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EFFECTS OF INORGANIC FERTILIZER (NPK) AND JATROPHA HUSK (JH) ON SELECTED SOIL CHEMICAL PROPERTIES AND GROWTH OF EGGPLANT (*Solanum melongena*)

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ABSTRACT

Cultivation of *Solanum melongena* (Eggplant) in the tropics is often confronted with low soil fertility, which indicates the need for sustainable approaches towards soil nutrient availability and management. Hence, this research focuses on the effects of inorganic fertilizer (NPK 15-15-15), Jatropha Husk (JH), and their combinations on the growth of *Solanum melongena* and selected properties of the soil, carried out at the Federal University of Technology, Akure. Randomized Complete Block Design was used with six treatments: control (no amendments), 100% JH, 100% NPK, 25% JH + 75% NPK, 50% JH + 50% NPK, and 75% JH + 25% NPK, replicated 3-times. Growth parameters measured were plant height, number of leaves, and stem diameter recorded bi-weekly, while pre-planting and post-planting soil analysis were analyzed. It was discovered that soil amendment significantly improved both plant leaf and height from four weeks post-planting. The highest measurements for leaf count (19.6) and plant height (44.40 cm) were observed with the treatment of 75% JH+ 25% NPK. Soil chemical characteristics were enhanced with 100% JH achieving the highest pH level (8.76), along with elevated concentrations of phosphorus, sodium, calcium, and potassium. Treatments with the largest amount of NPK resulted in slight soil acidification (pH 6.3). These findings suggest that using Jatropha husk, either singly or in combination with lower amounts of NPK fertilizer, can aid soil fertility and sustainable eggplant production. This study has revealed that a combination of JH and NPK has the potential to offer better growth output and improved soil quality.

Keywords: Inorganic Fertilizer, Jatropha Husk, Soil Chemical Properties, Growth, Eggplant (*Solanum melongena*)

INTRODUCTION

Sustainable cultivation of vegetables such as *Solanum melongena* (eggplant) is vital in tropical regions because of its considerable nutritional advantages and economic value (Chowdhury *et al.,* 2021). Nonetheless, a reduction in soil fertility presents a significant obstacle to reaching optimal productivity in sub-Saharan Africa, primarily as a result of continuous cropping and the restricted application of organic fertilizers (FAO, 2020).

Application of fertilizers has been crucial in addressing nutrient deficiencies, with inorganic options like NPK 15-15-15 frequently used to boost crop yields due to their rapid nutrient release (Obiora *et al.*, 2022). However, the over-reliance on synthetic fertilizers brings about concerns regarding environmental sustainability, such as nutrient leaching, soil acidification, and reduced microbial activity (Ayoola & Makinde, 2019).

Consequently, there has been a shift in emphasis towards organic and integrated sources of nutrients that enhance soil fertility while promoting environmental stability. Among these alternatives, by-products from agro-industrial processes, such as *Jatropha curcas* husk that is obtained from the local market, have the potential to contribute organic matter and essential nutrients, particularly nitrogen and potassium, while also improving soil structure and microbial diversity (Yusuf *et al.*, 2023). Jatropha husk, which is usually regarded as waste, functions as a sustainable nutrient source that can be incorporated into strategies for managing soil fertility, particularly in low-input farming systems.

While earlier studies have investigated the separate effects of organic and inorganic amendments on soil properties and crop productivity, there is insufficient information regarding the relative and combined impacts of Jatropha husk and NPK fertilizer on vegetable crops, specifically *Solanum melongena*. This research was conducted to evaluate the effects of Jatropha husk, NPK, and their mixtures on soil chemical properties and the growth performance of *Solanum melongena*, with the goal of identifying the formulation that can enhance yield and soil health.

MATERIALS AND METHODS

Study Location and Experimental Site

The research was carried out at the Teaching and Research Farm of the Federal University of Technology, situated in Akure, Ondo, Nigeria, Latitude: 7° 17' 0" N - 7° 19' 0" N and Longitude:5° 7' 0" E - 7° 19' 0" E. This region falls within the tropical rainforest agro ecological zone, known for its bimodal rainfall and average yearly temperatures ranging from 25–32 °C. The soil in the area is categorized as sandy loam, with moderate drainage and low organic matter content.

Experimental Design

A randomized complete block design (RCBD) was utilized, comprising six (6) treatments and three (3) replicates for each treatment. Eggplant was planted at a spacing of 50 cm x 50 cm, 1 plant/stand, 3 plants per row and 3 rows per plot. Each plot for the treatment was sized at 1 m × 1 m, 9 plant stands per plot with spacing of 0.5 m between plots and 1 m between blocks to reduce edge effects.

Treatments

The treatments were based on combinations of Jatropha husk (JH) and NPK 15-15-15 fertilizer as follows: Control (No amendment), 100% Jatropha husk (JH) (250 g/plant), 100% NPK (20 g/plant), 25% JH (62.5 g) + 75% NPK (15 g / plant), 50% JH (125 g) + 50% NPK (10 g/plant) and 75% JH (187.5 g) + 25% NPK (5 g/plant)

Soil Sampling and Analysis

Composite soil samples were collected with the aid of soil auger from the experimental field at a depth of 0–15 cm, prior to planting and after harvest. The samples were airdried, sieved through 2 mm mesh, and analyzed using standard methodologies, including pH measurement in a 1:2.5 soil-water suspension via a digital pH meter (Peech, 1965). Exchangeable bases (Na, K, Ca) were extracted using ammonium acetate (1 N, pH 7.0), Na and K were measured with a flame photometer, Ca was determined with atomic absorption spectrophotometer (Jackson, 1962) while available phosphorus (P) was determined using the Bray-1 method (Bray and Kurtz, 1945).

Table 1: Pre – cropping physical and soil chemical properties at the experimental site

Parameter	Value
Chemical Composition	
pH	7.0
Organic Manure (%)	1.68
Total Nitrogen (%)	0.1
Available Potassium (mg kg $^{-1}$)	1.58
Cation exchangeable Capacity	13.30
Exch. Bases	
Mg (cmol kg $^{-1}$)	1.69
K (cmol kg $^{-1}$)	0.25
Ca (cmol kg $^{-1}$)	2.66
Na (cmol kg $^{-1}$)	0.49
Physical Properties	
Sand (g kg-^{1})	526.50
Slit (g kg-^{1})	309.50
Clay (g kg^{-1})	159.00
Soil Textural Class	Sandy loam

Planting Material and Nursery Management

Certified seeds of *Solanum melongena* were obtained from a reliable seed supplier. The seeds were planted in a nursery and nursed for four weeks before being moved to the experimental plot. A single healthy seedling was placed in each hole, maintaining a spacing of 50 cm × 50 cm; with 3 stands/row; 3 rows/plot resulting in 9 plant stands/plot.

Application of Amendments

Jatropha husk was dried and crushed before application in the field. Both Jatropha husk (JH) and NPK fertilizers were applied manually and mixed into the soil two weeks before transplanting in order to facilitate mineralization and make nutrients available. Complimentary treatments were applied according to predetermined weight ratios per plant in grams as described in the treatment allotment (Control (No amendment), 100% Jatropha husk (JH) (250 g/plant), 100% NPK (20 g/plant), 25% JH (62.5 g/plant) + 75% NPK (15 g / plant), 50% JH (125 g/ plant) + 50% NPK (10 g/plant) and 75% JH (187.5 g/plant) + 25% NPK (5 g/plant)).

Growth Parameters Measured

Growth parameters were taken twice a week at 2, 4, 6, and 8 weeks after planting (WAP). Plant height (cm) was measured from the base to the apical meristem using a meter rule, number of leaves per plant was counted visually, and stem girth (cm) was gauged using a digital caliper at 5 cm above the soil level.

Statistical Analysis

All collected data were subjected to Analysis of Variance (ANOVA) using SPSS version 25. Treatment means were separated with Duncan's Multiple Range Test (DMRT) at a significant level of 5% (Gomez & Gomez, 1984).

RESULTS

The experimental site pre-cropping chemical and physical properties had sandy loam soil texture that comprised of 526.50 g kg^{-1} sand, 309.50 g kg^{-1} silt, and 159.00 g kg^{-1} clay (Table 1). Soil pH was 7.0, indicating a neutral reaction, organic matter content (1.68%), total nitrogen content (0.1%), available phosphorus (1.58 mg kg^{-1}) and the cation exchange capacity (CEC) was 13.30. The exchangeable bases were magnesium 1.69 cmol kg^{-1}, potassium 0.25 cmol kg^{-1}, calcium 2.66 cmol kg^{-1}, and sodium 0.49 cmol kg^{-1} (Table 1)

Plant height of the Solanum increased with age from 2 weeks to 8 weeks after planting (WAP). Application of NPK fertilizer, Jatropha husk or their combination at different rates did not significantly influence height of Solanum plant compared with no fertilizer control at 2 WAP (Table 2). Between 4 and 8 WAP, Solanum plant height from all the treatments were significantly higher than from unfertilized plots. Irrespective of the type and rate of fertilizer applied, Solanum plant responded similarly to applied fertilizer. Tallest Solanum plants (44.40 cm) were observed from plots treated with 75% JH + 25% NPK. This value was however not significantly higher than 43.72 cm, 38.74 cm, 38.50 cm and 37.60 cm observed with application of 50% JH + 50% NPK, 25% JH + 75% NPK, 100% NPK Fertilizer and 100% Jatropha Husk respectively (Table 2).

At 2 WAP, number of leaves produced from both the fertilized and unfertilized eggplants were similar (Table 3). The effect of the treatment was significant on the Solanum plant leaves from 4 to 8 WAP. Highest average number of leaves of 19.6 resulted from application of 75% JH + 25% NPK which was not significantly higher than 17, 12.8, 13.8 and 12.40 leaves obtained from 50% JH + 50% NPK, 25% JH + 75% NPK, 100% NPK Fertilizer, respectively but all were significantly higher than from 100% Jatropha Husk and control treatments (Table 3).

Irrespective of the type and rate of fertilizer applied, stem girth of Solanum plant from all the treatments were not significantly different from unfertilised control, from 2 to 8 WAP (Table 4).

Table 2: Effect of NPK Fertilizer and JH on Plant Height (cm) of Solanum Plant

	Weeks after Planting			
Treatment	2	4	6	8
Control	10.94a	18.06b	25.18b	28.30b
100% Jatropha Husk (JH)	10.02a	19.26a	29.40a	37.60a
100% NPK Fertilizer	12.62a	19.38a	28.88a	38.50a
25% JH + 75% NPK	12.92a	21.98a	32.86	38.74a
50% JH + 50% NPK	12.52a	23.38a	35.12a	43.72a
75% JH + 25% NPK	12.74a	24.34a	36.70a	44.40a

Means with the same letter along the columns are not significantly different using DMRT ($P< 0.05$)

Table 3: Effect of NPK Fertilizer and Jatropha Husk on Solanum Number of Leaves/ plant

	Weeks after Planting			
Treatment	2	4	6	8
Control	5.60a	7.60b	8.40b	9.20c
100% Jatropha Husk (JH)	6.40a	8.80a	9.60a	12.40b
100% NPK Fertilizer	5.20a	8.40a	10.40a	13.80a
25% JH + 75% NPK	6.40a	9.20a	12.60a	12.80a
50% JH + 50% NPK	6.80a	10.60a	13.60a	17.00a
75% JH + 25% NPK	6.80a	10.40a	14.40a	19.60a

Means with the same letter along the columns are not significantly different using DMRT ($P < 0.05$)

Table 4: Effect of NPK Fertilizer and JH on Stem Girth (cm) of Solanum Plant

	Weeks after Planting			
Treatment	2	4	6	8
Control	0.38a	0.41a	0.55a	0.67a
100% Jatropha Husk (JH)	0.39a	0.45a	0.63a	0.71a
100% NPK Fertilizer	0.38a	0.43a	0.68a	0.77a
25% JH + 75% NPK	0.50a	0.55a	0.57a	0.67a
50% JH + 50% NPK	0.47a	0.50a	0.66a	0.76a
75% JH + 25% NPK	0.53a	0.60a	0.71a	0.76a

Means with the same letter along the columns are not significantly different using DMRT ($P < 0.05$)

Soil Chemical Properties

For soil pH, plots amended with 100% and 75 % Jatropha Husk (JH) were more alkaline (8.76, and 8.46, respectively) while plots with 25% JH + 75% NPK were more acidic (6.33) - Table 5. For Na, P, K & Ca, treatment with 100% Jatropha Husk (JH) had the significantly high values 2.81cmol/kg, 0.58 cmol/kg, 2.84 cmol/kg and 11.00 cmol/kg, respectively while 25% JH + 75% NPK had the significantly low values of 1.09 cmol/kg, 0.06 cmol/kg, 1.27 cmol/kg, 5.00 cmol/kg (Table 5).

Table 5: Effect of Jatropha Husk and NPK Fertilizer on Soil Chemical Properties

Treatment	**pH**	**Na (cmol/kg)**	**P (cmol/kg)**	**K (cmol/kg)**	**Ca (cmol/kg)**
Control	7.07ab	2.47a	0.42a	1.57ab	4.00de
100% Jatropha Husk (JH)	8.76a	2.81a	0.58a	2.84a	11.00a
100% NPK Fertilizer	6.35b	1.14a	0.54a	1.28b	10.60ab
25% JH + 75% NPK	6.33b	1.09ab	0.06a	1.27b	5.00d
50% JH + 50% NPK	7.05ab	1.68a	0.54a	2.32a	7.10c
75% JH + 25% NPK	8.46a	1.91a	0.45a	2.68a	6.70c

Means with the same letter along the columns are not significantly different using DMRT ($P < 0.05$)

DISCUSSION

The soil of the experimental site was sandy loam in texture and low in fertility which could adversely affect the growth of Solanum plant. Hence soil amendment, either using NPK fertilizer, Jatropha husk or combination of both at different rates has proved to be effective in enhancing soil fertility status.

At 2 WAP, the various fertilizer application treatments (both NPK fertilizer and Jatropha husk with varying level of their combinations) that did not significantly differ from control in nutrient supply might be due to the little nutrient released from the soil at that period but was optimal for growth at the early stage. This was in accordance with the report of Moch *et al.,* (2014) who reported that available soil nutrients are optimal for Solanum growth and development during its adaptive phase.

The superiority of fertilizer-treated Solanum plants over the control during the vegetative growth indicated that plants from the unfertilized control treatment were in short supply of nutrients; this is in agreement with Moch *et al.,* 2014 who reported that egg plants are fertilizer- responsive.

The highest pH of 8.76 observed with 100% Jatropha husk, is an indication that Jatropha husk has a liming effect on the soil. This finding corroborates with that of Olowoake *et al.,* (2018) who reported that organic residues like Jatropha cake can raise soil pH as a result of their high base saturation and buffering capacity. Soil plots that received 100% NPK and 25% JH+75% NPK that had the low pH values indicates that slight acidification can be linked to chemical fertilizer; these finding agrees with that of Agbede (2021) and Adekiya *et al.* (2020), reporting that application of NPK fertilizer alone reduces soil pH. Neutral to slightly alkaline pH values in treatments with higher JH content (75% JH), (pH 8.46) suggest better pH stabilization. Across the treatments, there were no significant differences in the levels of Sodium, but numerically 100% JH had the highest, suggesting no effect of NPK and JK on soil sodium

There was no significant differences in soil Phosphorus content, but soils treated with 100% JH that had the highest value agrees with the findings of Wu *et al.,* (2025) that increased phosphate activities were always accompanied by an increase in available P under JK application.

The effect of the treatments that was significant on the potassium content of the soil indicates that Jatropha husk is a good source of potassium. This aligns with the findings of Zhao *et al.,* (2025) that the use of organic material has the tendency to increase Nitrogen, Phosphorus and Potassium, thereby enhancing the number of beneficial microorganisms which then improve crop growth. The lowest level of Potassium observed at 25% JH+75% and 100% NPK pointed to the fact that the chemical fertilizers may not sufficiently maintain potassium in soil until it is assisted/supported by organic materials.

There was a significant difference in calcium contents in all the treatments except with 50% JH + 50% NPK and 75% JH + 25% NPK, indicating that both organic and inorganic sources can improve the level of calcium in the soil.

CONCLUSION

This study has shown that fertilizer application either Jatropha husk, NPK fertilizer, or combination of both had positive influence on the growth of eggplant and chemical properties of soil. Fertilized egg plants outperformed non-fertilized egg plants in terms of vegetative growth. However, there is no significant difference in the use of 100% NPK and the combination of both NPK and JH on the growth of Solanum plant.

It is therefore concluded that Jatropha husk is a liming and fertilizer material that can be used alone or combined with NPK fertilizer at reduced rates.

RECOMMENDATION

Since the effect of NPK fertilizer did not differ significantly from that of Jatropha husk, Jatropha husk is therefore recommended for use in combination with NPK fertilizer at 50% JH + 50% NPK fertilizer or 75% JH + 25% NPK fertilizer for the production of egg plants in southwestern Nigeria, as this will reduce the cost of production without impairing the growth of egg plants and the chemical properties of the soil.

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