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Research Article

Growth and Yield Performance of Fluted Pumpkin (*Telferia Occidentalis* Hook F.) to Wood Shaving Biochar and Poultry Manure in Ikorodu, Lagos, Nigeria

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Abstract

In many tropical cropping systems, low soil fertility is a significant factor that hinders the development of vegetable crops. In order to get a good yield, it is necessary to increase the soil's nutrient status to satisfy the crop's needs, hence maintaining the soil's fertility status. To determine the effects of Wood Shavings Biochar (WSB) and Poultry Manure (PM) on the performance of fluted pumpkin (*Telferia occidentalis*), this study was conducted at the Teaching and Research Farms, Department of Crop Production and Horticulture, Lagos State Polytechnic, Ikorodu, Lagos State, Nigeria. Five (5) treatments—7.5 t/ha WSB, 7.5 t/ha PM, 2.5 t/ha WSB + 5 t/ha PM, 5 t/ha WSB + 2.5 t/ha PM, and control—were administered to the plots two weeks prior to planting. The experiment was set up using a Randomized Complete Block Design (RCBD). Vine length, leaf count, vine girth, and leaf yield per plot were among the data obtained. They were statistically examined using Analysis of Variance (ANOVA), and the Duncan Multiple Range Test (DMRT) was used to compare the means of the treatments at a 5% level of probability. The results revealed that the optimum performance was provided by 2.5 t/ha WSB + 5 t/ha PM and 7. 5 t/ha PM, followed by 5 t/ha WSB + 2.5 t/ha PM and 7.5 t/ha WSB in terms of enhancing the soil nutrients, which in turn improved growth and yield. The fluted pumpkin planted in control gave the worst performances. The plots receiving 7.5 t/ha of WSB significantly reduced the soil acidity and increased soil's concentration of Ca, K, and Mg respectively. While, 5 t/ha WSB + 2.5 t/ha PM significantly increased total N concentration, available P and organic matter. The study clearly showed that *T. occidentalis* leaves yield increased as a result of the addition of WSB and PM, hence WSB had the potential to increase the efficiency of nutrient utilization in the PM. For sustainable fluted pumpkin cultivation in the study area, utilization of 2.5 t/ha WSB + 5 t/ha PM and 7. 5 t/ha PM is therefore recommended.

Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook F.) a member of the family *Cucurbitaceae* is an important leaf and seed vegetable indigenous to southeastern Nigeria and widely cultivated across the warm regions of the world [1,2].

Nigeria is one of the majority of tropical nations that has production restrictions on vegetable crops due to inadequate soil fertility, weed control, and low-yielding varieties [3]. Fagwalawa and Yahaya [4], who observed that crop production in Nigeria is currently challenged by low yield, corroborated this notion as well. They attributed the low yield to inadequate soil fertility and a lack of essential mineral nutrients in the soil. Because organic matter decomposes quickly in the tropics, soil productivity is constrained by nutrient retention.

Utilizing amendments in the form of organic and inorganic fertilizers is one method for reversing the soil's deterioration and unproductiveness. Due to the physical degradation,

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nutritional imbalance, and soil acidity that synthetic fertilizer causes in tropical soils, its usage has not been sustainable [5]. The decomposition and release of nutrients for crop use are delayed by the direct incorporation of animal and plant-derived wastes into the soil [6]. Because they will have to wait longer for the effects of the applied waste to appear, the majority of farmers are discouraged from utilizing them. Therefore, it is crucial to discover the best methods for transforming these wastes into products that will that make their nutrients easily accessible to crops and decrease the quantity of carbon dioxide released into the environment, which contributes to global warming, is therefore essential [7].

Poultry manure a major waste from poultry enterprise when utilized as soil amendment input, enhances soil chemical characteristics, soil tilt, and biological activities [8]. While poultry manure has been determined to be the most valuable of all manures produced by livestock [9], it also has one of the highest nutrient contents of any animal manure, and using it as a soil amendment for agricultural crops will provide significant amounts of all of these nutrients.

The inclusion of biochar is one newly developed management technique to preserve higher agricultural yields and transform wastes [10]. According to Thies and Rillig [11], biochar boosts soil nutrient availability and prevents leaching, encourages the activity of agriculturally significant soil microorganisms, acts as a potent carbon sink for several hundred years, sequesters atmospheric CO_2 in soil, reduces emissions of other greenhouse gases, and lessens the negative effects of agrochemicals. Biochar has previously been recommended by Lehmann and Joseph [12] as a useful soil amendment material. On the other hand, the potential for using biochar for vegetable farming in southwest Nigeria has not yet been completely realized.

The study's goal was to assess the impact of biochar's solitary application and its combination with poultry manure on the growth and yield performance of fluted pumpkins in Nigeria's humid rainforest agro-ecological zones.

Materials and methods

Experimental location and condition

The experiment was carried out at the Teaching and Research Farm, Department of Crop Production and Horticulture, Lagos State Polytechnic, Ikorodu, Nigeria during the 2022 cropping season. The area lies between latitude 5° 10' N and longitude 3° 16' E of the Greenwich meridian with an elevation of 50 m above sea level. It has a mean average temperature of 25 and 29 °C with an annual rainfall range between 1670 mm and 2200 mm and relative humidity between 65 and 68%.

Experimental design and treatments

The experiment was laid out in Randomized Complete Block Design (RCBD) on a total area of land measuring 171 m^2 which was divided into three (3) blocks of 19 m x 9 m (171 m^2). Each plot size was 3 m x 2 m (6 m^2) with a discard of 0.5 m between blocks to give a total number of 15 plots. The land was plowed and harrowed to a fine tilt using a disc plow and harrow. Thereafter, seed beds were manually prepared.

Five (5) treatments which included 7.5 t/ha Wood Shavings Biochar (WSB), 7.5 t/ha poultry manure (PM), 2.5 t/ha WSB + 5 t/ha PM, 5 t/ha WSB + 2.5 t/ha PM and control (no application) were replicated three (3) times and applied to the plots two weeks before planting by broadcasting method and lightly incorporated into the soil with the aid of hand hoe to allow for proper and adequate decomposition, mineralization and release of nutrients into the soil for plant use [13].

Planting and maintenance of fluted pumpkin

Fluted pumpkin seeds were purchased from Sabo Market in Ikorodu, Lagos State. A total of 24 plants per plot and 360 plants overall were planted in situ at a spacing of 50 cm x 50 cm. The vines were staked to provide support, and hand weeding was done at 3 and 5 weeks after planting. Insecticides were used to effectively manage pests at intervals of every two weeks.

Wood shavings biochar and poultry manure collection and preparation

Following prescribed protocols, wood shavings were gathered from a carpentry workshop in Ijede, Ikorodu, Lagos State, Nigeria, and turned into biochar in a reactor at the Department of Crop Production and Horticulture. The poultry manure was sourced from the poultry pen, Department of Animal Production, Lagos State Polytechnic in Ikorodu, Lagos State.

Soil sampling and analysis

Soil sample from the topsoil (20 cm) at the experimental site was randomly collected with the soil auger prior to the commencement of the experiment and after harvesting for the determination of the soil's physiochemical properties. The soil samples were composited, air-dried, and sieved to pass through a 2 mm sieve before being subjected to routine laboratory analysis as described by IITA [14]. Soil pH was determined using an electronic pH meter [15] and particle size distribution was determined by the hydrometer method [16], and the textural class was determined using a textural triangle. Organic matter was determined by Walkley-Black wet oxidation method [17]. Total Nitrogen was determined using the Kjeldahl apparatus. Available phosphorus was determined with the Bray 1 method [18]. Potassium and sodium were determined by flame photometry [19] while calcium and magnesium were determined by EDTA titration method [20] and read using atomic absorption spectrophotometer

Data collection and statistical analysis

For the purpose of gathering information on growth and yield parameters, six (6) plant stands were randomly selected and tagged per plot. While yield parameters were obtained during harvest, growth parameters were measured at 2, 4, 6, and 8 Weeks After Planting (WAP). A graduated meter rule was used to measure the vine's length (in cm) from the plant's base to its apex. By physically counting the number of leaves on each tagged plant, the total number of leaves was determined. A Vernier caliper was used to measure the vine's circumference (in cm) at a consistent distance of 2 cm from the plant's

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base. The plucked fluted pumpkin leaves from each plot were weighed using a scale to determine the leaf yield per plot (kg).

Data collected was analyzed using Analysis of Variance (ANOVA). The statistically significant treatment means were compared using the Duncan Multiple Range Test (DMRT) at a 5% level of probability as a follow-up test to separate the means.

Results

Pre-experimental soil physio-chemical properties

The site was mildly alkaline (pH 8.69), low in organic matter (0.18%), total nitrogen (0.16%), and available P (5.28 ppm), as well as low in exchangeable bases Na (0.15 cmol/kg), K (0.17 cmol/kg), Ca (2.45 cmol/kg), and Mg (1.96 cmol/kg), according to the pre-cropping soil study. The soil was found to have a CEC of 4.76 cmol/kg, a sandy loam soil textural class, with a particle size distribution of 62.78% sand, 20.10% silt, and 17.12% clay.

Effects of wood shavings biochar and poultry manure on soil physico-chemical properties

In comparison to what is obtainable in the control plot, the post-soil analysis showed a significant difference ($p < 0.5$) in the soil pH, Ca, K, and Mg content as a result of the application of WSB and PM (Table 1). The plots receiving 7.5 t/ha of WSB had the greatest pH (8.14), followed by those receiving 5 t/ha of WSB plus 2.5 t/ha of PM (8.07), while the control plot had the lowest pH (6.49).

The soil's concentration of Ca (14.83 mg/kg), K (36.30 mg/kg), and Mg (23.66 mg/kg) all considerably increased with the addition of 7.5 t/ha WSB. This was followed by 5 t/ha WBS + 2.5 t/ha PM, and the least was recorded in plots with no amendment (control), 11.96 mg/kg (Ca), 26.70 mg/kg (K), and 16.84 mg/kg (Mg), with the exception of Na, where the highest was observed in 5 t/ha WSB + 2.5 t/ha PM (7.23 mg/kg), closely followed by 7.5 t/ha WSB (6.40 mg/kg), and the lowest Na content (4.16 mg/kg) was observed in 2.5 t/ha WSB + 5 t/ha PM (Table 1).

In a similar vein, the application of WSB and PM had a substantial (p 0.05) impact on the total nitrogen, available P, and Total Organic Matter (TOM) contents of the experimental soil. The soil's total N concentration was found to be highest in plots provided with 5 t/ha WSB + 2.5 t/ha PM (0.33%), followed closely by plots supplied with 7.5 t/ha WSB (0.31%), and lowest in the control (0.21%) (Table 1). Similar trends were seen for the contents of available P and TOM, with the highest composition being found in 5 t/ha WSB + 2.5 t/ha PM (28.65 mg/kg and 3.21%, respectively), closely followed by the application of 7.5 t/ha WSB (26.13 mg/kg and 3.08%), and the lowest being found in 5 t/ha WSB + 2.5 t/ha PM (19.77 mg/kg and 2.51%).

Effect of wood shavings biochar and poultry manure on vine length (cm) and number of leaves of fluted pumpkin

Fluted pumpkin vine length at 6 and 8 WAP was significant ($p < 0.05$) inclined by WSB and PM application (Table 2). The longest vines were recorded in 5 t/ha WSB + 2.5 t/ha PM at 6 (117.07 cm) and 8WAP (175.51 cm) correspondingly followed by 111.74 cm and 167.81 cm recorded from 7.5 t/ha WSB while the shortest vine (65.69 and 91.78 cm) was experiential in the control. However, non-significant differences ($p < 0.05$) were observed at 2 and 4 WAP (Table 2).

At 2, 6, and 8 WAP, the fluted pumpkin produced significantly different numbers of leaves (p 0.05) (Table 3). At 2 WAP, 7.5 t/ha WSB (32.95) and 5 t/ha WSB + 2.5, t/ha PM (31.34) had the most leaves, followed by 2.5 t/ha wood shavings biochar + 5 t/ha poultry manure (27.12), while the control had the fewest (18.43). At 6 and 8 WAP, fluted pumpkins with the fewest leaves (102.25 and 153.67) were found in the control, while those with the most leaves (146.74 and 212.17, as well as 143.00 and 211.17) were found in 5 t/ha WSB + 2.5 t/ha PM and 7.5 t/ha WSB, respectively. However, at 4 WAP, fluted pumpkins produced slightly fewer leaves ($p < 0.05$), which was not statistically significant (Table 3).

Effect of wood shavings biochar and poultry manure on stem girth (cm) of fluted pumpkin

At 6 WAP, the fluted pumpkin's stem girth development was significantly ($p < 0.05$) impacted by the application of WSB and PM. The thickest stem (2.58 cm) was found in plots that received 5 t/ha WSB and 2.5 t/ha PM, and it was followed by 2.54 cm, which was recorded from 7.5 t/ha WSB and was not statistically different from the other two. In contrast, the

Table 1: Effects of wood Shavings biochar and poultry manure on soil Physico-Chemical Properties.

Treatments	pH	Ca (mg/kg)	K (mg/kg)	Mg (mg/kg)	Na (mg/kg)	N (%)	P (mg/kg)	OM (%)
7.5 t/ha WSB	8.14a	14.83a	36.30a	23.66a	6.40b	0.31b	26.13b	3.08b
7.5 t/ha PM	7.07d	12.60d	29.36d	22.37c	4.80d	0.28c	21.85d	2.81d
2.5 t/ha WSB + 5 t/ha PM	7.50c	13.26c	31.70c	20.53d	4.16e	0.27d	22.24c	2.94c
5 t/ha WSB + 2.5 t/ha PM	8.07b	14.30b	34.83b	22.95b	7.23a	0.33a	28.65a	3.21a
Control (no application)	6.49e	11.96e	26.70e	16.84e	5.60c	0.21e	19.77e	2.51e
Significance	**	**	**	**	**	**	**	**

Means with a similar letter(s) in the same column are not significantly different at 5% D.M.R.T.
**: highly significant; PM= Poultry manure; WSB = Wood Shaving Biochar.

Table 2: Effect of Wood Shavings biochar and Poultry Manure on vine length (cm) of fluted pumpkin.

Treatment	2WAP	4WAP	6WAP	8WAP
7.5 t/ha WSB	28.14	53.41	111.74ab	167.81b
7.5 t/ha PM	23.14	46.46	97.32c	129.61c
2.5 t/ha WSB + 5 t/ha PM	25.42	48.69	102.56b	124.66cd
5 t/ha WSB + 2.5 t/ha PM	28.69	55.00	117.07a	175.51a
Control (no application)	21.30	43.69	65.69d	91.78d
Significance	ns	ns	*	*

Means with a similar letter(s) in the same column are not significantly different at 5% D.M.R.T.
*: significant, ns: non-significant; WSB = Wood Shaving Biochar; PM = Poultry Manure.

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control plot had the thinnest stem (1.98 cm). At 2, 4, and 8 WAP, respectively, no significant changes ($p < 0.05$) were found, though (Table 4).

Effect of wood shavings biochar and poultry manure on the yield (kg) of fluted pumpkin

The result in Figure 1 reveals that, in comparison to the yield obtained from the control, the application of WSB and PM considerably ($p < 0.05$) affected the yield of fluted pumpkin leaves. The 5 t/ha WSB + 2.5 t/ha PM treatment had the highest leaf yield (1.62 kg), followed by the 7.5 t/ha WSB treatment (1.55 kg), while the control (0.92 kg) had the lowest yield.

Table 3: Effect of Wood Shavings biochar and Poultry Manure on the number of leaves of fluted Pumpkin.

Treatment	2WAP	4WAP	6WAP	8WAP
7.5 t/ha WSB	32.95a	55.08	143.00ab	211.17a
7.5 t/ha PM	22.12c	54.17	113.92b	185.58b
2.5 t/ha WSB + 5 t/ha PM	27.12b	57.58	116.17b	189.25b
5 t/ha WSB + 2.5 t/ha PM	31.34a	58.67	146.74a	212.17a
Control (no application)	18.43cd	47.75	102.25c	153.67c
Significance	*	ns	*	*

Means with a similar letter(s) in the same column are not significantly different at 5% D.M.R.T.
*: significant, ns: non-significant; WSB = Wood Shaving Biochar; PM = Poultry Manure.

Table 4: Effect of Wood Shavings biochar and Poultry Manure on stem girth (cm) of fluted pumpkin.

Treatment	2WAP	4WAP	6WAP	8WAP
7.5 t/ha WSB	1.55	2.65	2.54abc	4.64
7.5 t/ha PM	1.51	2.40	2.24bc	4.53
2.5 t/ha WSB + 5 t/ha PM	1.53	2.37	2.38bc	4.10
5 t/ha WSB + 2.5 t/ha PM	1.62	2.44	2.58a	4.69
Control (no application)	1.12	1.98	1.86c	3.45
Significance	ns	ns	*	Ns

Means with a similar letter(s) in the same column are not significantly different at 5% D.M.R.T.
*: significant, ns: non-significant; WSB = Wood Shaving Biochar; PM = Poultry Manure.

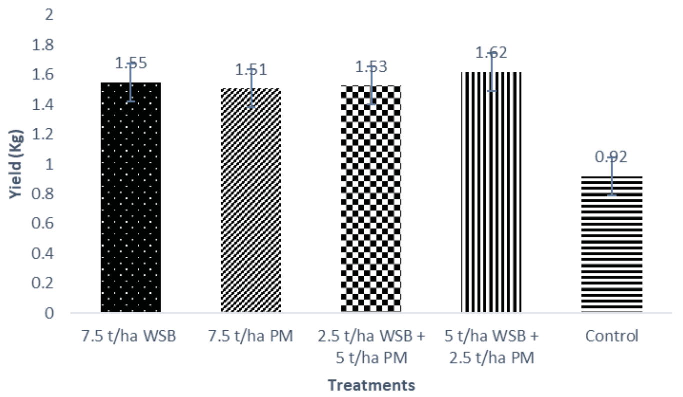

Figure 1: Effect of Wood Shavings biochar and Poultry Manure on the yield (kg) of fluted pumpkin.

Discussion

Sustainable vegetable cultivation requires adequate soil fertility. The nutrients in tropical soils are insufficient. So improving soil fertility by the application of fertilizer or manure is a crucial component in growing vegetables. The results of this trial showed that 5 t/ha WSB + 2.5 t/ha PM and 7.5 t/ha WSB performed best, followed by 2.5 t/ha WSB + 5 t/ha PM and 7.5 t/ha PM, while the control showed the worst results. This pattern was seen in the fluted pumpkin's growth, post-harvest soil physio-chemical characteristics, and yield. Because biochar has a considerable potential to increase the availability of nutrients in the soil, WBS has demonstrated high performance [12]. Mixing biochar with other soil amendments like manure or lime can increase its effectiveness because biochar has been shown to control nutrients and prevent them from leaching [21]. This increases the availability of nutrients by raising the pH of the soil, which was significantly raised by the biochar used in this experiment. According to Zheng, et al. [22] and Chan, et al. [23], who found that the application of biochar boosted soil nutrients and plant parameters, the outcome of this was consistent with their findings.

The combined effect of biochar and poultry manure in improving soil chemical properties as seen in the current study may be caused by the possibility that adding poultry manure to biochar may facilitate surface oxidation of the latter by increasing temperature, particularly at the start of the process. The high microbial activity or the co-metabolic decay during the breakdown of accessible carbon sources also changes the characteristics of biochar in a biological way [24,25]. Leachate produced during the process is absorbed by biochar, increasing the moisture content. Biochar absorbs organic matter and nutrients from the leachate as well, leading to higher concentrations of water-extractable organic carbon, total soluble nitrogen, plant-available phosphorus, and plant-available potassium, enhancing the soil's capacity to retain nutrients [26].

The use of WSB and PM was hypothesized to significantly boost the development and yield of fluted pumpkins. The applied biochar may have contributed to the improvement in soil qualities that led to an increase in the majority of the parameters measured as shown in this study. Adekiya, et al. [27] and Abdulkarim, et al. [28] both reported similar findings. Thus, by giving the required plant nutrients, the addition of biochar and PM had a favorable effect on the plant parameters. Additionally, it may be inferred that longer vines would result in more branches, more leaves, and enhanced stem girth development. This explains why there was an extremely strong and positive correlation between the number of leaves and vine length.

The significant interaction between the WSB and PM on the yield of fluted pumpkins suggested that the WSB had the potential to increase the efficiency of nutrient utilization in the PM. The output of fluted pumpkin leaves may have increased as a result of the addition of WSB and PM, which may have decreased nutrient loss and enhanced the soil's capacity to

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store nutrients. Additionally, through increased nutrient usage efficiency, the biochar's conditioning impact may have enhanced the benefits of the PM treatment on yield.

Conclusion

The significant interaction between the WSB and PM on the yield of fluted pumpkins suggested that the WSB had the potential to increase the efficiency of nutrient utilization in the PM. The output of fluted pumpkin leaves may have increased as a result of the addition of WSB and PM, which may have decreased nutrient loss and enhanced the soil's capacity to store nutrients. Additionally, through increased nutrient usage efficiency, the biochar's conditioning impact may have enhanced the benefits of the PM treatment on yield.

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