration with NaOH solution.

Field trials: Field trial was conducted between July and October, 2006. Land were manually cleared, three seeds of okra LD 88 were planted at spacing of 50×30 cm which were latter thin to one per stand. Before sowing, the seeds were soaked in water to determine its viability through floating method. NPK fertilizer was applied at 0, 150 and 450 NPK kg ha^{-1} and two method of fertilizer application (ring and band methods) were adopted. Treatments were arranged in split-plot design with application method as main plot factor and NPK fertilizer rates as sub-plot factor. Treatments were replicated three times to give a total of eighteen experimental field plot. Weeding commenced at two weeks after sowing of okra seed and subsequent weeding was carried out as at when due. Chemical spraying with hypermetricin was carried out to control some insect pests that affect the leaves of okra plant. Eight plants were selected per plot for determination of number of leaves, plant height, number of branches, stem girth and fruit yield.

RESULTS AND DISCUSSION

Characteristics of the soil used: The result of the analysis of soil used for the experiment were presented in Table 1, which gave particle size as sand 72 %, silt as 280 g kg^{-1} and clay as 151 g kg^{-1}. The pH of the soil was 6.3, organic carbon content was 6.15%, CEC was 1.03 Cmol kg^{-1} while total N and available P were 0.07% and 6.20 mg kg^{-1}, respectively. The soil was sand loam, Total N and available P content were very low compared with critical levels of 0.1% for N and a range of 10-12 mg kg^{-1} for available P (Adeoye and Agboola, 1985) obtained for soils in southwestern Nigeria (FMANR, 1990). Using the critical levels of 0.16-0.20 Cmol kg^{-1}, exchangeable K was low (Agboola and Obigbesan, 1974).

Effect of NPK fertilizer rates on growth characters of okra: The height of plant is an important growth character directly linked with the productive potential of plant in terms of fodder, grains and fruit yield. An optimum plant height is claimed to be positively correlated with productivity of plant. In this study, the effect of NPK fertilizer rates on growth characters of okra is indicated in Table 2. The results showed significant ($p<0.05$) response to different rates of NPK fertilizer application. Okra plants were taller in those plants that received 450 NPK kg ha^{-1} than those that received lower rates of application due to higher nitrogen content which induced higher plant height, number of leaves, leaf area, root length and number of branches. This is in agreement with the findings of Babatola *et al.* (2002) who reported that increasing level of NPK 20:10:10 was observed to increase growth and yield of okra in an okra/sweetcorn intercrop. There was however no significant difference in plant height, number of leaves and number of branches irrespective of the method of fertilizer application although, those plants that received ring method of application gave the highest value in plant height, number of leaves, number of branches while there was significant ($p<0.05$) increase in leaf area and root length.

Table 1: Physico-chemical properties of surface soil used

Soil properties	Values
pH (H_2O)	6.3
Organic C (%)	6.15
Total N (%)	0.07
Available P (mg kg^{-1})	6.20
Exch. Bases (cmol kg^{-1})	
K	0.17
Ca	0.40
Mg	0.06
Na	0.14
Exch. Acidity	0.26
CEC (Cmol kg^{-1})	1.03
Base saturation (%)	72.1
Sand (g kg^{-1})	720
Silt (g kg^{-1})	280
Clay (g kg^{-1})	151
Textural class	Sand loam

Effect of NPK fertilizer rates on fresh weight and dry matter yield of okra: Table 3 presents fresh weight as well as dry matter yield as affected by different rates of NPK fertilizer and methods of application. Fresh leaf, root and stem weight was higher in treatments that received 150 NPK kg ha^{-1} than those that received 0 and 450 NPK kg ha^{-1}. At higher fertilizer rate, there was decrease in the fresh leaf, root and stem weight. Also, dry weight shows that only root and stem weight were significantly higher (4.43 and 10.75 g $plant^{-1}$). There was no significant difference in dry fruit weight. These findings are in accordance with previous reports of Obi *et al.* (2005) who reported no significant increase in both fresh and dry weight of okra plant with increasing NPK fertilizer treatment rates. Treatments having ring method of application gave significant difference ($p<0.05$) at leaf fresh and dry weight. There was also significant increase in fruit dry weight in treatment that received ring method of fertilizer application. Olufolaji *et al.* (2002) in a comparative evaluation study on soil and foliar applied fertilizer on growth and yield of celosia argentea reported increase in leaf area and fruit yield.

Table 2: Effect of NPK fertilizer rates and application method on growth characters of okra

NPK kg ha^{-1}	Plant height (cm)	No. of leaves	Leaf area (cm^2)	Root length (cm)	No. of branches
0	17.36b	8.26a	162.90c	10.42b	1.03b
150	25.02a	8.05a	184.21b	12.16b	1.88b
450	26.32a	9.76a	192.3a	18.91a	2.51a
Method of application					
Band	21.71a	8.32a	172.61b	11.21b	2.00a
Ring	23.84a	8.21a	183.50a	13.68a	2.31a

Mean with the same letter(s) in each column for each factor are not significantly different ($p<0.05$) by DMRT

Table 3: Effect of NPK fertilizer rates and application method on fresh weight and dry matter accumulation of okra

Treatments	Fresh weight (g plant^{-1})			Dry weight g plant^{-1}			
NPK kg. ha^{-1}	Leaf	Root	Stem	Leaf	Root	Stem	Fruit
0	60.50a	14.69a	31.94a	8.63a	2.23b	5.39b	23.21
150	66.93a	15.29a	33.59a	12.31a	4.43a	10.75a	25.63
450	63.18a	12.07a	25.02a	11.03a	3.28a	6.72b	24.11
Method of application							
Band	59.32b	15.82b	35.47	12.03b	3.01b	9.62b	21.56b
Ring	67.47a	16.21a	32.20	14.15a	4.32a	10.12a	24.10a

Mean with the same letter(s) in each column for each factor are not significantly different ($p<0.05$) by DMRT

Table 4: Effect of NPK fertilizer rates and application method on yield and yield components of okra

NPK kg ha^{-1}	Fruit length plant^{-1} (cm)	Fruit girth plant^{-1} (cm)	No of fruit plant^{-1}	Fresh fruit weight plant^{-1} (g)
0	5.53c	6.88c	1.12b	40.96c
150	7.76a	10.00a	2.15a	48.96a
450	6.63b	8.60b	1.36b	46.83b
Method of application				
Band	5.96b	7.96a	1.52a	41.04b
Ring	7.34a	8.66a	1.76a	47.78a

Mean with the same letter(s) in each column for each factor are not significantly different ($p<0.05$) by DMRT

Effect of NPK fertilizer rates on yield and yield components of okra: The number of fruit per plant, fruit length, fruit girth and fresh fruit weight per plant were significantly ($p<0.05$) increased when 150 NPK kg ha^{-1} was applied. Trends in the data of yield and yield components was such that 150 NPK kg ha^{-1}> 450 NPK kg ha^{-1}> 0 NPK kg ha^{-1}. The ring method of fertilizer application gave a significant ($p<0.05$) increase in fruit length and fresh fruit weight per plant while there was no significant difference in fruit girth and number of fruit per plant (Table 4). Okra yield and yield components were least without application of N, P and K nutrients. This confirms findings from earlier studies in Nigeria which showed that application of these nutrients are important for enhanced yield of okra (Adediran and Banjoko, 2003; Adepoju, 1995; Akintunde *et al*., 2000; Kayode, 1986). Uyovbisere *et al*. (2000) noted that there was substantial depletion of nutrients when no NPK fertilizer was applied and that nitrates and available phosphorus were substantially reduced with cropping in humid zone of southwestern Nigeria.

CONCLUSION

Application of fertilizer to soil with preplant N, P and K values of 0.07%, 6.2 mg kg^{-1} and 0.17 Cmol kg^{-1}, respectively significantly affected fruit yield characters of okra. Application of 150 NPK kg ha^{-1} gave the maximum yield of okra and with ring method of fertilizer application.

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