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NL Journal of Agriculture and Biotechnology

(ISSN: 3048-9679)

Volume 2 Issue 2 April 2025

Research Article

Evaluation of Six Lines of Okra Under Organic and Mineral Fertilization for Yield and Mucilaginous Properties in Anyigba Kogi State Nigeria

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DOI: 10.71168/NAB.02.02.110

Received Date: February 25- 2025 **Publication Date:** March 28- 2025

Abstract: This study was conducted at the Prince Abubakar Audu University Research and Demonstration Farm, Anyigba during the 2023 cropping season. The experiment consists of six varieties of okra; Bagauda Spineless, Clemson Spineless, NH Okra 1, NHAe 47-4, LD 88 and Local; two NPK 20:10:10 fertilizer levels 0kg/ha and 100kg/ha; two poultry manure levels; 0kg/ha and 4t/ha respectively. These treatments were merged in a factorial combination and laid in a Randomized Complete Block Design with three replications. Bagauda Spineless had the highest germination count (87.5, 81.58 and 74.66 %) across all sampling stages. The variety produced the tallest plants (10.98, 18.4s5, 38.27, 50.39 cm), although did not differ significantly from those of Clemson Spineless. Clemson Spineless produced the highest number of leaves, thickest stems and largest leaf across all stage of sampling. For most of the growth characters, variety LD88 had the lowest result. Application of NPK fertilizer was not significant for some of the growth characters, however, tallest plant (32.56 cm), highest number of leaves (15.67) and largest leaf area (489.85 cm^2) were obtained when 150 kg/ha was applied at 9 WAS. For establishment count at 7 and 9WAS, control plots produced highest rates of germination (57.88 and 58.11%). Alternatively, Application of 4 t/ha of poultry manure produced the best results for almost all the growth characters at different stages of sampling. Yield characters such as; Fruit diameters and number of seed/fruits produced the highest result (8.62 cm & 84.73), longest fruit (8.81 cm) was obtained with Clemson spineless, highest number of fruit/plant (2.44) was obtained from NHAe 47-4 while local variety produced the highest yield (45.11 kg/ha). Result obtained from fruit weight was statistically at par with those of Bagauda Spineless. Fruit diameter and number of seeds/fruits were highest with the application of 150 kg/ha of NPK, other yield parameters were optimum at 4 t/ha poultry manure except number of lobes and fruit length. Physiochemical properties of okra mucilage shows that mucilage of Bagauda Spineless, NH Okra-1, and NHAe 47-4 varieties were mostly yellow in colour while Clemson Spineless, LD88 and Local had grey colours. All varieties tested were alkaline to neutral in pH with values ranging from 6.77-7.13. Plots treated with no fertilizer produced grey mucilage while those treated with 4.0 t/ha of poultry manure produced mucilage with pH of 7.09. Viscosity was not significantly affected by variety, NPK and poultry manure. Interaction of V × NPK and V × PM on fruit weight/ha shows that Local variety had the highest response to the application of 150 kg NPK/ha and 4 t/ha respectively.

Keywords: Color, Lines, Mineral Fertilizer, Mucilage, Organic fertilizer, Okra, Viscosity.

Introduction

Okra (Abelmoschus esculentus L.) known as Lady's finger, is a warm-season fruit vegetable that belongs to the family Malvaceae. It is widely grown throughout the tropics and is recognized as one of the world's oldest cultivated crops [1]. Out of the approximately 2,283 known okra species, 1,769 species were significantly found in West Africa, hence, West Africa is known as the primary center of okra's origin [2]. The term "Abelmoschus" is derived from the Arabic phrase "abul-l-mosk," which means "father of musk" or "source of musk" which refers to the seeds of the plant genus [3].

Cultivated Okra that contains chromosome number 2n=130 is an amphidiploid vegetable of Abelmoschus tuberculatus (2n=58) and an unknown species with chromosome number 2n=72 [4]. Approximately 9.95 million tons of okra are produced worldwide [5]. Okra plays a vital role in human diet [6], as a fast-growing annual crop mainly grown for its tender fruit. It is an important vegetable crop grown in tropical and subtropical parts of the world [7, 8, 9,10]. The tender fruits are used as vegetables either boiled or sliced and fried [11].

Okra fruit contains proteins, carbohydrates, it is a rich source of vitamins, calcium, potassium, iodine and other minerals. Okra mucilage is used for glace paper production and also a confectionary use. Mucilaginous preparation from the pod can be used as a blood plasma replacement. Okra can be consumed alone as a vegetable dish, or it can be combined with other foods to create tasty stews, soups, and sauces.

In the quest to boost yields and ensure optimum crop performance, significant amount of inorganic fertilizer is often applied to vegetable crops [12]. However, studies have shown that uncontrolled use of inorganic fertilizers alone may spell havoc for human and environmental health [13] vis-à-vis adverse effects on soil quality. Alternatively, Organic manures are very essential for the proper development of plants as they offer rapid growth with superior quality by containing some nutrients that are necessary for better development, they help in improving the soil physiochemical properties. Therefore, organic manure has potential of replacing chemical fertilizers to reduce detrimental effect of intensive use of the latter in agriculture. Highly concentrated and rapidly available nutrient content of inorganic fertilizers is instantly released for plant uptake and this often result in nutrient imbalance and soil acidity [14]. In comparison with high cost of mineral fertilizer, organic manures are cheap source of plant nutrients, additionally, vermicompost supplementation enriches the soil with substances not typically found in chemical fertilizers, and sustainable nutrient supply to crops and maintains soil health [15].

The use of Mineral fertilizer and Organic manure has been widely reported to boosting growth and fruit yield, however, there is a general apprehension among the general populace that the use of fertilizer solely or in combination with organic manure usually resulted in reduced mucilaginous properties of the crop. This belief calls for worry, especially among scientists. Some people though partially believe in this but will quickly add that such reductions (mucilage) are usually restricted to improved varieties only. Given the fact that these perceptions are not backed up by any scientific proof, we became eager to put the perspective straight and hence the conceptualization, design and eventual execution of the trial/experiment. This research seeks to evaluate six varieties of Okra (Abelmoschus esculentus L Moench) under varying levels of NPK and poultry manure fertilization on growth, yield and mucilaginous properties in Anyigba, Kogi State.

Materials and Methods

Study Area

The study was conducted during the cropping season of 2023/2024 at Prince Abubakar Audu University (PAAU) Student Research Farm, Anyigba, Kogi State (Lat. 7° 29'N and Long 7° 11'E) on elevation of 420 m above sea-level. Average rainfall is 180mm distributed between April and October, mean monthly min. and max. temperature is 17° C and 36.2° C, soil is generally sandy to sandy–loam [16].

Soil Sampling and Analysis

Samples of soil was taken from randomly selected points at depths (0-30cm) on the research field using tabular auger and bulked. It was analyzed for physical and chemical properties such as % clay, silt and sand. % Organic carbon, total Nitrogen, available P, exchangeable bases, Cation Exchange Capacity (CEC) and soil pH as described by [17,18,19,20].

Treatment and Experimental Design

The experiment consists of six (6) varieties of okra namely, BAGAUDA SPINELESS, CLEMSON SPINELESS, NH Okra 1, NHAE 47-4, LD 88 and Local Variety, two NPK 20:10:10 fertilizer levels 0kg/ha and 100kg/ha; two poultry manure levels 0kg/ha and 4t/ha respectively. These treatments were merged in a factorial combination (6 x 2 x 2). A total of twenty-four factorial combinations was laid in a Randomized Complete Block Design (RCBD) with three replications. A total of seventy-two (72) plots were obtained with each plot measuring $12m^2$. Plots within each replicate were separated by 0.5 m apart. Each replicate was separated from the adjacent one by a discard row of 1.0 m apart. The experiment covered a total land area of $1150.25m^2$.

The experimental field was ploughed, harrowed and ridged to give plants effective germination and reduce weed control. Each replication consisted of 24 treatments, separated from its adjacent one by 0.5m demarcation. Six okra varieties were obtained from the National Horticultural Research Institute (NIHORT) Ibadan,

Oyo State for the experiment while NPK 20:10:10 fertilizer and poultry manure were obtained from Anyigba Local market. The okra was sown two seeds per hole on ridges. Sowing was carried out on the 20th day of July 2023. Intra-plant spacings of 30cm was maintained on ridges spaced 75cm apart. NPK 20:10:10 fertilizer was applied at 0 t/ha, and 0.1 t/ha basally after planting, which translate into 120gm/plot and 4.8kg/plot of NPK and poultry manure respectively.

Weed control was done by spraying pendimethalin pre-emergence at 1.00kg/ha, 1-3 days after sowing. Fluazifopbutyl at 0.25kg/ha was applied post emergence followed by one hand weeding at 30days after sowing to keep field weed-free throughout the experiment. Mainly, Okra blight affected the growth of okra during this research, cypermethrin, Lambda-cyhalothrin 2.5EC was sprayed at 10ml a.i/ ha for the control of these pest and others such as pink bollworm, whitefly, thrips, mites and Aphids. Ten plants from the subplot were randomly selected and tagged for growth studies sampling such as; establishment count, plant height (cm), number of leaves per plant, leaf area per plant (cm^2), and stem girth (cm) at 3, 6, 9 & 12WAS. Yield Characters such as days to flowering, days to fruiting, number of fruits/plants, number of seeds/fruits, fruit weight (kg/ha), fruit length were measured at harvest.

Physical and Chemical Analysis of Fruit Extracts

Fresh okra fruits were washed to remove adhering dirt. The okra was grated using a hand-held grater. The grated okra was collected in beakers according to the sample numbers. The grated okra was taken and 80g of distilled water was added and left to stand overnight. After that the beakers containing the extracted mucilage were heated for 2hours at 60^0C with constant stirring. The beakers were allowed to cool for another 2 hours to release the mucilage in water. The mucilage was precipitated, washed with acetone and dried at 50^0C in the oven. Viscosity of the okra mucilage was measured by taking 2g of the mucilage and dissolving same in 200mL of distilled water using Brookfield viscometer.

Analysis of Data

All data collected were subjected to Analysis of Variance (ANOVA) using MSTAT statistical software to determine significant differences among the treatments. Significantly different treatment means were subjected to the Duncan Multiple Range (DMRT) as described by Duncan [21]. Relationships existing between yield vs yield characters, yield vs growth characters and yield characters' vs growth characters shall be determined by means of Simple Linear Correlation Analysis as described by Steel and Torrie [22].

Results and Discussion

The result of the soil Analysis obtained for the experimental site (table) indicate that the soil is sandy-clay-loam with Organic Carbon content of 0.88%, Organic Matter (1.52%), percentage N of 0.04% (low), available P of 5.36 mg/kg, K 2.31 mg/kg. this result indicated that the soil is suitable for okra production. however, low N, P, K and organic matter content present necessitated the choice of NPK 20-10-10 and poultry manure at rates used in this experiment.

Properties	0 - 15 and 15 – 30 cm depth
Physical	
Sand	2.28
Slit	21.20
Clay	76.52
Textural Class	Sandy Clay Loam
Chemical	
P_H in H_20 (1:2:5)	4.61
Organic carbon (%)	0.88
Organic matter (%)	1.52
Total Nitrogen (%)	0.04
Available phosphorus (mg/kg)	5.36
Exchangeable Cation (Meq/100gm Soil)	
K^+	2.31
Mg^+	2.74
Ca^+	4.39
Na^+	0.41
CEC	10.91

Table 1: Physical and Chemical characteristics of Soil taken from the Experimental Site before the Establishment

Response of Okra Lines to Growth and Growth Characteristics under Organic and Mineral Fertilizations application in Anyigba, during the 2023 Cropping Season.

Varieties differ ($P \leq 0.05$) in their establishment (table 2). Bagauda Spineless had the highest germination count giving 87.5, 81.58 and 74.66 % respectively at all stages of sampling. This was at par with the local variety across all stages of sampling. LD88 produced the lowest gemination (16.66, 16.16 and 14.00 %) at all stages of sampling. Clemson Spineless and NH Okra-1 did not differ significantly in their establishment at 5 and 7WAS, while establishment of NHAe 47-4 and NH Okra-1 were at par at 7 and 9WAS. Control plots for NPK fertilizer produced the highest germination at 57.88 and 58.11 % at 7 and 9WAS against plots treated with 150 $kgha^{-1}$ which gives lowest establishment. However, plots treated with 4t/ha of poultry manure produced the highest germination (68.50 and 65.05 %) at 7 and 9 WAS when compared with the control plots. Interaction of V × NPK was significant for establishment count at 7 and 9WAS, V × PM was significant at all sampling stages while V × NPK × PM was not significant at all sampling stages.

Bagauda Spineless produced the tallest plants consistently at all stages of sampling (table 2). This was at par with heights of Clemson Spineless and local variety. LD88 consistently produced the shortest plants at all stages of sampling. Heights of NH Okra-1 and NHAe 47-4 were at pr in most cases. Application of NPK fertilizer had no significant influence on plant heights at 7 and 11 weeks of sampling. However, control plots produced the tallest plant (8.73 cm) at 5WAS, while plots treated with 150 $kgha^{-1}$ produced the tallest plant (32.56 cm) at 9WAS. Plots treated with 4tha-1 consistently produced the tallest plants when compared with the plots treated with 0 tha^{-1} of poultry manure. Interaction of V × F was significant at all stages of sampling.

Clemson Spineless produced the highest number of leaves at 5, 7 and 9 WAS as LD88 produced the highest number of leaves at 11 WAS (table 2). Varieties LD88, NHAe 47-4 and Bagauda Spineless produced the lowest number of leaves (4.35, 6.45, 12.00 and 10.38) at 5, 7, 9 and 11 weeks of sampling respectively. plots treated with 150 $kgha^{-1}$ of NPK fertilizer and 4tha-1 poultry manure produced the highest number of leaves (15.67, 18.45) when compared with the control plots only at 9 WAS. Interaction of V × F was significant for number of leaves per plant at all stages of sampling.

Clemson Spineless produced plants with the thickest stems (2.53, 2.97, 4.05 cm) while LD88 produced plants with the thinnest stems consistently at 5,7 and 11 weeks of sampling (table 2). Stem girths obtained with other varieties were at par during this sampling periods. Plots treated with 4tha^{-1} of poultry manure consistently produced plants with the thickest stems (2.77, 3.13, 4.16, 4.07 cm) when compared with plots treated with 0 tha^{-1} of poultry manure at all stages of sampling. NPK 20-10-10 fertilizer had no significant effect on stem girths at all stages of sampling. Interaction of V × F was significant for stem girth at all stages of sampling.

Clemson Spineless produced the largest leaf area (131.34, 527.48, 530.45 cm^2) at 5, 8 and 11 weeks of sampling (table 3). LD88 produced the smallest leaf area (80.22 cm^2) at 5WAS while local variety produced the smallest leaf area (338.25, 349.37 cm^2) respectively at 9 and 11 weeks of sampling. leaf areas produced by Bagauda Spineless were at par with those obtained with NH Okra-1 at 5, 9 and 11 weeks of sampling. Plots treated with 150 $kgha^{-1}$ of NPK fertilizer produced plants with the largest leaf area (489.85 cm^2) only at 9WAS when compared with the plots treated with 0 $kgha^{-1}$ of NPK fertilizer (371.83 cm^2). Similarly, plots treated with 4tha^{-1} produced the largest leaf area (170.92, 431.68 cm^2) at 5 and 7WAS when compared with the control plots. Interaction of V × F was significant for leaf area at all stages of sampling.

Response of Okra Lines to Yield and Yield Characteristics under Organic and Mineral Fertilizations application in Anyigba, during the 2023 Cropping Season.

Yield characters of okra crop were significantly affected ($P < 0.05$) by NPK and poultry manure application in Anyigba, during the 2023 Cropping Season (table 4). Variety, NPK fertilizer Poultry manure and interaction did not significantly affect the number of lobes produced by okra crop in Anyigba. Local variety produced the longest fruit diameter (8.71 cm) and this is at par with fruit diameters obtained with Bagauda spineless and NH Okra-1. LD88 produced the shortest fruit diameter. Plots treated with 150 kg/ha of NPK produced the longest fruit diameter when compared with the control plots. similarly, application of 4t/ha of poultry manure produced the longest fruit diameter. Interaction of V × NPK, V × PM and V × NPK × PM were not significant for this character. Clemson spineless produced the longest fruit (8.81 cm). This differs significantly from the length of fruits obtained with other varieties. LD88 produced the shortest fruit.

Table 2: Effect of Variety, Organic and Mineral Fertilizer on some Growth Characters of six Okra Lines (Abelmoschus esculentus L.) in Anyigba, during the 2023 Cropping Season.

	Establishment count			Plant height (cm)				Number of Leaves				Stem Girth (cm)			
	Sampling Periods (Weeks After Sowing)														
Treatments	5	7	9	5	7	9	11	5	7	9	11	5	7	9	11
Varieties (V)															
Bagauda Spineless	87.50^{a}	81.58^{a}	74.66^{a}	10.98^{a}	18.45^{a}	38.27^{a}	50.39^{a}	5.97^{ab}	7.35^{ab}	12.00^{b}	10.38^{b}	2.34^{a}	2.63^{ab}	3.60	3.85^{ab}
Clemson Spineless	66.75^{c}	52.91^{c}	52.66^{c}	10.83^{ab}	17.99^{ab}	38.34^{a}	47.13^{a}	6.50^{a}	8.93^{a}	17.85^{a}	13.87^{b}	2.53^{a}	2.97^{a}	3.95	4.05^{a}
NH Okra-1	71.41^{c}	60.58^{bc}	56.75^{b}	9.44^{b}	14.94^{bc}	25.36^{bc}	33.49^{b}	5.36^{b}	6.82^{ab}	14.39^{ab}	11.09^{b}	2.29^{a}	2.55^{ab}	3.38	3.55^{ab}
NHAe 47-4	79.25^{b}	61.41^{bc}	66.16^{ab}	9.74^{ab}	14.52^{bc}	28.92^{bc}	34.85^{b}	5.82^{ab}	6.45^{b}	14.18^{ab}	11.18^{b}	2.42^{a}	2.54^{ab}	3.47	3.51^{ab}
LD88	16.66^{d}	16.16^{d}	14.00^{d}	4.85^{c}	9.56^{d}	24.15^{c}	34.07^{b}	4.35^{c}	8.22^{ab}	18.29^{a}	20.03^{a}	1.51^{b}	2.20^{b}	3.33	3.15^{b}
Local	82.33a^{b}	69.00^{ab}	64.41a^{bc}	10.17^{ab}	17.63^{ab}	33.13^{ab}	40.97^{ab}	5.55^{b}	7.77^{ab}	14.81^{ab}	11.78^{b}	2.56^{a}	2.84^{a}	3.50	3.57^{ab}
SE	2.69	4.50	4.14	0.51	1.12	3.01	4.27	0.30	0.75	1.67	1.84	0.14	0.20	0.27	0.29
NPK 20-10-10 (N)															
0kgha^{-1}	67.05	57.88^{a}	58.11^{a}	8.73^{a}	13.62	26.00^{b}	33.36	5.55	7.13	12.44^{b}	11.17	2.13	2.35	3.08	3.32
150 kgha^{-1}	65.50	46.77^{b}	41.44^{b}	8.63^{b}	14.56	32.56^{a}	40.17	5.31	7.57	15.67^{a}	13.36	2.23	2.61	3.46	3.61
F-LSD $_{(0.05)}$	ns			0.98	ns	5.78	ns	ns	ns	3.20	ns	ns	ns	ns	ns
Poultry Manure (P)															
0 tha^{-1}	69.27	54.61^{b}	54.50^{b}	8.68^{b}	14.26^{b}	26.72^{b}	35.20^{b}	5.60	7.81	14.45^{b}	12.00	1.97^{b}	2.40^{b}	3.45^{b}	3.45^{b}
4tha^{-1}	67.44	68.50^{a}	65.05^{a}	11.28^{a}	19.62^{a}	40.51^{a}	51.87^{a}	5.92	7.84	18.45^{a}	15.68	2.77^{a}	3.13^{a}	4.16^{a}	4.07^{a}
SE	2.20	3.68	3.38	0.42	0.91	2.46	3.48	0.24	0.61	1.36	1.50	0.11	0.16	0.22	0.24
Interaction															
V × NPK	ns	*	*	ns	ns	ns	ns	*	ns	*	ns	ns	ns	*	*
V × PM	*	*	*	*	ns	*	ns	*	ns	*	ns	ns	ns	*	*
V × NPK × PM	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Means followed by the same letter(s) within the parameter are not statistically different at 0.05 level of probability using N-DMRT.
* - Significant at 5% level of probability.

Application of NPK fertilizer and poultry manure did not significantly affect fruit length. Similarly, Interaction of V × NPK, V × PM and V × NPK × PM were not significant for this character. NHAe 47-4 produced the highest number of seeds per fruit (82.59). this was at par with the number of fruits obtained with Bagauda spineless and Clemson spineless. Local variety produced the least number of seeds per fruit. Plots treated with 150 kg/ha of NPK fertilizer and 4t/ha of poultry manure produced the highest number of seeds per fruit (79.46 and 75.80) and this differ significantly from the number of seeds per fruit obtained with their respective control plots. Interaction of V × NPK, V × PM and V × NPK × PM were not significant for this character.

	Sampling periods (Weeks After Sowing)			
Treatments	5	7	9	11
Varieties (V)				
Bagauda Spineless	138.83ab	376.64	461.05^{ab}	452.10^{ab}
Clemson Spineless	131.34ab	356.68	527.48^{a}	530.45^{a}
NH Okra-1	104.56abc	308.55	446.64^{ab}	422.80^{ab}
NHAe 47-4	136.41ab	363.63	518.05^{a}	480.42^{ab}
LD88	80.22c	275.07	438.49^{ab}	412.97^{ab}
Local	142.94a	254.83	338.25^{b}	349.37^{b}
SE	17.45	46.04	54.96	53.20
NPK 20-10-10 (N)				
0kgha^{-1}	95.15	259.32	371.83^{b}	417.57
150 kgha^{-1}	105.42	325.04	489.85^{a}	456.57
F-LSD $_{(0.05)}$	ns	ns	105.60	ns
Poultry Manure (P)				
0 tha^{-1}	118.05^{b}	274.22^{b}	450.60	425.64
4tha^{-1}	170.92^{a}	431.68^{a}	507.70	465.38
SE	14.25	37.59	44.88	43.44
Interaction				
V × NPK	ns	ns	ns	ns
V ×PM	*	*	*	*
V × NPK × PM	ns	ns	ns	ns

Table 3: Effect of Variety, Organic and Mineral Fertilizer on the Leaf Area (cm2) of six Okra Lines (Abelmoschus esculentus L.) in Anyigba, during the 2023 Cropping Season.

Means followed by the same letter(s) within the parameter are not statistically different at 0.05 level of probability using N-DMRT. * - Significant at 5% level of probability.

Treatments	**No of Lobes**	**Fruit diameters (cm)**	**Fruit Length (cm)**	**No. of Seed/ fruit**	**No. of Fruit/ plant**	**Fruit Weight/ha^{-1}**
Varieties (V)						
Bagauda Spineless	8.80	8.62^{a}	6.45^{b}	84.73^{ab}	1.78^{ab}	36.98^{ab}
Clemson Spineless	7.88	5.67^{d}	8.81^{a}	76.11^{ab}	1.72^{bc}	20.13^{c}
NH Okra-1	8.69	8.16^{a}	5.97^{b}	82.30^{a}	1.042^{c}	7.63^{d}
NHAe 47-4	8.65	7.73^{b}	5.36^{b}	82.59^{a}	2.44^{a}	33.30^{b}
LD88	8.30	7.45^{c}	5.09^{c}	70.69^{bc}	1.52^{bc}	15.27^{c}
Local	8.30	8.71^{a}	6.29^{b}	58.85^{c}	0.88^{c}	45.11^{a}
F-LSD $_{(0.05)}$					*	*
NPK 20-10-10 (N)						
0kgha^{-1}	8.36	7.32^{b}	5.84	74.71^{b}	1.40	17.57
150 kgha^{-1}	8.48	7.79^{a}	6.29	79.46^{a}	1.50	18.53
F-LSD $_{(0.05)}$	ns	0.14	ns	2.01	ns	ns
Poultry Manure (P)						
0 tha^{-1}	8.42	7.81^{b}	6.29	73.54^{b}	1.04^{b}	12.48^{b}
4tha^{-1}	8.49	7.96^{a}	6.86	75.80^{a}	1.63^{a}	28.46^{a}
F-LSD $_{(0.05)}$	ns	0.14	ns	2.01	0.26	10.49
Interaction						
V × NPK	ns	ns	ns	ns	ns	*
V × PM	ns	ns	ns	ns	ns	*
V × NPK × PM	ns	ns	ns	ns	ns	ns

Table 4: Effect of Variety, Organic and Mineral Fertilizer on the Yield Characters of six Okra Lines (Abelmoschus esculentus L.) in Anyigba, during the 2023 Cropping Season.

Means followed by the same letter(s) within the parameter are not statistically different at 0.05 level of probability using N-DMRT. * - Significant at 5% level of probability. ns= not significant.

Characterization of Mucilaginous Properties of Okra in Anyigba during the 2024 cropping Season

As shown in table 5, variety had no significant effect (P > 0.05) on viscosity of okra mucilage. Mucilage of Bagauda Spineless, NH Okra-1 and NHAe 47-4 were mostly yellowish in colour, LD88 and Local varieties were mostly greyish, while Clemson Spineless produced ash colored mucilage. Clemson Spineless and NH Okra-1 had the highest pH (7.13) amongst all varieties examined. This was however statistically at par with Ph obtained with those of Bagauda Spineless, NHAe 47-4 and LD88 respectively. local variety produced the lowest pH (6.77). NPK fertilizer had significant effect only on the colour of okra mucilage with plots treated with no fertilizer producing yellow mucilage while plots treated with 150kg/ha of NPK produced grey colored mucilage. Poultry manure had no significant effect on viscosity, color and pH throughout the sampling periods. Interaction of V x NPK was significant for colour and pH. Interaction of V x PM was significant for viscosity, colour and pH respectively. a CV of 26.1, 24.4 and 4.5% respectively were obtained for these characters.

Treatments	Viscosity (cP)	Colour	Viscosity (cP)
Varieties (V)			
Bagauda Spineless	10.52	2.54^{a}	6.95^{ab}
Clemson Spineless	9.85	1.96^{b}	7.13^{a}
NH Okra-1	11.82	2.50^{a}	7.13^{a}
NHAe 47-4	11.46	2.58^{a}	6.98^{ab}
LD88	11.77	2.33^{ab}	6.96^{ab}
Local	11.41	2.04^{b}	6.77^{b}
SE (±)	0.84	0.16	0.09
NPK 20-10-10 (N)			
$0kgha^{-1}$	11.24	2.39^{a}	7.00
150 $kgha^{-1}$	10.35	2.00^{b}	6.90
F-LSD $_{(0.05)}$	ns	0.38	ns
Poultry Manure (P)			
0 tha^{-1}	10.77	2.44	6.96^{b}
$4tha^{-1}$	12.20	2.47	7.09^{a}
SE (±)	0.68	0.13	0.07
Interaction			
V × NPK	ns	*	*
V × PM	*	*	*
V × NPK × PM	ns	ns	ns
CV%	26.1	24.4	4.5

Table 5: Effect of Organic and Mineral Fertilizer applications on some Physical and Chemical Properties of six varieties of Okra (Abelmoschus esculentus L.) grown in Anyigba during the 2024 Cropping Season.

Means followed by the same letter(s) within the parameter are not statistically different at 0.05 level of probability using N-DMRT. C.V- Coefficient of variation * - Significant at 5% level of probability.

The determinations were done at an ambient temperature of 28.5^{0}C. The colors were the colour of the mucilage in water solutions (2.5 – 3.0=Yellow, 2.0 – 2.49=Grey 1.0 – 1.99=Ash).
The mucilaginous properties of the okra fruits were measured using a Brookfield DV-E viscometer (Brookfield USA), Speed: 100rpm, Spindle no:3

Interaction of Variety × Fertilizer on Fruit Weight of Okra Crop grown in Anyigba during the 2024 Cropping Season.

Interaction of V × NPK (table 6) shows that Local variety had the best response to NPK fertilizer. this variety produced yield 45.11 kg/ha when treated with 150 kg/ha of NPK. This response was followed by Bagauda spineless (36.96 kg/ha), NH Okra-1 (34.27 kg/ha) and LD88 (36.00 kg/ha) in that order. Other varieties did not respond to 150 kg/ha NPK fertilizer application. Similarly (table 7), Bagauda Spineless had the best response to the application of 4.0 t/ha of poultry manure producing the highest yield (46.23 kg/ha). This was followed by NHAe 47-4 (36.14 kg/ha) and Clemson Spineless (33.30 kg/ha) respectively. other varieties did not respond to poultry manure fertilization.

NPK ($kgha^{-1}$)	Varieties					
	Bagauda Spineless	Clemson Spineless	NH Okra-1	NHAe 47-4	LD88	Local
0	7.6^{d}	36.98^{ab}	7.63^{d}	15.27^{c}	15.27^{c}	20.13^{c}
150	36.96^{ab}	33.30^{b}	34.27^{b}	20.13^{c}	$36.^{ab}$	45.11^{a}
SE (±)						

Table 6: Interaction of Variety (V) × Fertilizer (NPK) on Fruit weight of Okra Crop grown in Anyigba during the 2023 cropping season.

Means followed by the same letter(s) are not statistically significant at 5% level of probability using the N-DMRT

PM (tha^{-1})	Varieties					
	Bagauda Spineless	Clemson Spineless	NH Okra-1	NHAe 47-4	LD88	Local
0	7.63^{d}	15.27^{c}	16.87^{c}	17.39^{c}	20.17^{c}	36.98^{ab}
4.0	46.23^{a}	33.30^{b}	20.13^{c}	36.14^{ab}	15.11^{c}	46.11^{a}
SE (±)						

Table 7: Interaction of Variety (V) × Poultry Manure (PM) on Fruit weight of Okra Crop grown in Anyigba during the 2023 cropping season.

Means followed by the same letter(s) are not statistically significant at 5% level of probability using the N-DMRT

Discussion

Effect of Variety on Growth and Yield and Yield Characters of Okra.

Okra growth and yield was significantly influenced by variety, mineral and organic fertilizers. This has been reported in so many researches [23,24,25,26,27,28]. Significant influences of variety on establishment count, plant height, number of leaves, leaf area, stem girth obtained in this research could be attributed to their variation in their genetic make-up. Ayoub et al. [29] had confirmed variation in growth of crops subjected to similar environmental conditions and attributed these differences to differences in the genetic make-up of these crops. Our result conforms with Muhammed et al. [28] who obtained tallest plants with Dogowas (local) variety of okra similarly, he reported higher number of branches with improved okra varieties (LD88, NHAE47-4). In most cases, local varieties often grow taller than improved, this reflects a phenomenon peculiar to local okra cultivars. This characteristic taller statue may have resulted from wide adaptation to wider range of climatic environment. This is in agreement with Ojo et al [30] who confirmed that local okra varieties have characteristic taller statue compared to the improved varieties. Other growth characteristics in this research were optimum with improved varieties. This agrees with the reports of Jamala [31] and Rahman et al. [32]. Yield characters such as fruit diameters, fruit length, number of seed/fruits, number of fruit/plants were significantly higher with improved okra varieties in this research. This result aligns with the work of Muhammad et al. [28]. Akinfosoye et al. [33] also reiterated that okra cultivars' yields varied significantly. Alternatively, highest yield was obtained with local variety in his research. This yield advantage shows that the local variety is more robust in harnessing and mobilizing photosynthates which reflected in yield. this result corroborates with the report of Khan et al. [34], Ojo et al. [30] and Rahman et al. [32]. This is however in opposition to the finding of Abdulmaliq et al. [35] who reported that the NHAe 47-4 variety of okra outperformed all other soil treatment over the course of two years of research explaining this observation by pointing to the selection of the cultivar cultivated and its particular genetic composition.

Effect of Organic (Poultry Manure) and Mineral Fertilizer (NPK 20:10:10) on Growth and Yield and Yield Characters of Okras

Significant increase in growth observed with the application of 150 kg/ha of NPK fertilizer and 4.0 tons per ha of poultry manure have been reported by many authors [36,37]. From our experiment growth of okra crop seems to perform optimally with poultry manure more than NPK fertilizer in most cases. Application of 150 kg/ha of NPK fertilizer seemed insignificant in some cases and at par with control plots for some growth characters in most cases. This is because poultry manure is claimed to be a better soil treatment because of its stronger ability to maintain nitrogen [38], therefore, superior N supply by the manure may improve okra growth and development [38]. Quick mineralization of organic fertilizers and early nutrient release to a short-gestation crop like okra, often result in increased plant's morphological growth, which seldom translates to increased production [39]. This confirms the result of this experiment where application of 4.0 tons/ha of poultry manure improved establishment, plant height, number of leaves, leaf area, stem girth respectively. Similarly, yield characters such as fruit diameters, number of seeds/fruit performed optimally under 150 kg/ha NPK, 4.0 tons/ha poultry manure while number of fruit/plant and yield (fruit weight/ha) was highest with 4.0 tons/ha poultry manure. This result conforms with the earlier reports of Akande et al. [14] who observed that inorganic fertilizer can improve nutrient availability and increase crop yield. Kana et al. [41] also reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to plants. Akande et al. [40] noted that application of organic materials could ameliorate slightly acidic tropical soil to improve crop production. Ukamaka, [25] reported that okra cultivated on poultry manure produced higher results in terms of growth and output. Our result is also in agreement with Omotosho and Shittu [42] who reported that NPK fertilizer application significantly increased yield and yield components with optimum yield of okra at 150 NPK kg/ha in South Western Nigeria.

Effect of Variety, NPK fertilizer and Poultry Manure on Okra Mucilaginous Properties

No much work has been done in this area, however, our result shows that Viscosity was not significantly influenced by variety, poultry manure and NPK fertilizer. Significant interaction of variety x poultry manure on viscosity, color, pH, V x NPK interaction on color and pH explained that a differential coloration and increased pH observed with varieties resulting from the influence of NPK fertilizer and poultry manure. This result is in line with report of many authors who attributed most physical and chemical properties of okra mucilage to factors such as nutrient, temperature, pH, sugar and salt contents, and storage time [43,44].

Effect of Interaction of Variety × Mineral fertilizer (V × NPK) and Variety × Organic (V × PM) on Yield of Okra

Our result corroborates with the report of Okee et al. [27] who asserts that 150 kg/ha of NPK fertilizer suffices for the production of hybrid okra varieties in Lokoja environment. Akande et al., [14] also reported that inorganic fertilizer can improve nutrient availability and increase crop yield. higher interaction obtained in this experiment also reflected in the works of Omotosho and Shittu [42] who reported that NPK fertilizer application significantly increased yield and yield components of improved okra varieties with optimum yield of okra at 150 NPK kg/ha in South Western Nigeria.

Conclusion

The use of organic and chemical fertilizers resulted in increased growth and fruit yield of okra. This response may be due to low basal nutrient content of the soil (see pre-field soil test result) and/or high Nitrogen rate as contained in NPK and poultry manure which increased photosynthetic activities and therefore led to increased fruit yield. The fact that local okra variety outyielded the improved ones could be due to the fact that the so called 'local' may not be local in the true sense of the word as most of them are either improved variety that have lost their identity/name and therefore sold as local in our village markets. The case of mistaken identity is very rampant with self-pollinated crops and okra is no exception. Given the inconsistent result of viscosity value with poultry and NPK fertilizer application, a different result could have been obtained if viscosity analysis were to be carried out with every fruit harvest. However, the cost of carrying out such analysis is very expensive. The interaction of Variety x poultry manure on viscosity value is extremely interesting, as it indicates that okra crop manured with poultry droppings appears to be more viscous than those from the control plots, however, the exact opposite was seen with NPK fertilizer (20:10:10). Though, a one - year trial, the general belief that fertilizer/poultry manure application usually resulted in decreased mucilaginous content of okra fruit cannot be sustained scientifically and therefore rejected without prejudice to the observations above.

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Citation: Abdulsalam Fatimat Jumai., et al. "Evaluation of Six Lines of Okra Under Organic and Mineral Fertilization for Yield and Mucilaginous Properties in Anyigba Kogi State Nigeria". NL Journal of Agriculture and Biotechnology 2.2 (2025): 22-33.