



RESEARCH ARTICLE

EFFECT OF SELECTED LIQUID FERTILIZER ON GROWTH AND YIELD OF OKRA (*ABELMOSCUHUS ESCULENTUS* L. MONECH) IN MAKURDI SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT

A field experiment was conducted during the 2023 cropping season to evaluate the effect of selected liquid fertilizer on the growth and yield of Okra. The treatment was 100 ml/ha in 4 liters of water (control), 100 ml/ha in 4 liters of water of ferti-plus, 100 ml/ha in 4 liters of water of Gron-Tech, 100 ml/ha in 4 liters of water of Boost Extra and 10grams N.P.K 20:10:10. The treatments were laid in a Randomized Complete Block Design (RCBD) and replicated three times. Crop data collected was, plant height, leaf area, number of leaves, pod length, pod weight, these treatments were subjected to statistical analysis and the parameter which indicated statistical difference were separated using Fishers-least significant difference (F-LSD). The result of the study indicated that liquid fertilizer treatments does not affect the soil physical and chemical properties and this is evidences from the % of sand, silt and clay obtained from the soil analysis. The organic carbon and organic matter content were not affected by the fertilizer treatments. The result of the statistical analysis indicates that plant height, number of leaves, pod length was significantly improved by the treatments. The highest fruit weight was obtained from the 0 kg/ha (control) of liquid fertilizer treatments with the value of 69.0 kg and the lowest was obtained from Boost Extra (43.0 kg) and there were no significant differences among the treatments. And also, the highest weight of pod was obtained from Grown-Tec with the value of (67.0 kg) and the lowest was obtained from the Boost Extra (43.0kg) its therefor recommended that Grown-Tec should be adopted among the selected liquid fertilizer for optimum rate of Okra growth and sustainable production in Makurdi.

KEYWORDS

Okra, liquid fertilizer, Gron-Tech, Boost Extra, Ferti-plus, NPK 20:10:10, growth, yield, RCBD, plant height

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is a warm-season vegetable crop widely cultivated for its tender pods, which are used in various culinary dishes and have significant nutritional value (Uwiringiyimana et al., 2024). The Southern Guinea Savanna Zone of Nigeria, where Makurdi is located, experiences distinct wet and dry seasons, with rainfall typically occurring from April to October. The region's soils are predominantly sandy to sandy loam, with low organic matter content and inherent nutrient deficiencies (Olayinka et al., 2018). Its pods are rich in vitamins A and C, folate, and dietary fiber, making it a valuable component of a healthy diet. In many developing countries, okra is a crucial food source and cash crop, contributing to food security and livelihoods. The seed contains oil that is edible by man as well as in soap industry.

Okra (*Abelmoschus esculentus* L. Moench) is one of the key vegetable crops grown in this region due to its adaptability to the local climate, high nutritional value, and its role as a cash crop (Akinyele and Temikotan, 2020).

Despite the favorable climatic conditions, agricultural productivity in this region is often hampered by the inherent low fertility of the soils, which are generally acidic with low organic matter content and poor nutrient availability (Edeh et al., 2019). These soil conditions make it challenging for farmers to achieve optimal yields without the use of external inputs such as fertilizers. Traditional farming practices in the region, which often

involve the use of locally available organic amendments or minimal use of synthetic fertilizers, have proven insufficient in addressing the nutrient deficiencies prevalent in these soils (Adediran et al., 2022). The soils in the Southern Guinea Savanna Zone are often characterized by low levels of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K), which are critical for plant growth and development (Ojeniyi et al., 2019). These nutrient deficiencies can lead to suboptimal crop growth, reduced fruiting, and lower yields, which in turn affects the economic viability of okra farming in the region. Addressing these soil fertility challenges through effective fertilization strategies is essential to improve crop productivity and ensure food security. Liquid fertilizers have emerged as a promising alternative to traditional solid fertilizers, offering several advantages, including faster nutrient uptake by plants, ease of application, and the potential to be used in precision agriculture (Choudhary et al., 2021).

Liquid fertilizers offer a potential solution to address soil nutrient deficiencies and improve crop productivity in the Southern Guinea Savanna Zone. Compared to conventional granular fertilizers, liquid formulations can be more easily absorbed by plant roots, leading to faster nutrient uptake and utilization (Obalum et al., 2018). Additionally, liquid fertilizers can be applied in precise doses, minimizing nutrient wastage and environmental pollution (Ogunremi et al., 2021).

The main objective of this study is to evaluate the effect of selected liquid fertilizer on the growth and yield of okra in Makurdi.

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2. MATERIALS AND METHODS

2.1 Site Description

The research was conducted at the Soil Science Research farm behind the college of Agronomy laboratory of Joseph Sarwuan Tarka University Makurdi. The area lies at 104 meters above sea level with average temperature ranging from 22 to 35 with distinct two season which are wet and the dry season respectively, the wet season lasted from April till October with annual rainfall of ranging between 1200 mm and 1500 mm, although the raining pattern is subject to seasonal variation.

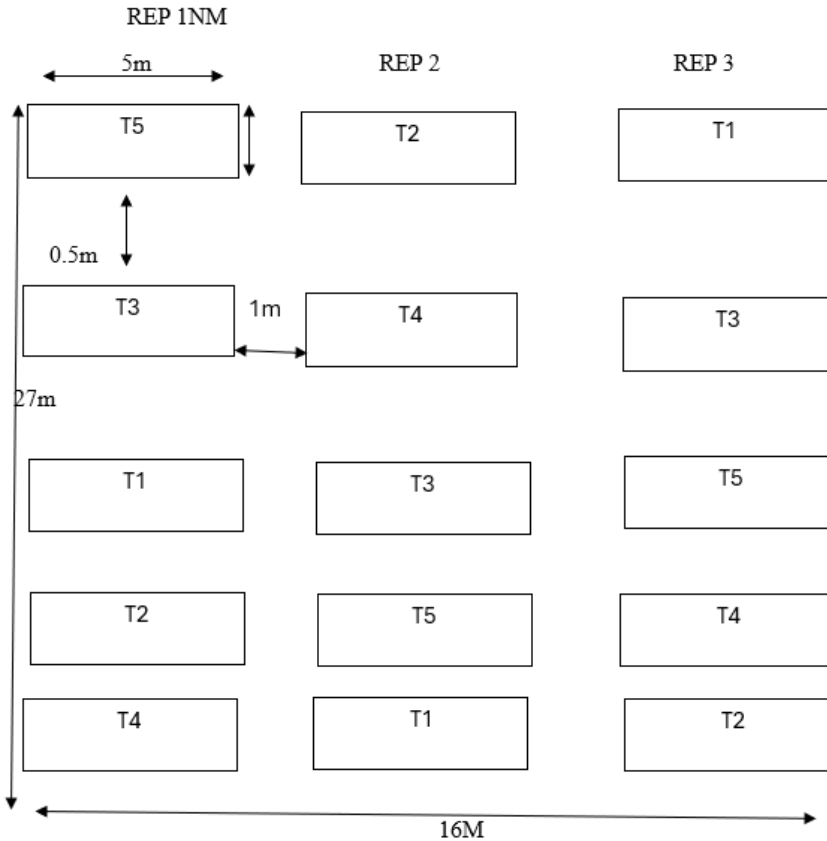


Figure 1.

2.4 Land Preparation and Planting

The experiment measuring 27 x 16m (432 m²) was manually cleared of vegetation including weeds, shrubs and any remaining crop residues from previous cultivation using cutlass, ridges were made with the use of hoe and mapped into fifteen plots. A plot consists of 3 ridges of 0.5 m apart each 5 m long with plot width of 5 m giving a plot size of 15 m, a distance of 1m was ensure between plots.

The seed of okra was planted at a spacing of 25 cm apart on a row with a seed per hole at a depth of 2-3 cm to ensure good seed to soil contact and optimal germination. The date of planting was on 8 November, 2023.

2.5 Fertilizer Application

Selected liquid fertilizer was applied using the foliar method of application on the crop at regular interval of two weeks after planting, with 22nd of November, 2023 been the first date of application. Where T1= Grow Tec, T2=100ml of Boost Extra, T3= 100ml of Ferti plus, T4 =N.P. K 15:10:10, T5= control, also the liquid fertilizer where diluted in 4liters of water before applying

2.6 Soil Data Analysis

The sample soil collected were air dried, grinded and passed through a 2mm sieve ad was analyzed in the advanced and analytic soil science laboratory of the department of soil science, college of Agronomy, Joseph Sarwuan Tarka University Makurdi.

2.7 Particles size distribution

This was determined using Bouyoucous (hydrometer) method as described by, fifty grams (50g) of soil sample were stirred for 15minutes. The dispersed suspension was then transferred into a glass cylinder and the cylinder tilled distilled water to mark (Udo et al., 2009). After that, the

2.2 Experimental Treatments and Design

The experimental treatments in this study involves the application of selected liquid fertilizers which were applied at different rate as follows; 100 ml/plot, 80 ml/plot 60 ml/plot, 40ml/plot and 20ml/plot respectively. There was a total of 5 treatments which were laid out in a Randomized Complete Block Design and replicated three times. The treatments are; T1= Control, T2= Boost Extra, T3= Fertiplus, T4= Gron-Tec and treatment 5(T5) =N. P. K 20:10:10.

2.3 Field Layout

top of the cylinder was covered with hand and inverted several times until the dispersion was properly mixed. A plunger was also used to ensured proper stirring of the suspension. Hydrometer and thermometer determine the percentage composition of the suspended materials. The first hydrometer reading was taken at 40 seconds and this measured the amount of silt and clay in suspension. The second reading was taken after 3 hours and the this indicated the percentage of total clay suspension. The percentage composition of sand silt and clay was determine using the formular below

- % sand = $100(H1 + 0.2 (T1-68)-2.0)2$
- %clay= $H2-0.2(T2-68)-2.0$
- %silt= $100(\%sand + \%clay)$

Where;

H1=first hydrometer reading at 40 seconds

T1=first thermometer reading at 40 seconds

H2= second hydrometer reading after 3 hours

T2= second thermometer reading after 3 hours

2.8 Soil pH

The soil pH was determined in 1:1 soil water suspension by the glass electrode method (IITA, 1979). Ten Grams (10g) of air-dried soil sample passed through 2mm sieve was measured into a 50ml plastic beaker. Twenty (20) ml of was water was added and the suspension was allowed to stand for 30 minutes and stirred occasionally with glass rod, after which the suspension was allowed to settled and the electrode of the pH meter was inserted to measure the active acidity at a 1:1 ratio. This procedure was repeated using 0.01ml calcium chloride solution at a ratio of 1:2

2.9 Organic Carbon

This was determined by the modified walking-black method as describe by which involves the oxidation of soil samples with dichromate and tetraoxosulphate (iv) acid (Nelson and Sommers, 1982). Two grams of sieved soil was mixed with 10ml of distilled water was added, three drop of phenolphthalein indicator was added and titrate against ferrous sulphate. A blank solution was prepared with soil samples and their reading was taken. The organic carbon was calculated using the relationship

$$\% \text{OC} = \text{NVI} \quad (1)$$

N= normality of ferrous sulphate solution

V1= mol ferrous ammonium sulphate for the blank

V2= mol ferrous ammonium sulphate for the samples

F= correction factors =1.33

% Organic matter in soil = % Organic carbon*1.729

2.10 Total nitrogen

Total Nitrogen was determined by Macro-Kjeldahl digestion and distillation method as described by (Bremner, 1965). This method makes use of mercury catalyst tables to aid the digestion. The soil samples were digested with concentrated tetraoxosulphate (iv) acid after addition of excess caustic soda. Ten grams (10g) of samples was weighed into dry 500ml conical flask, 20ml of the distilled water was added. The flask was swirled for few minutes and the allows standing for about 30minutes then was added. Then 30mls of concentrated sulphuric acid was added through a measuring cylinder. The flask was allowed to cool, and then 100ml of distilled water was added slowly. the digest was transferred to a clean 250mls volumetric flask with caution. The stand particles were then washed wit distilled water and flask mark with distilled water. The samples were then distilled with boric acid using 10Ml NAOH.

2.11 Cation exchange capacity

The CEC of the samples was determined using the procedures as describes and modified by (Anderson and Ingram, 1979; IITA, 1979). The principle involves the solution of the exchange salt of the soil with a known salt solution and displacement of the salt to determine the soil colloids. Potassium chloride (KCL) and neutral $\text{NH}_4\text{O AC}$ solution were use in this saturation displacement methods. A 2.5g of samples was taken into a 50ml centrifuge tube, 33ml of 1ml was added and the suspension was shaken for five minutes. The tube was centrifuged to get a clear supernatant discarded. The saturation with KCL and discarding supernatant was obtained.

2.12 Available Phosphorus

This was also discarded. the washing with alcohol was repeated two times to remove excess K, 33ml of 1ml $\text{NH}_4\text{O AC}$ was added to the tube and was shaken for 5 minutes. The suspension was centrifuged to obtain a clear supernatant solution to make up the volume of the 100ml mark and the

solution was thoroughly mixed by swirling. The concentration in the flask was determine by graphically. The CEC (Cmol/kg) is equal to mg kg/100 soil. This is numerically equal to Cmol/kg soil.

2.13 Exchangeable acidity

This was determined by the ammonium acetate extraction method as describe, the soil sample was shaken for two hours then centrifuged at 2000rpm for 5-10=110 minutes after decanting into a volumetric flask by (IITA, 1979). Ca and mg were then determine using the atomic absorption spectrometer (ASS) while the EDTA extracts Na and K was determine using flame photometer.

3. RESULT AND DISCUSSIONS

3.1 Result of the Soil Physical and Chemical Properties as Influenced by the Fertilizer Treatment

The result of the soil physical and chemical properties as influenced by the fertilizer treatment is presented in Table 1. The soil pH both at planting and after harvest was not affected by the treatments. Similar, the soil physical properties in terms of the particle size distribution were not affected by the treatments. This is evidenced from the % sand, silt and clay obtained from the soil analysis.

The organic carbon and organic matter content of the soil of the sandy area was not affected by fertilizer treatments. The N (Nitrogen) concentration in the soil was lowest for Boost Extra (0.067%) and Ferti-plus (0.067%) while the highest was obtained from Control and N.P.K. The P (phosphorus) concentration in the soil is lowest for Boost Extra (2.96%) and Ferti-plus (2.96%) while the highest was obtained in Control (3.68%) and Grown-Tec (3.64%) The K (potassium) concentration in the soil was lowest for Boost Extra (0.24%) and Ferti-plus (0.24%) while the highest was obtained in Grown-Tec (0.29%) and Control (0.27%). The Na (sodium) concentration in the soil was lowest for Boost Extra (0.21%) and Ferti-plus (0.21%) whereas, the highest was obtained in Grown-Tec (0.25%) and N.P.K (0.24%) these agree with the work of (Vanlauwe, 2011). The Mg concentration in the soil was lowest for Boost Extra (2.80%) and Ferti-plus (2.80%) while the highest was obtained in Control (3.79%) and Grown-Tec (2.99%) this aligns with the findings of (Ogunwale et al., 2002). The Ca concentration in the soil was lowest for Boost Extra (2.96%) and Ferti-plus (2.96%) whereas, the highest was obtained in Grown-Tec (3.21%) and N.P.K (3.0%). The EB concentration in the soil was lowest for Boost Extra (6.21%) and Ferti-plus (6.21%) while the highest was obtained in Grown-Tec (6.85%) and Control (6.64%). The EA concentration in the soil was lowest for Boost Extra (1.08%) and Ferti-plus (1.08%) whereas, the highest was obtained in N.P.K (1.15%), Control (1.13%) and Grown-Tec (1.13%). The CEC concentration in the soil was lowest for Boost Extra (7.27%) and Ferti-plus (7.29%) whereas, the highest was obtained in Control (7.98%) and Grown-Tec (7.98%). The BS concentration in the soil was lowest for Control (84.75%) and N.P.K (84.770%) whereas, the highest was obtained in treatment Grown-Tec (85.84%), Boost Extra (85.19%) and Ferti-plus (85.19%).

Table 1: Soil Physical and Chemical Properties as Influenced by Fertilizer Treatments.

Sample ID	pH (H ₂ O)	Sand (%)	Clay (%)	Silt (%)	O.C (%)	O.M (%)	N (%)	Mgls P	K CMO/kg	Na	Mg	Ca	EB	EA	CEC	BS (%)
COMP	6.10	66.80	21.0	13.20	0.84	1.43	0.086	3.65	0.28	0.26	2.97	3.27	6.75	1.13	7.98	86.84
T1	6.10	67.50	21.0	12.50	0.82	1.39	0.080	3.68	0.27	0.22	3.79	2.98	6.64	1.13	7.98	84.75
T2	6.25	69.80	17.20	13.0	0.64	1.11	0.067	2.96	0.24	0.21	2.80	2.96	6.21	1.08	7.29	85.19
T3	6.26	68.20	16.80	15.0	0.64	1.11	0.067	2.96	0.24	0.21	2.80	2.96	6.21	1.08	7.29	85.19
T4	6.10	67.80	21.0	11.20	0.81	1.42	0.078	3.64	0.29	0.25	2.99	3.21	6.85	1.13	7.98	85.84
T5	6.08	68.64	19.36	12.0	0.59	1.28	0.080	3.44	0.26	0.24	2.90	3.0	6.40	1.15	7.55	84.77

KEY: OC= Organic Carbon, OM= Organic Matter, P= Phosphorous, K= Potassium, N= Nitrogen, Mg= Magnesium, Ca= Calcium, EA= Exchangeable Acidity, Na= Sodium, EB= Exchangeable Base, CEC= Cation Exchange Capacity, BS=Base Saturation, COMPO= Composite.

3.2 Results of the Effect of Fertilizer Treatments on Number of Leaves of Okra

The results of the effect of fertilizer treatments on Number of leaves of okra is presented on Table 2. From the results at two weeks after sowing (WAS), treatment 1, 3 and 5 produced the same number of leaves that is higher than the number of leaves produced by treatment 2 and 4.

However, there was significant differences at (0,05%) among the treatments this supports the findings of Adeoti and Olabiya (2023), who highlighted NPK's role in vegetative growth. At four weeks after sowing, treatment 2 and 3 produced similar number of leaves (9.53 and 9.20) that were higher than the number of leaves produced by treatment 5 (7.67), T4 (8.40) and treatment 1 (8.67). However, there was no significant differences among the treatments. At six weeks after sowing, treatment 1, 2 and 4 produced similar number of leaves that were higher than the number of leaves produced by treatment 3, but the number of leaves produced by treatment 5 (19.3) was higher than the number of leaves produced by treatment 1, 2, 3 and 4 (15.5, 15.1, 10.7 and 15.9). However,

there was no significant differences among the treatments.

3.3 Results on the Effect of Fertilizer on Leaves Area of Okra

The results on the effect of fertilizer on leaves Area of Okra is presented on Table 3. From the results at two weeks after sowing (WAS), treatment 1, 2, 4 and 5 produced similar number of leaves area that is less than the number of leaves area produced in treatment 3 (46.0). However, there was no significant difference at (0.05%) among the treatments. At four weeks after sowing, treatment 2,3, and 4 produced similar number of leave Area (65.9, 62.4, 62.7) that were higher than the number of leave Area produced by treatment 5 (58.2) and treatment 1 (74.5) produced a number higher than 2, 3, 4 and 5 this supports who reported higher leaf expansion with

balanced nutrient supply, especially nitrogen and potassium (Patel et al., 2022). However, there was no significant differences at (0.05%) among the treatments. At Six weeks after sowing, treatment 1 and 5 (120.6, 120.2) produced the same number of leave Area higher than treatment 2, 3 and 4. However, there was no significant differences at (0.05%) among the treatments. At Eight weeks after sowing (WAS), treatment 1 (122.2) and 5 (123.1) produced similar number of leave Area that were higher than the number of leave Area produced by treatment 2,3 and 4, although, treatment 2 (96.5) and 4 (97.7) produced similar number of leave Area that were higher than the number of leave Arae produced by treatment 3 (76.8). However, there was no significant differences at (0.05%) among the treatments.

Table 2: Effect of Fertilizer Treatments on the Number of Leaves of Okra.

Treatment	2WAS	4WAS	6WAS	8WAS	10WAS
T1	5.13	8.67	15.5	17.60	15.7
T2	4.87	9.53	15.1	14.53	16.1
T3	5.00	9.20	10.7	12.27	11.1
T4	4.93	8.40	15.9	17.40	16.3
T5	5.00	7.67	19.3	22.08	19.8
LSD 0.05	S	NS	NS	6.01	NS

KEY; WAS= Weeks after sowing, LSD = Least significant Differences at 5%level of significant, S= significance, NS not significance

Table 3: Effect of Fertilizer Treatment on Leaves Area of Okra

Treatment	2WAS	4WAS	6WAS	8WAS	10WAS
T1	21.7	74.5	120.6	122.2	142.0
T2	24.3	65.9	105.3	96.5	159.0
T3	46.0	62.4	83.8	76.8	133.0
T4	24.4	62.7	101.3	97.7	117.0
T15	21.0	58.2	120.2	123.1	147.0
LSD 0.05	36.57	35.26	62.11	43.63	81.5

KEY: WAS= Week After Sowing, LSD= Least significant difference at 5% level of significance, NS= not significant.

3.4 Result of Effect of Fertilizer Treatment on Pant Height

The result of effect of fertilizer treatment on Pant Height of Okra is presented on Table 4. From the results at two weeks after sowing (WAS), Control (6.10cm) and Boost Extra (6.13cm) produced the same number of plant height that were higher than Ferti-plus, Grown-Tec and N.P.K while Ferti-plus (5.03cm) and N.P.K(5.57cm) produced also the same number of plant height that is higher than the number of plant height produced by Grown-Tec (4.97cm). However, there was no significant differences at (0.05%) among the treatments. At four weeks after sowing, treatment 1 (9.67), 2 (9.87) and 4 (9.03) produced similar number of plant height higher than the number of plant height produced by treatment 3(8.80) and 5 (8.83) affirmed that fertilizer types impact height depending on their release patterns and nutrient composition (Sulaiman and Bello, 2023). However, there was no significant differences at (0.05%) among the treatments. At Six weeks after sowing, Control (14.00cm), Boost Extra (14.37cm), Grown-Tec (14.23cm) and N.P.K (14.52cm) produced similar number of plant height that were higher than the number of plant height produced by Ferti-plus (12.13cm). However, there was no significant difference at (0.05%) among the treatments. At Eight week after sowing (WAS), Control (15.33cm), Grown-Tec(15.80cm) and N.P.K (15.93cm) produced similar number of plant height that is higher than the number of plant height produced by Ferti-plus (14.20cm) whereas, Boost Extra (16.10cm) produced a number of plant height that is higher than Control, Ferti-plus, Grown-Tec and N.P.K. However, there was no significant differences at (0.05%) among the treatments. At Tenth week after sowing (WAS), Control (15.17cm), Boost Extra (15.30cm), Grown-Tec (15.47cm) and N.P.K (15.28cm) produced similar number of plant height that were higher than the number of plant height produced by Ferti-plus (13.17cm). However, there was no significant difference at (0.05%) among the treatments.

3.5 Results of the Effect of Fertilizer on Yield Parameter of Okra

The results of the effect of fertilizer on Yield parameter of okra is presented on Table 5. from the results, Grown-Tec (67.0kg) and N.P.K (67.0kg) produced the same number of weights of pod higher than Boost Extra (43.0kg) and Ferti-plus (54.0kg) whereas, Control (69.0kg) produced a weight of pod higher than the weight of pod produced by Boost Extra, Ferti-plus, Grown-Tec and N.P.K However, there was no significant difference at (0.05%) among the treatments this according to the study, organic-based inputs often enhance yield due to gradual nutrient release and improved soil structure (Ibrahim et al., 2023).

From the results, Boost Extra (8.77cm) and Ferti-plus (8.77cm) produced the same number of pod length, Grown-Tec (8.07cm) and N.P.K (8.83) produced similar number of pod length, whereas, Control (9.87cm) produced a higher number of pod length than Boost Extra, Ferti-plus, Grown-Tec and N.P.K. However, there was no significant differences at (0.05%) among the treatments.

From the results at Eight weeks after sowing(8WAS), Ferti-plus (2.07), Grown-Tec (2.20) and N.P.K (2.86) produced similar numbers of pods that is higher than the number of pods produced by Control (1.60) and Boost Extra (1.67). However, there was no significant differences at (0.05%) among the treatments.

From the results at Tenth weeks after sowing (10WAS), Boost Extra (23.0), Ferti-plus (23.3) produced the same number of pods, Control (27.7) and Grown-Tec (28.3) produced similar number of pods higher than the number of pods produced by Boost Extra, Ferti-plus and N.P.K. However, there was no significant difference at 90.05%) among the treatments.

Table 4: Effect of Fertilizer Treatment on Plant Height of Okra.

Treatment	2WAS	4WAS	6WAS	8WAS	10WAS
T1	6.10	9.67	14.00	15.33	15.17
T2	6.13	9.87	14.37	16.10	15.30
T3	5.03	8.50	12.13	14.20	13.17

Table 4 (cont): Effect of Fertilizer Treatment on Plant Height of Okra.

Treatment	4.97	9.03	14.23	15.80	15.47
T4	4.97	9.03	14.23	15.80	15.47
T5	5.57	8.83	14.52	15.93	15.28
LSD= 0.05	1.59	2.51	2.96	2.43	2.83

KEY: WAS= Week After Sowing, LSD= Least Significant Differences at 0.05% level of significant; NS= not significant

Table 5: Effect of fertilizer treatment on the Yield Parameter of Okra.

Treatments	Weight of Pod	Pod length	Number of Pods	
			8WAS	10WAS
T1	43.0	8.07	2.44	22.7
T2	53.0	8.23	3.67	23.0
T3	54.0	8.48	2.07	23.3
T4	69.0	8.87	3.07	28.3
T5	68.0	8.83	2.87	29.3
LSD= 0.05	86.6	NS	NS	NS

KEY: WAS= Week After Planting, LSD= Least Significant Differences at 5 % level of significant, NS= not significant.

4. CONCLUSION

The application of selected liquid fertilizer treatments does not affect the soil physical and chemical properties however, its showed significant varying effect on the growth and yield of Okra

RECOMMENDATION

From the results obtained from this study: Grow-Tec and NPK 20:10:10 fertilizers gave the highest growth and yield parameters of Okra. Grow-Tec is therefore recommended among the liquid fertilizers for the production of Okra in the study area.

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