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Effects of different levels of NPK (20: 10: 10) fertilizer on the growth and yield of okra (*Abelmoschus esculentus*) in Agbor, Delta State, Nigeria (implication for extension service delivery)

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Abstract

Umeri, C., Onyemkonwu, R. C., Moseri, H., Belonwu, N. E., Chisonum, M. & Imahia, I. M. (2025). Effects of different levels of NPK (20: 10: 10) fertilizer on the growth and yield of okra (*Abelmoschus esculentus*) in Agbor, Delta State, Nigeria (implication for extension service delivery). *Bulg. J. Agric. Sci., 31*(2), 295–300

Field trial was conducted at the University of Delta Agbor demonstration farm with focus to evaluate different levels of NPK 20:10:10 fertilizer during the 2022 cropping season on the growth and yield of okra (*Abelmoschus esculentus*). The fertilizer was applied at 0, 100, 150, 200, and 250 kg/ha^{-1}. The five levels of fertilizer were replicated four times in the experimental design, which was a randomized complete block. The parameters measured were plant height, number of leaves, leaf area, stem girth and yield of the plant. Data were analyzed using analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) at 5% probability level. Results show that plant height was highest in 250 kg/ha (10.00 cm) and least in 0 kg/ha (9.30 cm) at 2WAP with no significant difference among the various treatments. Number of leaves per plant showed no significant difference across the treatment at 2, 4 and 8 WAP with significant differences at 10 and 12WAP. Leaf area per plant showed significant differences at 2, 4, 8, 10 and 12 WAP. At 2WAP, leaf area per plant was highest in treatment 200 kg/ha (23.65 cm^2) and least in 100 kg/ha (15.32 cm^2). Stem girth showed significant difference across the treatments at 2, 4, 8, 10 and 12 WAP. At 2 WAP, and was highest in treatment 0 kg/ha (1.40 cm) and least in treatment 250 kg/ha, at 12 WAP, stem girth was highest in treatment 250 kg/ha (5.00 cm) and least in 150 kg/ha (3.20 cm). Significant differences existed in the yield across the treatments 0 kg/ha, 150 kg/ha, and 200 kg/ha at 8WAP and yield was highest at 10WAP in treatment 150 kg/ha (0.15 t/ha) and lowest 200 kg/ha (0.03 t/ha). At 10WAP, yield was highest in treatment 200 kg/ha (0.045 t/ha) and least in 250 kg/ha (0.03 t/ha). At 12 WAP, yield was highest in treatment 200 kg/ha (2.16 t/ha) and least in treatment 0 kg/ha (1.02 t/ha). It was concluded that the application of 200 kg/ha of N: P: K: 20:10:10 performed better both in vegetative parameters and yield and was therefore recommended for extension interventions.

Keywords: okra; treatment; fertilizer; growth characters; yields

Introduction

Okra (*Abelmoschus esculentus*) is an essential vegetable crop that occupies a land area of 277 000 ha with a production of 731 000 metric tons world-wide and productivity of 263 000 t in Nigeria (FAO, 2006). Okra is treasured for its green pods (Fruits) that is edible to man; a capsule that contains many seeds, although the leaves are equally consumed as a vegetable. The seeds of Okra are important sources of nutrients such as oil and protein, they are equally used as

substitute for coffee as non-caffeinated foods (FAO, 2006). Okra being a multipurpose crop is useful to man as a result of the numerous uses of its fruit (pods), fresh leaves, flowers stem, buds, and seeds. The immature fruits of Okra (pods) are consumed as vegetables in the form of fruit salads, stews and soups, fresh or dried, fried or boiled. Irrespective of the nutritional composition of the various parts of Okra, the valuable nature and nutritional composition of okra pod made researches to term it as a powerhouse nutrient such as affordable protein, carbohydrates, minerals, vitamins and dietary fiber which are needed by man (Adetuyi et al., 2011).

In Nigeria, okra is made into soup with or without palm oil; fish and other condiments or it's boiled as vegetable and served with rice. The leaves are also cooked to make a popular soup called Ilesha in Nigeria (Cook et al., 2000). It is often used in making soups, stews and sauces but can also be eaten raw as a snack.

The leaves of okra can be dried, powdered and stored for later use as flavoring. Also, because of its content in pectin fiber, it is used as a thickener for soups, stews and sauces. The roasted seeds of okra are to prepare a replacement drink of coffee without caffeine, with appreciated flavor and aroma. The leaves of okra are sometimes eaten raw in salad.

Fertilizer is any material that is added to the soil to supply one or more elements required for plant growth and development (Masarirambi et al., 2011). Fertilizer enhances the natural fertility of the soil or replaces the chemical element taken from the soil by the plant, harvesting, grazing, leaching or erosion. The plant requirement for the different nutrient elements supplied in fertilizer needed for growth and development may differ. Nitrogen, phosphorous and potassium (NPK) fertilizer have different concentration of the elements needed by the plants for their growth and development. With the different concentrations of NPK fertilizer, the growth rate and yield of the plants may be different. These are formulated in appropriate concentrations and combination which supply the main nutrients.

Okra as a vegetable has formed part of food for most people especially in the rural areas and low income earning groups in tropical and sub-tropical countries including Nigeria. However, its production is declining rapidly over the years in many states in Nigeria due to poor fertility status of the soil (Akinyele & Temikotan, 2007; Agba et al., 2011). The plants nutrient requirements for the different elements supplied in fertilizer needed for growth and development may differ. Nitrogen, phosphorus and potassium (NPK) fertilizer have different concentration of the elements needed by the plant for their growth and yield with the different concentration of the NPK fertilizer needed by the plants, the yield and growth may also differ and sometimes if wrongly applied will have adverse effect on the growth and yield of the plant, hence, the need to investigate the effects of different levels of NPK 20:10:10 fertilizer on the growth and yield of okra.

The overall objective of the study is to evaluate different levels of NPK 20:10:10 fertilizer on the growth and yield of okra (*Abelmoschus esculentus*) in Delta State, Nigeria.

Thus, the specific objectives are to:

i Evaluate the growth of okra using different levels of NPK 20:10:10 fertilizer;

ii Evaluate the yield of okra using different levels of NPK 20:10:10 fertilizer;

iii Make appropriate recommendations for extension service delivery.

Materials and Methods

The study was carried out during the 2022 cropping season at the University Demonstration farm, University of Delta, Agbor Delta State. Delta State is one of the 36 states of the federation in Nigeria with a population of 4 098 391 (NPC, 2006), it is located in southern part of Niger-Delta at longitude 5^{o}.00 and 6^{o}.04 East and latitude 5^{o}.00 and 6^{o}.30 North of the equator and occupies an area of 176 108 km^2 (Chisonum et al., 2021 The soil has loose brownish top soil over a great depth of large non-differentiated, non-mottled, non-gravely porous sub-soil with coarse sand as the predominant fraction and clay content up to 35% (Umeri et al., 2018).

Experimental material

The okra (*Abelmuschus esculentus*) seeds (NHAR47-4 cultivar originated from Ilorin and developed by NIHORT with a characteristic of early maturing) were obtained from the Delta State Agricultural Programme (Agricultural Input Purchase Centre), Agbor, Nigeria. Five levels of N:P:K: 20:10:10 fertilizer (0, 100, 150, 200 and 250 kg/ha) was laid out in a randomized complete blocks design (RCBD) with three replicates.

Experimental design

Prior to planting, representative soil samples randomly collected from the surface soil 0-15 cm depth using soil auger. The samples were bulked, mixed, air dried and passed through a 2mm mesh sieve to determine the routine physical and chemical properties of the soil in the laboratory; using the procedure described by Okalebo et al. (2002).

Land preparation

The land was carefully examined, prepared and the seeds were sown on the 30th March, 2022 at the onset of the

rain. Two seeds of okra were sown on minimally prepared beds at a spacing of 60 × 30 cm intra and inter-row, which was later thinned down to one plant per stand at eight days after planting (DAP). The individual plot size was 2.4 m × 1.8 m with spacing of 0.6m within plots and between replicates. A total of twenty 20 plots (5 × 4) with twenty-four 24 plants each were involved to give a total of four hundred and eighty plants an equivalent to 55 556 plants/ha were used.

Weed control was done manually using hoe at 3 and 6 (WAP). And subsequent weeding operation was done by rouging.

Data collection

Data were collected on the growth and yield parameters. Growth parameters: Four plants were tagged in the net plot for data collection. The growth parameters collected included: plant height, number of leaves per plant, leave area, stem girth cm at 2, 4, 6, 8, 10 and 12 weeks after planting (WAP) and fresh pod yield.

Statistical analysis

All the parameters collected were subjected to appropriate statistical analysis using analysis of variance (ANOVA) at 5% and Duncan's Multiple Range Test (DMRT), when F-ratio proved significant (Steel & Torrie, 1980).

Results

Soil analysis

The soil used for the research was sandy soil, slightly acidic with a moderate organic carbon, low in nitrogen marginal in available phosphorus and exchangeable bases (Table 1).

Table 1. Physico-chemical properties of teaching and research farm

Parameter	Soil test Values
Sand, gkg^{-1}	93.4
Silt, gkg^{-1}	4.0
Clay, gkg^{-1}	2.6
Textural class	Sand
P^{H} (H_2O 1:1)	5.4
Organic carbon, gkg^{-1}	1.10
Total nitrogen, gkg^{-1}	0.06
Available phosphorus, $mgkg^{-1}$	12.81
Exchangeable calcium, $cmolkg^{-1}$	1.78
Exchangeable magnesium, $cmolkg^{-1}$	2.26
Exchangeable potassium, $cmolkg^{-1}$	0.19
Exchangeable sodium, $cmolkg^{-1}$	0.69
Total Exchangeable Bases, $cmolkg^{-1}$	1.23
$[Ca^{2+} + Mg^{2+} + K^{+} + Na^{+}]$	
Total Exchangeable Acidity, $cmolkg^{-1}$	0.30
$[Al^{3+} + H^{+}]$	
Effective cation exchange capacity, $cmolkg^{-1}$	1.33
Base saturation, %	100.00

Plant height, cm

The plant heights of Okra with different treatments are presented in Table 2. The result showed that plant height was highest in 250 kg/ha (10.00 cm) and least in 0 kg/ha (9.30 cm) at 2WAP. However, there was no significant difference among the various treatments. At 4WAP, plant height showed significant difference among the treatments with highest being 200 kg/ha (21.33 cm) and 0 kg/ha (18.7 cm) being the least. Similar trend was observed in 8, 10 and 12 WAP. Nevertheless, at 8 and 12 WAP, plant height was highest in 250 kg/ha (31.89 cm; 39.94 cm) and least in 0 kg/ha (25.00 cm; 27.00 cm) respectively. This result indicates that progressive growth stages resulted in significant difference in the plant of Okra among the various treatments.

Number of leaves per plant

The number of leaves per plant of Okra with different treatments as presented in Table 2 revealed that number of leaves per plant showed no significant difference across the treatment at 2, 4 and 8 WAP. The trend maintained found 250 kg/ha being the highest while it was least at 0 kg/ha. Similar trend was maintained at 10 and 12 WAP. At 10WAP, number of leaves/per plant was highest in 200 kg/ha and 250 kg/ha with 12 leaves and was least in 0 kg/ha with 9 leaves with significant differences among the treatment. At 12WAP number of leaves was highest 250 kg/ha and 250 kg/ha with 14 leaves and was lowest in 0 kg/ha with 10 leaves. Accordingly, significant differences were found among the various treatment levels.

Leaf area/plant

The leaf area/plant is presented in Table 3. The result revealed that leaf area/plant showed significant differences at 2, 4, 8, 10 and 12 WAP. At 2WAP, leaf area/plant was highest in treatment 200 kg/ha (23.65 cm^2) and least in 100 kg/ha (15.32 cm^2). Following the same trend, at 4WAP, leaf area/plant was highest 200 kg/ha (142.93 cm^2) and least 100 kg/ha (96.30 cm^2). At 8WAP, leaf area/plant was highest in treatment 250 kg/ha (197.67 cm^2) and least in 100 kg/ha (183.83 cm^2) with significant differences found among the

Table 2. Evaluation of Okra with different treatments at Agbor, Delta State

	(WAP)				
Treatments, kg/ha	2	4	8	10	12
Parameters					
Plant height, cm					
0	9.30ns	18.7^{b}	24.63^{c}	25.00^{d}	27.00^{d}
100	9.60	18.50^{ab}	24.88^{c}	28.70^{c}	40.50^{bc}
150	10.19	19.25^{ab}	27.25^{b}	32.00^{b}	40.00^{c}
200	11.38	21.33^{ab}	34.00^{a}	36.25^{ab}	45.20^{ab}
250	10.00	18.34^{ab}	28.30^{ab}	37.50^{a}	47.00^{a}
Mean	10.09	19.23	27.81	31.89	39.94
DMRT	7.36	15.24	18.55	20.56	25.76
No of leaves per plant					
0	6ns	8ns	9ns	9^{bc}	10^{c}
100	6	7	8	10^{b}	12^{b}
150	6	7	8	10^{b}	13^{ab}
200	6	7	8	12^{a}	14^{a}
250	6	8	8	12^{a}	14^{a}
Mean	6	7.4	8.2	10.6	12.6
DMRT	4.05	5.20	6.01	8.11	9.92
Leaf area/plant, cm^2					
	18.41bc	97.50d	205.00a	210.00d	210.20c
100	15.32c	96.30d	183.83ab	220.40bc	208.00d
150	20.67b	123.80b	179.34bc	221.70bc	220.40ab
200	23.65a	142.93a	181.00b	234.60b	234.00ab
250	15.94d	103.75c	197.67ab	256.80a	249.70a
Mean	18.79	112.85	189.36	228.70	224.46
DMRT	17.11	99.04	168.32	201.22	211.23
Stem girth, cm					
0	1.40^{a}	3.13^{b}	3.50^{b}	4.10^{b}	4.00^{b}
100	1.20^{b}	3.04^{bc}	3.80^{a}	4.00^{bc}	4.00^{b}
150	0.80^{b}	3.04^{bc}	3.50^{b}	3.00^{d}	3.20^{c}
200	0.86^{b}	3.33^{a}	3.80^{a}	4.80^{a}	4.00^{b}
250	0.50^{bc}	2.84^{c}	3.20^{c}	4.00^{bc}	5.00^{a}
Mean	0.95	3.07	3.56	3.98	4.04
DMRT	0.46	2.72	3.11	3.74	3.99

Means with different superscript are statistically different using Duncan's Multiple Range Test at 5% level of probability; ns; not significant

various treatment levels. The same trend was maintained at 10WAP with leaf area per plant being highest in 250 kg/ha (256.80 cm^2) and lowest in 0 kg/ha (210.00 cm^2) with significant differences observes across the various treatment levels. At 12WAP, significant differences were observed in the leaf area/plant among the treatment levels with treatment 250 kg/ha (249.70 cm^2) having the highest leaf area/plant and was lowest in 100 kg/ha (208.00 cm^2).

Stem Girth

The girth of Okra with different treatments as presented in Table 2 revealed that, stem girth showed significant difference across the treatments at 2, 4, 8, 10 and 12 WAP. At 2 WAP, stem girth was highest in treatment 0 kg/ha (1.40 cm) and least in treatment 250 kg/ha (0.50 cm). At 4WAP, stem girth was highest in treatment 200 kg/ha (3.33 cm) and lowest in 250 kg/ha (2.84 cm). Similar trend was maintained at 8WAP but stem girth was highest in 200 kg/ha (3.80 cm) and least in OK/250 (3.20 cm). At 10 WAP stem girth was highest in 200 kg/ha (4.80 cm) and lowest in 150 kg/ha (3.00 cm). However, at 12 WAP, stem girth was highest in treatment 250 kg/ha (5.00 cm) and least in 150 kg/ha (3.20 cm). However, it is important to note that increase in stem girth in specifically with progressive month in treatment 250 kg/ha.

Table 3. Yield (t/ha) of Okra with different treatments at Agbor Delta State

	(WAP)				
Treatments, kg/ha	2	4	8	10	12
0			0.010	0.021	1.02[c]
100				0.010	1.222[b]
150			0.015	0.036	1.44[b]
200			0.003	0.045	2.16[a]
250				0.003	0.45[c]
Mean			0.009	0.230	1.25
DMRT				0.014	0.38

Means with different superscript are statistically different using Duncan's Multiple Range Test at 5% level of probability; ns; not significant

Yield

Yield of Okra with different treatments (Table 3) showed yield significant difference was noticed in treatments 0 kg/ha, 150 kg/ha and 200 kg/ha at 8WAP. However, yield was highest at WAP in treatment 150 kg/ha (0.015 t) and lowest 200 kg/ha (0.003 t). At 10WAP, yield was highest in treatment 200 kg/ha (0.045 kg) and least in 250 kg/ha (0.3 t). At 12 WAP, yield was highest in treatment 200 kg/ha (2.160 t) and least in treatment 0 kg/ha (1.020 tons). However, there was significant difference across the various treatments.

Discussion

The evaluation of different levels of NPK 20:10:10 fertilizer on the growth and yield of okra (*Abelmoschus esculentus*) in Agbor, Delta State, Nigeria. The soil used for the research was sandy soil, slightly acidic with a moderate organic carbon, low in nitrogen, marginal in available phosphorus and exchangeable bases was observed to determine their vegetative characters and fresh pod yield of okra in consonance with previous finding of Aliyu (2000). The vegetative characters considered include plant height, stem girth, leaf area, number of leaves and okra pod yield.

Significant difference in yield was noticed in treatments 0 kg/ha, 150 kg/ha and 200 kg/ha at 8WAP and yield was highest at 10WAP in treatment 150 kg/ha (0.15 t/ha) and lowest 200 kg/ha (0.03 t/ha). At 10WAP, yield was highest in treatment 200 kg/ha (0.045 ton) and least in 250 kg/ha (0.03 t/ha). At 12 WAP, yield was highest in treatment 200 kg/ha (2.160 t/ha) and least in treatment 0 kg/ha (1.020 t/ha). This observation is indicative of the effect of different levels of NPK (20:10:10) on the performance of okra (Omotoso & Johnson, 2015). The difference could be as a result of the level of fertilizer application and micro-climatic conditions.

Conclusion

The result emanating from the study clearly shows that treatment 200 kg/ha performed better when compared with other varieties. It is therefore concluded that the application of N:P:K:20:10:10 in treatment 200 kg/ha or fertilization rates: N - 40, P_20_5 – 20 and K_20 – 20 kg/ha had better performance both in the vegetative parameters and yield. This was established because further increase of N:P:K: 20:10:10 or fertilization rates: N - 40, P_20_5 – 20 and K_20 – 20 kg/ha to the treatment of 250 kg/ha did not enhance the production performance both in yield.

Implication for Agricultural Extension Services Delivery

The study emanated from farmers curiosity for the right requirement for N: P: K: 20:10:10 or fertilization rates: N - 40, P_20_5 – 20 and K_20 – 20 kg/ha optimum productivity of Okra. As a basic mandate of agricultural extension service to disseminated research findings back to farmers, it is therefore recommended that extension service providers in the study area to educate Okra farmers on the need to adopt the application of N: P: K: 20: 10: 10 at the rate of 250 kg/ha as the study have established that this treatment had the best performance. This is so important to the farmers and extension service providers in the study area since the researchers undertook a soil testing of the nutritional status of the soil in the course of this research.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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