EFFECTS OF SAWDUST ASH ON SOIL NUTRIENT CONTENT AND YIELD OF CUCUMBER (*Cucumissativas*) IN SOME ULTISOLS OF THE NIGER-DELTA, NIGERIA.

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Abstract
Field experiment was conducted to study the effects of saw dust ash as source of nutrient for cucumber (*Cucumissativas*) cultivation in an ultisols of a humid environment. Six levels of saw dust ash namely: 0, 2, 4, 6, 8 and 10 t/ha were applied to seedlings in the field two weeks after planting by ring method in a randomized complete block experimental design replicated three times. The saw dust ash treatment increased significantly (P<0.01) in all growth and yieldcharacters evaluated. The 6 and 8 t/ha treatment application produced higher values of 110.23 and 126.54 cm in vine length and 17.20 and 17.95 in number of branches than the control. Number of fruits per plant 6.75 and 5.82 and weight of fruits per hectare 175.32 and 178.12 were also significantly influenced (P≤ 0.05) compared to the control. Soil pH, organic matter, total nitrogen, available phosphorus and exchangeable cationswere all positively influenced with treatment applications.The leaf contents of nitrogen, phosphorus, calcium, magnesium and potassiumwere all significantly influenced compared to the control. Application ratesof 6 and 8 t/ha proved most promising in enhancing growth and yield characters when compared to the control.

Keywords: Saw dust ash, soil nutrient content, Cucumber, Ultisols.

Introduction

Soil is a fundamental resource for multi-purpose agricultural productionthus, its continuous cultivation activities without replenishing lost nutrients will lead to both physical and chemical deterioration resulting to low productivity. According to Busari*et al*., (2004), the need for improved management practices through the use of external inputs from different sources (organic or inorganic) is of great importance in tropical agriculture. Most Ultisolsof tropical origin are derived from acid parent materials that are poor in clay, and structural stability, low in water holding capacity and highly prone to water erosion (Agboola*et al*., 1997).In most urban cities of Nigeria, saw dust generated from saw-milling and wood industries is a common feature that is causing serious disposal and environmental problem. The product is usually derived from highly lignified part of logs of hard trees such as mahogany and chlorophora spp.Little is known about the efficacy of its fertilizing and liming power hence, it is often dumped as waste, and constantly burnt as refuse. It is only in few cases that the saw dust is exploited by poor resource urban dwellers as alternative source of fire wood for cooking purposes. Although, saw dust is highly carbonaceous however, the chemical analysis of its ash Ojeniyi (2006) showed that it contains 0.25% N, 1.28% P, 0.09% K, 0.86% Ca, 0.10% Mg, 0.026% Fe, 0.7% Mn, 0.008% Zn, 0.006% Cu and has a pH range of 8.5 – 9.0. Ashes derived from vegetation have been found for ages to reduce soil acidity, improve soil chemical qualities and yield of crops in different ecological zones (Ojeniyi, et al., 2002; Arakio, 2003:Adudapaah*et al.,* 2004).

Cucumber (*Cucumissativas*) is an important fruit vegetable with great economic potentials as source of industrial raw materials and medicinal fruit in the treatment of constipation, hyperactivity, gastric and duodenal ulcers (Akinbode*et al.*, 2010). However, low inherent soil fertility, high acid soil condition and short shelf life of the crop are some of the factors militating its growth (Enestina, 2001). In the Niger Delta region of Nigeria that is characterized by over 1,225 mm of rainfall per annum, the cultivation of cucumber is not common. The common erroneous belief is that it can only be grown successfully in the northern part of the country. The objective of this study therefore, was to investigate the effects of saw dust ash as an alternative to chemical fertilizers on soil nutrient content and yield components of cucumber in an acid-laddenultisols of Nigeria.

Materials and Methods

Field experiments were conducted at the Delta State University Research and Teaching Farms, Anwai, Asaba, Nigeria in 2010 and 2011 minor rainfall period. Anwaifalls is located between Latitude 5˚ 43` and 5° 30` N andLongitude 6˚ 14`Eand 6° 49`E of the equator and lies significantly in the tropical rainforest zone with over 1,225mm of rainfall per annum.The soil of the study area is unconsolidated up to 1.5 meter depth, loamy in texture and belongs to the Order ultisols and classified as TypicHaplustalt (FDALR, 1987). An estimated land area of 40 x 25m^2 was manually cleared, ploughed, slightly harrowed and marked out into 15 plots of 5 x 3m each. Six saw dust ash levels: 0, 2, 4, 6, 8 and 10 t/ha were evaluated and replicated three times on Cucumber (var. Palomor) using a randomized complete block design (RCBD). Each of the fifteen (15) plots was sown with three seeds and later thinned to two seedlings at 2 WAP. Application of treatment (saw dust ash) was by ring method 2

WAP. Manual weeding was carried out on plots before treatment was administered. No insect pest control measure was undertaken against leaf eating beetles which caused leaf defoliation. Six plants were randomly selected per plot for parameter measurement. The growth characters measured were vine length,number of leaves, leaf area and number of primary branches per plant. Yield and yield components assessed included number of fruits per plant, weight of fruits per plant and total fresh weight of fruits per hectare. These parameters were done at harvest 10 WAP.

Soil analysis

Auger soil samples 0 – 15 cm depth were collected at the experimental site after clearing, bulked and composited for the initial physico-chemical analysis. Also surface (0-15cm) depth samples were collected after harvest and routinely analyzed. In each case, the soil samples were air-dried and sieved through sieve aperture of 2mm and chemically analysed as described by Agbenin, (1996). The parameters analyzed were soil pH in soil water 1:1 medium using sensitive pH electrode, organic matter was determined using dichromate wet-oxidation method, total nitrogen was by micro-Kjeldahl method, available phosphorus was extracted using Bray-l extract followed by Molybdenum blue colorimetry. The exchangeable cations were determined using ammonium acetate solution. The potassium in the extract was determined in flame photometer while calcium and magnesium were evaluated using EDTA titration.

Leaf Analysis

Representative leaf samples were randomly collected per plots at mid-flowering. The leaf samples were air-dried, ground and ashed for eight hours in a muffle furnace at 450˚C. Ash was extracted in a mixture of concentrated perchloric, nitric and sulphuric acid and filtered. Uptake of phosphorus, calcium, magnesium and potassium by leaf were determined by multiplying nutrient concentration by weight of sample dry matter.

Statistical analysis

The data collected was statistically analysed based on Gomez and Gomez (1984) principles using analysis of variance (ANOVA). Treatment means were separated using New Duncan Multiple Range Test (DMRT).

Results and Discussion

Initial Physico-chemical properties of the soil

The data on initial physico-chemical properties of the soil (Table 1), showed that the soil used for the study is sandy loam in texture with over 80% sand content. The sandy loam related texture could be attributed to the sand stones origin of the parent material. The pH is within the range of very strong acid with a mean value of 4.85. The acidic nature of the soil could be as a result of the high rainfall nature of the area which brings about excessive leaching and abrupt losses of exchangeable cations. Organic matter, total nitrogen and available phosphorus contents were low with mean values of 1.18%, 0.05% and 5.24 mgkg^{-1} respectively, and invariably below the established critical values of 20 gkg^{-1}, 1.5 gkg^{-1} and 8 mgkg^{-1} for organic matter, total nitrogen and available phosphorus for the ecological zone (*FMANR*, *1990*) The exchangeable cations of Ca, Mg and K were low with mean values of 2.35 cmolkg^{-1}, 0.36 cmolkg^{-1} and 0.34 cmolkg^{-1} respectively as against 5 cmolkg^{-1} for Ca, 1.5 cmolkg^{-1} for Mg and 0.40 cmolkg^{-1}for K as established for the zone (*FMANR*, *1990*). The low contents of exchangeablecationsdepict the low activity clay mineralogy of the soil. The content of cation exchange capacity was also low with a mean value of 8.47 cmolkg^{-1}. The general results showed that the soil is low in inherent fertility and response to applied soil amendment is assured.

Table 1: Initial Physico-chemical properties of the experimental site

Parameters	Value
Sand (%)	84.6
Silt (%)	7.4
Clay (%)	8.0
Texture	Sandy loam
pH (H_20)	4.85
Organic matter (g kg^{-1})	1.18
Total nitrogen (g kg^{-1})	0.05
Available phosphorus (mg kg^{-1})	5.24
Exchangeable Cations (cmolkg^{-1})	
Ca	2.35
Mg	0.36
K	0.34
CEC (cmolkg^{-1})	8.47

Effect on Growth Parameters

Table 2 shows data on some growth parameters evaluated. There was a significant ($P \leq 0.05$) treatment effects in most of the parameters studied. Vine length of cucumber at harvest was significantly higher than the control at various application rates of 4,6,8 and 10 t/ha, with mean values of 92.21 cm, 110.23 cm, 126.54cm and 121.82cm, respectively. The vine length was most influenced at 6 and 8 t/ha application rate with mean values of 110.23 cm at 6 t/ha, and 126.54 cm at 8 t/ha. However, these values tend to decrease at 10 t/ha application rate to 121.82 cm.

Statistically, vine length at 8 and 10 t/ha treatment application rates were not significantly different ($P > 0.05$) but significant different at 0, 2, 4 and 6 t/ha application rates (Table 2).

Number of leaves was also significantly increased at 6 and 8 t/ha treatment rates with mean values of 15.55 and 17.38 compared to 7.31 and 7.45 obtained in the control and 2 t/ha application rates which were not significant ($P > 0.05$).

Leaf area (cm) was also significantly influenced at 6 and 8 t/ha with mean values of 17.25 cm and 17.74 cm compared to 12.43 cm in the control plot. Leaf area of cucumber was most established at 6 and 8 t/ha treatment rates but tend to drop relatively to 15.25 cm at 10 t/ha rate of application. The number of branches per plant at harvest also followed the same trend as other growth characters evaluated. They were highly and significantly influenced positively.

Table 2: Effect of different levels of saw dust ash (t/ha) on the growth characters of cucumber (*Cucumissativas*) at 10 WAP

Treatment (t/ha)	Vine length (cm)	No of leaves	Leaf area (cm)	No of branches
0	78.32^{a}	7.31^{a}	12.43^{a}	10.74^{a}
2	80.13^{a}	7.45^{a}	12.74^{a}	10.94^{a}
4	92.21^{b}	9.82^{b}	13.23^{b}	13.78^{b}
6	110.23^{c}	15.55^{c}	17.25^{c}	17.20^{a}
8	126.54^{d}	17.38^{d}	17.74^{c}	17.95^{a}
10	121.82^{d}	15.57^{c}	15.25^{b}	14.38^{b}

Values with different subscripts in a row are significantly different ($P > 0.05$)

Effect on yield parameters

The yield parameters evaluated were number of fruits per plant, weight of fruits per plant, and weight of fruits per hectare (Table 3). Number of fruits per plant was significantly higher ($P \leq 0.05$) at 6 and 8 t/ha application rates with mean values of 5.75 and 5.82 compared to 1.35 and 1.38 obtained in the control and 2 t/ha application rates. Weight of fruits per plant was also significantly influenced ($P \leq 0.05$) by various rates of application compared to the control (Table 3). The highest value of 385.25 kg/plant was obtained at 8 t/ha, followed by 375.30 kg per pant at 6 t/ha treatment rate. Weight of fruits however tend to decline at 10 t/ha with a mean value of 310.72 kg/plant. The values of 125.74 and 126.94 kg/plant obtained in the control plots and 2 t/ha rate of application of treatment were statistically different ($P > 0.05$). Weight of fruits per hectare also followed the same trend of weight of fruits/plant (Table 3).

The results showed that saw dust ash has pronounced effects on growth and yield characters of cucumber at various rates of application. In all the growth and yield characters evaluated, the control and application rate of 2 t/ha were not significant ($P > 0.05$). Most growth and yield characters were at best in 6 and 8 t/ha treatment application rates and tend to decline relatively at 10 t/ha. In other words, application of saw dust ash as a treatment beyond 8 t/ha could reduce some morphological growth and yield components of cucumber. This could be adduced to high pH of the soil (7.85) which should have reduced uptake of some nutrients and root growth (Brady and Weil, 2007).

Table 3: Effect of different levels of saw dust ash (t/ha) on the yield and yield component of cucumber (*Cucumissativas*) at 10 WAP

Treatment (t/ha)	No of fruits per plant	Weight of fruits per plant (Kg ha^{-})	Weight of fruits per (t ha^{-})
0	1.35^{a}	125.74^{a}	66.35^{a}
2	1.38^{a}	126.94^{a}	67.28^{a}
4	3.42^{b}	258.44^{c}	152.74^{b}
6	5.75^{c}	375.30^{d}	175.32^{d}
8	5.82^{c}	385.25^{d}	178.12^{d}
10	5.27^{d}	310.72^{e}	164.38^{c}

Values with different subscripts in a row are significantly different (P > 0.05)

Effect on soil chemical properties

There was a significant effect (P>0.05) on some soil chemical properties studied (Table 4) soil pH was significantly influenced from strongly acidic (pH 4.85) to alkaline status (pH 7.2 – 7.8). Soil nutrient contents of organic matter, total nitrogen, and exchangeable Ca, Mg and K were all significantly increased (P ≤ 0.05) at various rates of application compared to the control (Table 4).The increase could be attributed to the chemical composition of saw dust ash which showed the presence of both macro and micro-nutrients. Thus, increase in soil pH, was consistent with its relative high Ca- content. Saw dust ashtherefore, apart from having some nutrients, it also acts as a liming material. The significant increase in soil nutrient content led to increase in all growth and yield parameters evaluated. The findings are consistent with some earlier reports of Owolabi*etal.*, (2002), Odedina*et al.*, (2003), Nottidge*et al.*, (2005) Owodun*et al.*, (2006) and Ojeniyi, (2006), respectively who found that addition of various types of ash to soil at various rates increased macro-nutrient status of soil and uptake of N, P, K, Ca and Mg of various crops. The acidity of the soil was also significantly influenced (P ≤ 0.05) from strongly acid to slightly alkaline.

Saw dust ash treatments increased leaf N, P, K, Ca and Mg of cucumber (Table 5). The increases were significant (P > 0.05). The 8 t/ha rate gave the highest leaf nutrient contents of 1.95% (N); 3.25% (P), 2.28% (Ca), 2.03% (Mg) and 1.93% (K). Thee values were not significantly different (P > 0.05) from the control thereby depicting some levels of nutrient content in saw dust ash.

Table 4: Effect of saw dust ash on soil chemical properties after harvest (10 WAP)

Treatment (t/ha)	pH (H_2O)	O. M (%)	N (%)	P ($mgkg^{-1}$)	Ca →	Mg $Cmolkg^{-1}$	← K
0	4.85^a	1.18^a	0.05^a	5.24^a	2.35^a	0.36^a	0.34^a
2	5.64^b	1.34^a	0.08^a	8.73^b	2.45^a	0.38^a	0.37^a
4	6.35^c	2.12^b	0.17^b	12.52^c	2.78^b	0.45^b	0.47^b
6	7.20^d	2.36^c	0.19^b	18.75^d	3.14^c	0.52^c	0.78^c
8	7.35^d	2.42^c	0.21^c	21.20^e	3.17^c	0.54^c	0.92^d
10	7.85^d	2.45^c	0.21^c	28.75^f	2.17^d	0.48^b	0.68^c

Values with different subscripts in a row are significantly different (P > 0.05)

Table 5: Leaf nutrient composition of cucumber (*Cucumissativas*) as influenced by different rates of application of saw dust ash (%)

Treatment (t/ha)	N (%)	P (ppm)	Ca →	Mg %	← K
0	0.05^a	1.35^a	1.32^a	0.07^a	0.12^a
2	0.08^a	1.38^d	1.35^a	0.09^a	0.13^a
4	1.75^b	2.34^b	1.95^b	1.22^b	1.07^b
6	1.85^c	3.21^c	2.14^c	1.98^c	1.75^c
8	1.95^c	3.25^c	2.28^c	2.03^d	1.93^d
10	135^d	2.37^d	1.98^b	1.75^e	1.35^e

Values with different subscripts in a row are significantly different (P > 0.05)

Conclusion

The need to potentially assess saw dust ash as a veritable alternative source of nutrient in crop production and as alkalinizing material especially in the acid-laddenultisols of the humid environment cannot be undermined. The results of the study showed that ashes derived from saw dust was found to significantly influence all growth and yield characters evaluated. Soil acidity was significantly reduced and increased in soil chemical properties were influenced positively. The 6 and 8 t/ha application rates gave the highest values of all parameters evaluated. The 2 t/ha application rate however did not significantly influence growth and yield characters compared to the control. Thus, the minimum recommended levels of saw dust ash as a locally sourced soil amendment for cucumber production in the humid environment should be 6 and 8 t/ha. Application rates beyond 8 t/ha could negatively affect growth and yield components of the crop.

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