

EFFECTS OF GREEN MANURE AND CONVENTIONAL FERTILIZER ON OKRA ((*Abelmoschus esculentus* L. (Moench)) PRODUCTION IN ABUJA NIGERIA

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ABSTRACT

A trial was conducted to evaluate the fertility potentials of green manure and conventional fertilizers in Okra (*Abelmoschus esculentus* L. Moench) Production in Southern Guinea Savannah Region of Nigeria, during the 2020 cropping season. The Experimental treatments whose effects were evaluated are; *Leucaena leucocephala* leaves, *Gliricidia sepium* leaves, *Moringa oelifera* leaves, *Azadirachta indica* (Neen) leaves, *Hyptis suaveolens* leaves, Poultry manure, NPK fertilizer with Zero fertilization) as the Control. A Randomized Complete Block Design with 3 replications was used in the study. Each replicate contained 8 plots; thus, 24 plots were used for the study. Data collected include Plant parameters, Plant height, Number of leaves per plant, Stem Girth, Weight of fruit, Number of fruits, Number of shoots/plant and fruit yield (t/ha). NPK fertilizer outperformed other treatments however, it was not significantly different from organic in terms of vegetative growth and fruit yield. The green manure although less than NPK in performance was not significantly different from poultry manure. The mean of all green manure (2.1 t/ha) increased the fruit yield of okra by 23.5% over the control plots that had 1.7 t/ha. The vegetative parameters such as height (cm), number of leaves and stem girth (cm) of Okra were significantly ($p \leq 0.05$) influenced by NPK followed by Poultry manure and to a lesser extent by green manure. To achieve maximum okra production and increased market value in the study area, applying poultry manure at a rate of 8t/ha-1, or a combination of 200 kg/ha of NPK 15:15:15 and 4 tons/ha of poultry manure is recommended based on this study.

Keywords: Okra, Green Manure, NPK fertilizer, Poultry manure, Soil fertility, Growth and Yield

INTRODUCTION

Okra (*Abelmoschus esculentus* L. (Moench)) is an annual, herbaceous flowering plant in the *Malvaceae* family. Okra is native to West Africa and originated in tropical and subtropical Africa. In Nigeria's agricultural landscape, okra is important and the main source of employment (Ibrahim *et al.*, 2020). Okra is native to West Africa and originated in tropical and subtropical Africa. In Nigeria's agricultural landscape, okra is important and the main source of employment (Ibrahim *et al.*, 2020; Onyekere *et al.*, 2020), providing between 70 and 80% of job opportunities and significantly contributing up to 30% of foreign exchange profits. This vegetable crop is widely grown in Nigeria in several different regions (Anyaocha *et al.*, 2023) providing between 70 and 80% of job opportunities and significantly contributing up to 30% of foreign exchange profits. This vegetable crop is widely grown in Nigeria in several different regions (Anyaocha *et al.*, 2023). However, insufficient soil moisture content frequently limits the productivity of okra cultivation, especially during the dry season (Patra *et al.*, 2023). The yearly rainfall unpredictability in economically disadvantaged tropical regions particularly in certain parts of Nigeria presents a major challenge to the sustainability of rain-fed farming systems (Chukwuone and Amaechina, 2021). According to Mgozeli *et al.* (2020), temperature, relative humidity (RH), and light intensity are significant climate characteristics that impact crop development and productivity.

In the tropics and subtropics, okra is one of the most widely cultivated vegetable crops (Singh *et al.*, 2012; Anjorin *et al.*, 2013). Due to its significance for the economic growth of these areas, its production and cultivation have become widely accepted, and it is present in practically every

African market (Opong-Sekyere, 2011). Okra is grown throughout Nigeria's various ecological zones because it provides a cheap source of protein, vitamins A and B, and minerals Ca, P, Fe, and I for many households, in addition to being a source of income for farmers (Adebisi *et al.* 2007,). It is an essential part of the human diet since it is a highly nutritious vegetable that contains 86.1% water, 22.22% protein, 0.22% fat, 9.7% carbohydrate, 1.00% fibre, and 0.88% ash (Saifullah and Rabbani, 2009).

Climate, soil type, and cultivation techniques all have an impact on the water requirements for okra production in Nigeria (Musa *et al.*, 2017). The coarse fibre found in mature stems is utilized in the paper industry and for making ropes. Adopting conservation agriculture, which protects the soil and reduces erosion, can help address the issues faced by rural farmers (Rodenburg *et al.* 2021; Strauss *et al.* 2021). Of the techniques used, mulching stands out as a practical way to alter soil heat flux and soil temperature. By lowering water loss from evaporation from the soil surface, mulching is a popular technique that aids in soil moisture conservation (El-Beltagi *et al.*, 2022).

Okra is grown on a variety of soil types in both irrigated and rain-fed environments. The application of substandard and inappropriate manure doses, along with low-yielding local varieties, has a major negative impact on production. Because it is frequently linked to decreased crop yield, acidic soil, and nutritional imbalance, the use of inorganic fertilizer has not been beneficial under intensive agriculture (Ojeniyi, 2000).

Research on the application of organic fertilizers in Nigeria is comparatively scarce, according to Ojeniyi (2000). The global adoption of organic fertilizers is being spurred by the need to use renewable energy sources and lower crop fertilization

costs. Encouragement of greater use of organic materials is justified in part by the improvement of public health and environmental conditions (Onyekwere, 2020).

Okra is grown by farmers in the northern region of Nigeria as an irrigated and rainfed crop using a variety of organic materials at subpar levels, which lowers crop yield. Even with high-yielding cultivars, the naturally low soil fertility level plus insufficient fertilizer application remains the most important factors determining agricultural performance in Nigeria.

Adding more organic nutrients to the soil is one way to preserve its organic matter, which generally improves the soil's chemical and physical characteristics. According to Oshunsanya (2011), ongoing agriculture, deforestation, and improper farming techniques are causing Nigerian soils to deteriorate at an alarming rate. In addition to the decreased organic matter brought about by these techniques, the soil becomes more susceptible to compaction and erosion (Oshunsanya, 2011). This causes raindrops to crash into the delicate soils. As a result, the soil's ability to sustain strong growth and crop yield to feed the world's growing population is drastically diminished. Schippers (2000) asserts that vegetables are essential for improving human nutrition.

One very important input in the production of crops is fertilizer. Fertilizer application is required to improve the nutrient status of the soil and raise crop yield (Olaniyi *et al.*, 2010). The use of inorganic fertilizer is limited due to its scarcity, high cost, nutrient imbalance, and acidity of the soil, although it can boost crop yield as well as the total content and availability of nutrients (Olaniyi *et al.*, 2010). It has been suggested that using organic manures can help maintain and improve soil fertility

(Smil, 2000). According to Abou El-Magd *et al.* (2006), organic manures increase soil microbial biomass activity and improve nutrient cycling, which in turn improves the biological and physical properties of the soil and cropping systems.

Nigerian soils are deteriorating at an alarming rate due to ongoing management, deforestation, and poor agricultural practices and these practices lead to low levels of organic matter, fragile soils that collapse under the weight of rain, and susceptibility to erosion and compaction (Oshunsanya, 2011). The soil's capacity to produce enough food to feed the world's expanding population is severely diminished; thus, Vegetable crops are now crucial for enhancing human nutrition (Schippers, 2000).

Fertilizer is a vital component in crop production. Utilizing mineral fertilizers can boost crop yields and the amount of nutrients available, but there are drawbacks as well. These include imbalanced nutrient levels, high costs, scarcity, and acidity of the soil. (Olaniyi *et al.*, 2010). However, it has been suggested that the use of organic fertilizers can preserve and enhance soil fertility (Smil, 2000). This study aimed to determine whether applying green manure alone would successfully boost okra production in place of NPK and poultry manure, as well as to assess the effects of NPK, green, and poultry manure fertilization on okra yield.

MATERIALS AND METHOD

The field trial was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Abuja, Nigeria, during the 2020 cropping season. The experimental field was prepared manually using local farm tools such as hoe, cutlass, rake and spade to clear the land. Thereafter, the experimental

layout was established using measuring tapes and pegs (60 cm high) and Beds were made in all the designated plots.

Using traditional farm equipment like a hoe, cutlass, rake, and spade, the experimental field was manually prepared. The experimental arrangement was then created using measuring tapes and 60 cm-high pegs, and beds were built in each of the plots that were assigned. A soil auger was used to gather nine core soil samples at random depths of 0 to 15 and 15 to 30 cm, respectively, from various locations within the experimental layout before planting. The soil samples that had been gathered were then combined and allowed to air dry in the laboratory. Following the process outlined by Walkley-Black (1934), the samples were dried and then sieved using a 2 mm mesh size sieve (sieve pan). Following this, the samples were subjected to laboratory analysis.

The experimental material used for the study was Cajun Delight dwarf okra variety. The Experimental treatment used of which effects were evaluated are; *Leucaena leucocephala* leaves (A), *Gliricidia sepium* leaves (B), *Moringa oelifera* leaves (C), *Azadirachta indica* (Neem) leaves (D), Organic fertilizer (Poultry manure) (E), NPK fertilizer (F), *Hyptis suaveolens* (G), and the control (Zero fertilization) (H). A Randomized Complete Block Design (RCBD) with 3 replications was used in the study. Each replicate contained 8 plots; thus, a total of 24 plots were used for the study. Each plot measures 2.5m x 2.5m separated from each other by a 0.5m pathway. Between the replicates was an access route (1m) for monitoring the trial.

The respective green manures of *Leucaena leucocephala*, *Gliricidia sepium*, *Moringa oelifera*, *Azadirachta indica* (Neem) and *Hyptis suaveolens* were applied at the rate of 5t/ha as

recommended by Anyaegbu (2013). Each designated plot for the green manure of any plant received 2.5 kg of green manure. The leaves (2.5 kg) of the individual fallow species were first spread evenly on the plots and then worked into the soil using a garden fork, two weeks before planting. Organic fertilizer (Poultry manure) was applied at the recommended rate of 5t/ha. The manure was first spread evenly on the designed plots and then also worked into the soil using a garden fork, two weeks before planting.

Growth and yield parameters determined include; plant height, leaf number, stem girth, weight of fruit, number of fruits number of shoots, weight of fruits/plot (kg), length/pod and diameter/pod. After harvesting the crops, post-harvest soil physical and chemical analysis was carried out to evaluate the effect of the fertilizer applied on the soil nutrient status. Data generated from field experiments and laboratory analysis were subjected to analysis of variance (ANOVA) using the R statistical program and the treatment means were separated using the Duncan Multiple Range Test (DMRT) at a 5% probability level.

RESULTS

The results of the physical and chemical properties of the sites before the start of the experiment showed that the soils are sandy loamy, acidic, low in organic matter (OM), available P, total N, exchangeable K, Ca and Mg, and high in bulk density. The site for the experiment was moderate in Ca and adequate in P according to the critical level of 3.0% OM, 10.0 mg kg⁻¹ available P, 0.20% N, 0.16–0.20 Cmol kg⁻¹ exchangeable K, 0.76 Cmol kg⁻¹ exchangeable Ca, and 0.40 Cmol kg⁻¹ exchangeable Mg.

Table 1: Influence of Multipurpose Green Manure on plant height (cm) of Okra.

Manure	4 WAS	6 WAS	8 WAS
Control	23.6a	38.3c	48.7c
Gliricidia	23.4a	41.9bc	54.5bc
Hyptis	23.5a	45.1ab	57.1abc
Leucaena	24.2a	44.0bc	55.3bc
Moringa	24.4a	43.9bc	53.9bc
Neem	24.4a	45.8ab	58.4abc
NPK	25.2a	51.1a	67.5a
Organic	24.6a	46.8ab	61.5ab
SE $\pm$	0.92	1.91	3.25

Means followed by the same letter(s) along a column are not significantly different at $p = 0.05$ (DMRT). WAS = weeks after sowing.

Table 2: Influence of Multipurpose Green Manure on the number of leaves of Okra planted in the research farm, UniAbuja, 2020.

Manure	4 WAS	6 WAS	8 WAS
Control	13.1a	16.8b	22.8c
Gliricidia	13.0a	22.1ab	26.4bc
Hyptis	11.7a	21.7ab	27.4bc
Leucaena	11.8a	25.2a	27.6bc
Moringa	12.5a	21.5ab	28.3bc
Neem	12.1a	23.2ab	31.1ab
NPK	13.5a	25.7a	35.8a
Organic	12.8a	24.8a	33.4ab
SE $\pm$	0.98	2.04	2.15

The same letter(s) after a mean indicates that there is no significant difference at $p = 0.05$ (DMRT). Weeks after sowing = WAS.

Table 3: Influence of Multipurpose Green Manure on stem girth (cm) of Okra planted in the research farm, UniAbuja, 2020.

Manure	4 WAS	6 WAS	8 WAS
Control	2.0a	2.9a	3.1d
Gliricidia	1.8a	2.8a	3.8bc
Hyptis	1.9a	2.8a	3.4cd
Leacaena	2.0a	3.0a	3.8bc
Moringa	2.0a	2.9a	3.7bcd
Neam	2.0a	2.8a	3.9abc
NPK	2.0a	3.1a	4.5a
Organic	1.9a	3.0a	4.1ab

The same letter(s) after a mean indicates that there is no significant difference at $p = 0.05$ (DMRT). Weeks after sowing = WAS.

Table 4: Influence of Multipurpose Green Manure on the yield and yield traits of Okra planted in research farm, UniAbuja, 2020.

Manure	Weight of fruits/plot (kg)	Length/pod (cm)	Diameter/pod (cm)
Control	1.1c	7.8c	3.8c
Gliricidia	1.3bc	9.7ab	4.8ab
Hyptis	1.2bc	8.1bc	5.1ab
Leacaena	1.3bc	10.3ab	5.3ab
Moringa	1.4bc	10.3ab	4.4bc
Neam	1.4bc	10.4ab	5.4a
NPK	1.8a	11.1a	5.7a
Organic	1.6ab	10.8a	5.6a
SE $\pm$	0.12	0.55	0.27

The same letter(s) after a mean indicates that there is no significant difference at $p = 0.05$ (DMRT). Weeks after sowing = WAS.

DISCUSSION

The pre-planting soil physical and chemical analysis of the experimental site showed that apart from the acidic nature of the soil (pH 4.6), there was low base saturation, low Organic Carbon levels and low Nitrogen level which is an indication that the soil fertility status is relatively poor. A comparable finding by Anyaegbu (2013) is confirmed by the low pH level (4.6) that was noted in the trial, which indicates a barrier to increased crop productivity in the area. In order to produce Okra and other crops to their best potential, Nedunchezhiyan and Ray (2010) suggested that the pH of the soil be between 5 and 6.

The cropping history of the experimental site revealed that the area has been under continuous cropping for more than 6 years with Okra and potato crops and this perhaps explained why the base saturation, Cation Exchange Capacity and organic carbon were generally low. However, the post-harvest result of soil analysis showed significant improvement in soil fertility in plots that were treated with NPK and Poultry Manure. Hence, soil pH increased from 4.6 to 6.7 and all basic and exchangeable cations (K, Mg and Ca) were significantly improved.

Vegetables are essential in the maintenance of human health and prevention of bodily diseases thereby combating food insecurity and raising ailments that bedevil Africa as a continent. Okra, a high-valued vegetable loved for its slimming-sticky consistency is currently an orphan crop as it has not gained research attention (Sonto *et al.*, 2021). The ability of green manure to release an adequate amount of nitrogen and the residue effect it

leaves over time determine how nutrient-rich the soil and crop plants become. According to Kaleem *et al.*, (2007), the rate and timing of manure application when used as nitrogen (N) fertilizer depends on the organic manures' N-releasing capacity (mineralization).

One of the main components of an integrated nutrient delivery system in okra propagation is multipurpose green manure combined with inorganic and biofertilizer fertilizers. In this study, organic manure, NPK and the green leaves of *Gliricidia sepium*, *Hyptis suaveolens*, *Leucaena leucocephala*, *Moringa oleifera*, and Neem (*Azadirachta indica*) were used to amend experimental plots influenced the vegetative traits of Okra to various degree. The vegetative parameters of Okra such as height (cm), number of leaves and stem girth (cm) of Okra were significantly ($p \leq 0.05$) influenced mostly by NPK followed by Organic manure and to a lesser extent by the green manure as shown in Tables 1, 2, and 3. The plot treated with NPK fertilizer performed better although not always significant. The fact that okra plants responded favourably to NPK application may be because most vegetable crops need NPK fertilizers for ideal growth and development (Muhammad *et al.*, 2020). Nonetheless, it is highly encouraged and advised to apply the deficient elements through fertilization under varied agronomic conditions that can be adjusted to maximize production from a unit area when these nutrients are lacking or insufficient; hence, the increase in growth with NPK fertilizer.

The significant increase in plant height and the number of leaves as a result of the application of organic manure can be attributed to the beneficial role of manure in improving soil nitrogen, phosphorus, potassium and other essential nutrients,

which in turn promotes the growth and development of the plants during the experiments. Given the low levels of organic carbon in the soil, the favourable effects of manure on these growth features may also be explained by the manure's contribution to soil fertility. The breakdown of manure increases the amount of macro and micronutrients in the soil and enhances its physicochemical qualities. Its high vegetative growth could have been caused by this. Organic manure has a relatively high nitrogen concentration, which promotes plant vegetative growth.

Numerous plant species can be used as green manure; each species has unique advantages, and several factors influence the final decision. When applied as a soil bio-amendment, *Gliricidia sepium* can increase soil fertility. Keya *et al.* (2020) confirmed that the pH of the soil rises as more *Gliricidia sepium* leaves are added and as N fertilizer is applied. According to this study, NKP greatly enhanced the fruit output of okra. This is corroborated by research conducted by Musa *et al.* (2017) and Smith *et al.* (2001), which found that the development of cowpea and okra was greatly impacted by the application of NPK in favourable environmental conditions. For optimal growth and yield, the culture needs an adequate supply of nutrients, especially nitrogen, phosphorus and potassium. Growth traits such as plant height, shoot fresh weight, the number of leaves per plant, number of main shoots per plant are maximized at either 60 or 90 kg N ha⁻¹ in the early growth stage.

On yield qualities, okra cultivated on poultry manure outperformed green leaves. This indicates the availability of organic manure in the right amounts for simple plant root absorption, which improves plant morphological growth.

Further supporting this are the results of Ibrahim *et al.*, (2020) in Okra Production, which showed that crop branching, fruit output, and plant height increased when treated with organic manure.

CONCLUSION

The fruit yield of okra was significantly increased by NKP fertilizer while organic manure was effective in increasing the fruit yield of okra to a great extent. However, green manure significantly impacts soil Organic Carbon (OC), Cation Exchange Capacity (CEC), and Total N and leaf N content; thus, the fruit yield and above-ground biomass are improved due to its application. To achieve maximum okra production and increased market value in the study area, applying poultry manure at a rate of 8tha⁻¹, or a combination of 200 kg/ha of NPK 15:15:15 and 4 tons/ha of poultry manure is recommended based on this study. When selecting a fertilizer for an okra farm, consideration should be given to the cost, availability, and condition of the soil at the time of application.

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