International Journal of Organic agricultural Research & Development
Volume 20 (2) (2025)

Evaluation of sawdust used as soil amendment on the performance of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

In this study, the effect of rates of sawdust (0g, 80g, 120g and 160g) on soil chemical properties and the performance of Groundnut (*Arachis hypogaea* L.) was investigated for a period of 15 weeks. The experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated 3 times. 48 polybags of sandy topsoil were prepared and 0g (control), 80g, 120g and 160g of sawdust were incorporated into the 10kg soil contained in each of the polythene bags. Then, 3 groundnut seeds were sown on the same day and the seedlings were thinned to one exactly 2 weeks after planting (2WAP), while data were collected weekly on parameters such as germination percentage, plant height, number of leaves, leaf area, number of pods, number of seeds, weight of pods and of the seeds. The data collected were subjected to analysis of variance (ANOVA) using the personal computer software packages SPSS version 20.1. Significant treatment means were compared using the Duncan multiple range test ((DMRT)) at $P \leq 0.05$. Results showed that increasing rates of sawdust increased the germination percentage and plant height of groundnut except at 6WAP. Leaf area increased from 8.918mm^2 to 9.477mm^2 at 120g, number of leaves was not significantly ($P \leq 0.05$) increased, number of seeds increased from 19 at 0g to 21 at 160g of sawdust application, seed weight increased from 20.0g at control to 22.3g at 160g but the number of pod and weight of pod was not significantly ($P \leq 0.05$) increased when compared to control. The sawdust rates (80g, 120g and 160g) incorporated in the soil significantly decreased the soil pH range but still within a pH range of 6 and 7, required for groundnut cultivation. It also decreased the available phosphorus and potassium content in the soil which resulted in the reduced number of pods and weight of pods of the groundnut plant. In conclusion, sawdust as a soil amendment significantly increased vegetative growth, the number and weight of the groundnut seed but did not significantly increase the number and weight of pods of the groundnut plant.

Keywords: *Soil amendment, Sawdust, groundnut, soil pH, Available Phosphorus, CEC.*

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) or peanut as it is sometimes referred to is grown in a commercial scale in the Northern region of Nigeria. Nigeria is the 4th highest producer of groundnut in the world and groundnut is the 13th most important food crop and 4th source of edible oil and protein in the world, according to the Food and Agriculture Organization (FAO,1994). Groundnuts are useful to humans and animals as food. A 100 grams of raw peanuts is estimated to contain: 567 Calories, 25.8g Protein, 49.2g Fat (Saturated - 6.28g, Monounsaturated - 24.43g, Polyunsaturated - 15.56g), 16.1g Carbohydrate, 4.7g Sugar, 8.5g Fiber and 7% Water (Toppo, 2021). It is useful in farm practices to help replenish nutrients in the soil due to its ability as a leguminous plant to fix atmospheric nitrogen in soil (Brady, 2017).

Sawdust is a waste material generated from the timber industry and is composed of fine wood particles. It is a common and affordable organic material that lay waste in several sawmills, dumpsites, and parts of Nigeria (Owoyemi *et al.,*2016). Hence, the need for its usefulness and ability to influence plant growth should be investigated to determine to what extent it imparts to the soil and improves the vegetative growth of crops and crop yield.

Sawdust contains 40% lignin and 60% cellulose with a little bit of waxes, resins and oils mixed in. It is low in nutrient density, only containing 0.048% nitrogen (N), 0.007 % phosphorus (P), 0.017% potassium (K) and 0.106% calcium (Ca), which varies depending on the wood the sawdust comes from. Also, the physical properties of sawdust, such as water content (10.8%), apparent gravity (0.14%), porosity (84%), and water retention capacity (50%), are favourable factors that improve soil properties for plant growth and development (Terazawa *et al*.,1999).

Sawdust decomposition depends on the complete hydrolysis of lignin and cellulose by ligninase and cellulase, respectively (Ververis *et al.,* 2007). Sawdust is converted to biofertilizers by composting, which ties up nitrogen for 180 days in soil (Olayinka and Adebayo, 1989). It is a non-degradable organic waste because of its low nitrogen content and high lignin and cellulose content. Studies have shown that sawdust does break down into humus, creates soil structure, increases aeration (porosity and permeability), increases a soil's water-holding capacity, and increases microbial activity after it has broken down. This depends on many factors and may take months to years. Some microorganisms, especially Actinobacteria, effectively decompose sawdust with nitrogen supplementation (Eriksson *et al.,* 1990, Ting et al., 2014).

The soil microbial population was observed to increase when sawdust was incorporated into the soil (Barney *et al.,* 1991). Researchers have reported the favourable effect that organic growing media (sawdust and Coir) have on plant growth (Maboko *et al;*2003, Tzortzakis and Economakis, 2008), as it increased the porosity and water retention of the growing medium (Hardgrave and Harrisman,1995; Marinou *et al;* 2013). Maboko *et al.,* (2013), however, reported that organic growing media (sawdust) did not have a significant effect on tomato yield. Sawdust applied either as a mulch or mixed with the soil decreased the nitrate content of the soil (Barney *et al.,* 1991).

The usage of sawdust as a plant growth medium in manufacturing industries is highly recommended due to the positive physical properties of the sawdust, such as biodegradability at an accepTable rate, low superficial specific gravity, high porosity, high water retention, moderate drainage and high bacterial tolerance (Maharani *et al;*2010).

Hence, the objective of this study is to evaluate the effect of sawdust used as a soil amendment on the performance of groundnut.

MATERIALS AND METHOD

Area of Study

The experiment was carried out in the Faculty of Agriculture, Teaching and Research Farm, Ignatius Ajuru University of Education (IAUE) Ndele campus, Rivers State, Nigeria (latitude 4^0 58' N and Longitude 6^0 48' E).

Sources of Samples and Pot Preparation.

The sawdust was collected from a Sawmill and a local variety of groundnut seeds was bought from a local market within the community. A digital weighing scale was used to measure the respective weight of the sawdust and applied to the soil in the polythene bag.

48 polybags of width 45cm and height of 27cm were perforated with 10 small holes each to allow easy drainage were made available for the pot. Sandy topsoil (0-15cm) was collected from the demonstration farm weighing 10kg and filled into the polybag up to the height of 25cm leaving a space from the top of about 2cm to allow for the application of water. This was replicated into three.

Experimental treatment design and field layout.

The experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated 3 times (Grant, 2010). The sawdust was measured into the polybag using a digital weighing machine at the rates of 0g, 80g, 120g and 160g. The 0g of sawdust polybag serves as a control. On the same day, the polybags were prepared; sawdust treatment was applied and the groundnut seed was sown at 3 seeds per polybag, in which the seedling was thinned to one after 14 days.

Collection and arrangement of Data

Data on the plant were collected from the field weekly from the date of planting. Data collected from the field include: Germination Percentage, Plant height, Number of leaves, Leaf area, Number of pod per plant, weight of pod per pot and weight of the groundnut per plant.

Soil samples were collected at planting (immediately after application of treatment) and at harvest (immediately after harvesting) for laboratory analysis (Lovel and, 2011).

Statistical analysis

The result was subjected to the analysis of variance (ANOVA) using the statistical software, SPSS 20.1 version. Significant treatment means were compared using the Duncan multiple range test at $P \leq 0.05$.

RESULTS

Germination rate increased with increasing sawdust rate. Table 1 shows control at 87% while 80g, 120g and 160g sawdust rate resulted in 90%, 94% and 96% germination percentage, respectively.

Table 1: Influence of sawdust rates on the germination of Groundnut.

Sawdust (g)	germination percentage
0	87%
80	90%
120	94%
160	96%

An increasing rate of Sawdust significantly at P≤0.05 increased the growth rate of the groundnut seedling when compared to the control, as shown in Table 2, except for week 6. At 3WAP, growth increased from 15.21cm for the control to 17.48cm for the 120g sawdust rate. At 6WAP, growth increased from 32.20cm for the control to 30.28cm for the 160g sawdust rate. At 9WAP growth rate increased from 41.53cm for the control to 43.09cm for the 10g sawdust rate. At 12WAP, growth increased from 71.95cm at the control to 77.13cm at the 120g sawdust rate. At 15WAP, growth increased from 83.28cm for the control to 91.27cm for the 160g sawdust rate.

Table2: Influence of sawdust rates on the Growth of Groundnut.

	Plant height week after planting				
Sawdust(g)	3WAP	6WAP	9WAP	12WAP	15WAP
0	15.21a	32.20d	41.53a	71.95a	83.28a
80	15.72b	31.72c	43.09d	68.84a	82.58a
120	17.48c	31.50b	42.98c	77.13b	89.88b
160	15.80b	30.28a	42.80b	76.03ab	91.27b
SE	0.047	0.020	0.037	1.505	0.710

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test. WAP=Weeks After Planting. SE=Standard Error.

Leaf area at 120g and 160g sawdust rates resulted in 9.477mm^2 and 9.200mm^2 respectively and exceeded the leaf area of the control of 8.918mm^2 significantly at P≤0.05 and 80g sawdust rate resulted to 8.558mm^2 leaf area which is below control.

The number of leaves was influenced by increasing sawdust rate which exceeded control;146.917 significantly (P≤0.05) at 120g;161.833 and non-significantly at 160g; 147.333.

Table 3: Influence of sawdust rates on the number and area of leaves of Groundnut at 8th weeks after planting, respectively.

Sawdust(g)	Number of leaves	Leaf area (cm^2)
0	146.917b	8.918b
80	140.167a	8.558a
120	161.833c	9.477d
160	147.333b	9.200c
SE	0.875	0.012

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test, WAP=Weeks After Planting. SE=Standard Error.

Number of pod and pod weight were not significantly increased by sawdust as seen in Table 4 while number of seed and seed weight were significantly (P≤0.05) increased by sawdust and exceeded control at 160g. Number of seed increased from 17.8 at 80g to 19.1 at 120g to 21.5 at 160g. Likewise Seed weight increased from18.4g at 80g to 19.7g at 120g to 22.3g at 160g.

Table 4: Yield of groundnut response to sawdust rates.

	Groudnut Yield Parameters			
Sawdust(g)	Number of pod	Pod Weight	Number of seed	**Seed weight**
0	24.7c	51.3c	19.3b	**20.0b**
80	16.2a	43.5a	17.8a	**18.4a**
120	25.2c	44.7b	19.1b	**19.7b**
160	17.9b	50.6c	21.5c	**22.3c**
SE	0.320	0.276	0.331	**0.336**

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test. WAP=Weeks After Planting. SE=Standard Error.

Table 5: Influence of sawdust rates on the chemical property of the soil at Planting.

Sawdust (g)	pH	%N	%O.M	Available P (Ppm)	K (Cmol/kg	CEC (Cmol/kg)	EC (μ/cm)	%BS
0	6.83b	0.184b	3.154b	15.386c	0.029b	7.380b	66.925c	97.180a
80	7.09c	0.215c	3.733c	13.055b	0.016a	7.891d	60.092b	97.643ab
120	6.64a	0.152a	2.267a	11.416a	0.030b	7.435c	58.692a	98.094b
160	6.84b	0.218c	3.742d	19.024d	0.028b	6.451a	88.758d	97.510ab
SE	0.007	0.005	0.001	0.375	0.001	0.002	0.058	0.270

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test.WAP=Weeks After Planting. SE=Standard Error. Available P= Available Phosphorus. CEC=Cation Exchange Capacity. EC=Bulk density. BS=Base saturation.

As observed in Table 5 at planting, pH was least at 120g; 6.64 but highest at 80g; 7.09 then at 160g; 6.84 it was not significantly different with Control 0g; 6.83. Total Nitrogen was least at 120g; 0.152%, but highest at 80g;0.215% but not significantly different at 160g; 0.218% and that exceeded Control 0g; 0.184%. Organic matter was least at 120g; 2.267%, exceeded Control 0g;3.154% at 80g; 3.733% and 160g; 3.742%. Available P was least at 120g; 11.416ppm, and exceeded Control 0g; 12.323ppm at 160g;

3.742ppm. Potassium was least at 80g; 0.008Cmol/kg and exceeded Control 0g; 0.029Cmol/kg at 120g; 0.030Cmol/kg, and not significantly different at 160g; 0.028Cmol/kg. Cation exchange capacity (CEC)was least at 160g; 6.451Cmol/kg and highest at 80g; 7.891Cmol/kg and still exceeded Control 0g; 7.380 Cmol/kg at 120g; 7.435Cmol/kg. Bulk density (EC)was least at 120g; 58.692μ/cm and exceeded Control 0g; 65.550μ/cm at 160g; 58.575μ/cm. Base saturation increased from 97.180% at control to 98.094% at 120g.

Table 6: Influence of sawdust rates on the chemical property of the soil at Harvest.

Sawdust (g)	pH	%N	%O.M	Available P (Ppm)	K (Cmol/kg)	CEC (Cmol/kg)	EC(μ/cm)	%BS
0	6.98c	0.202a	3.019a	12.323b	0.023d	6.100b	65.550c	97.358b
80	7.11d	0.223a	3.990d	14.168d	0.008a	6.128b	51.128a	97.438b
120	6.18a	0.253a	3.521b	13.673c	0.012b	5.676a	67.675d	96.651a
160	6.96b	0.218a	3.663c	9.131a	0.014c	6.969c	58.575b	97.447b
SE	0.007	0.005	0.001	0.375	0.001	0.002	0.058	0.270

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test. WAP=Weeks After Planting. SE=Standard Error. Available P= Available Phosphorus. CEC=Cation Exchange Capacity. EC=Bulk density. BS=Base saturation.

At harvest, as seen in Table 6, pH was lowest at 120g; 6.18, but exceeded Control 0g; 6.98 at 80g; 7.11. Application of sawdust did not significantly influence Total Nitrogen; however, it exceeded Control 0g; 0.202%. It had the least effect at 160g; 0.218%, but the highest at 120g; 0.253% and at 80g; 0.223%. Organic matter exceeded Control; 3.019% at treatment application of 80g; 3.990%, 120g; 3.521%, and 160g;3. 663%. Available P was least at 160g; 9.131ppm, highest at 80g; 14.168ppm, and also exceeded Control 0g; 15.386ppm at 120g; 13.673c ppm. Potassium significantly increased with increasing rate of sawdust from 0.008Cmol/kg at 80g, 120g; 0.012Cmol/kg to 0.014Cmol/kg at 160g, but lower than Control 0g; 0.023Cmol/kg. CEC was least at 120g; 5.676Cmol/kg and exceeded Control 0g; 6.100Cmol/kg at 160g; 6.969 Cmol/kg. Bulk density exceeded Control 0g; 65.550μ/cm at 120g; 67.675μ/cm, but least at 80g; 51.128μ/cm. There was no significant increase in base saturation with application of treatment at 80g; 97.438% and 160g; 97.447%. But a significant decrease at 120g; 96.651% when compared to Control; 97.538%.

DISCUSSION

From the results, the 80g sawdust incorporated in the soil increased pH significantly (P≤0.05) exceeding control but decreased pH at 120g and 160g. Agbim and Adeoye, 1994 have reported that organic wastes incorporated into the soils are capable of increasing the soil pH because they contain exchangeable cations. The Nitrogen was not significantly influenced by sawdust. Although, Barney *et al.,* (1991) reported that sawdust applied either as a mulch or mixed with the soil decreased the nitrate content of the soil. Whereas Eneje and Ukwuoma, (2005) attributed this to nitrogen immobilization by the sawdust. The sawdust increased the organic matter content of the soil significantly (P≤0.05). Eneje and Ezeakolam, (2009) also reported soil organic matter significantly increased with the application of sawdust as a soil amendment. The Available phosphorus was decreased with increasing Sawdust at harvest but increased with increasing sawdust at planting. This can be attributed to the increased use of available P in soil by the groundnut plant for nodulation and root formation toward harvest. Sulieman and Tran, (2015) and Valentine *et al.,* (2017) already reported that Phosphorus is an essential nutrient used by groundnut plants, especially for nodulation and root development. Although the treatment with Sawdust had no significant difference in K at planting but at harvest, increasing sawdust resulted to a significant increase in K. This corresponds with Starbuck (1999) report of an increase in the K content of the soil with an increase in sawdust quantity. Sawdust in this study increased the CEC of the soil. Moreover, sawdust as an organic matter will result in increased exchangeable cations. Ayuba *et al.,* (2001) reported that organic matter contains high exchangeable cations. The bulk density of the soil decreased with increasing sawdust. Susan *et al.,* (2020) also reported a decrease in bulk density with increased sawdust. The percentage Base Saturation was not influenced by the sawdust significantly (P≤0.05). However, Awodun (2006) reported an increase in the organic matter, pH, N, P, K, Ca and Mg contents of the soil with the incorporation of sawdust.

This study shows that increasing sawdust rate significantly (P≤0.05) resulted in increased germination percentage, vegetative growth (leaf area, number of leaves and plant height) and the number of seeds and weight of seeds of the groundnut. Amoako et al. (2019) had reported highest emergence percentage of cocoa with increased sawdust incorporation in top soil and when compared with poultry manure mixed with topsoil, the sawdust mixed topsoil resulted in higher mean height of cocoa. Again, this increase can be attributed to other favourable attributes of sawdust applied to the soil, such as water content, apparent density, porosity, and water retention capacity, which improve soil properties for plant growth and development (Terazawa et al., 1999). Also, when used as organic growing media (sawdust and Coir), it was reported to increase plant growth (Maboko *et al;*2003, Tzortzakis and Economakis, 2008), as it increased the porosity and water retention of the growing medium (Hardgrave and Harrisman,1995; Marinou *et al;* 2013). Moreover, with the nitrogen-fixing characteristic of groundnut root (leguminous) plant in the soil, microbial activities are likely to increase favourably resulting to decomposition of the sawdust and supply of organic matter for plant growth (Eriksson *et al.,* 1990, Ting et al., 2014). Moreso, as seen in Tables 5 and 6, the sawdust application maintained a soil pH range of between 6 and 7, which is suiTable for groundnut cultivation (TIMEIS Project and TIMEIS Project, 2019). However, the Sawdust incorporated in the soil did not significantly increase the number of pods and pod weight. This can be attributed to decreased phosphorus and potassium which is highly required for pod production in groundnut. Baughman *et al,* (2015) reported that groundnut plant requires an adequate level of phosphorus, potassium and other micronutrients and a pH of less than 7.

CONCLUSION.

The sawdust rates (80g, 120g and 160g) incorporated in the soil maintained the soil pH range of 6 and 7, which is required for groundnut cultivation. However, increasing sawdust rates in the soil as a soil amendment did not significantly increase the number of pods and weight of pods of the groundnut plant, but resulted to increase in vegetative growth, the number and the weight of seeds of the groundnut plant.

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