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EFFECT OF DIFFERENT MULCH MATERIALS ON THE GROWTH AND YIELD OF MAIZE (ZEA MAYS) ON COASTAL PLAIN SAND IN SOUTHERN NIGERIA

Gbarabe Roland[1] and Daye Barango[2]

[1&2]Captain Elechi Amadi Polytechnic, Rumola, Port Harcourt, Rivers State.

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ABSTRACT: *The presence of residue mulches in farm has been known to effectively save the soil surface, prevent soil erosion on slopes, help reduce soil moisture loss through evapotranspiration and insulates soil, protect roots from extreme temperature, improve soil biology, aeration, aggregation of soil particles and reduce drainage over-time, improve soil fertility as certain mulch type decompose, inhibit plant diseases, give planting beds a uniform and provide favourable preservation of ecological stability. This experiment was conducted in Teaching and research farm of Akwa ibom State University, Obio Akpa Campus to assess the effect of sawdust, calopogonium leaves, and siam weed on microbial, physicochemical properties and performance of White Maize (Zea mays) on a coastal plain sand of Obio Akpa in Southern Nigeria. Results showed that soil mulches with calopogonium mucunoides recorded highest in the following parameters measured; ECEC 10.35%, Cmol and AV.P323mg/kg^{-1},% base saturation (91.11),100% seed emergence and less leaf area, the highest moisture(35%) was obtain in the soil mulched with saw dust. The highest moisture content in Zea mays ,(5.63%) crude fibre (3.91), lipid (4.71), Total Ash(4.42) and carbohydrates (61.98%) were obtained in the soil mulched calopogonium mucunoides while the highest bacterial count 37x10^{5}cful/g-1 and fungi counts 5.1x10^{3}cfu/g^{-1} which gives rise to typical adult characteristics of soil derived from coastal plain sand.*

KEYWORDS: Mulches, Microbial, Zea mays

INTRODUCTION

Mulch is any material that covers the soil's surface. In nature, mulch is simply fallen leaves and plant debris (Robin Sweeter,2022). In the garden mulch can also include compost, wood chips, rooted manure, cardboard, or even seaweed. However, some other materials can also be used as much as trimmings of trees and shrubs, wastes of animals, stubbles, and residues of crop plants. Landscape mulches were also seen in 1957 but there was no scientific research work carried out on them (Anonymous, 1957).

Mulching has also some other positive environmental effects such as temperature regulation of soil and plant roots, minimum nutrients loses, cut down. Soil erosion and compactness, and improved physical conditions of soil (Ngouajio and McGiffen2002): some plant can be completely suffocated by organic leaf or wood chop mulch, as they interfere with the process, as determined by many researches that mulch applications increase yield in both one year and multiple-year culture plants, and this increase is provided by reduction of rivalry in root area, increase available usable nitrogen in soil and by the increase of usable water (Esu, 1999), plant harvest residues which consist of water, minerals and, organic componentare also used as mulching material(Zhang et al.,2021; Etukudoh et al., 2019). Mulching is an environment friendly application and it contribute to preserving soil moisture, controlling weeds, increasing growth, improving micro organism actions in soil, preventing erosion, providing more regular soil temperature, increasing organic matter content of soil, preventing nutrition loss by leaching and saving money and time (Uguretal., 2017;" Etukudoh et al.,2019).In many previous studies, it was reported that mulch use in agriculture did not only support soil moisture preservation, weed control, stabilize soil temperature but therefore increased sapling quality and yield by promoting root growth (Etukudoh etal.,2019) The effect of mulching on coastal plain soil can be related to the physiochemical properties. Although, information on the effect of mulching on coastal plain soils is scanty; research on the effect of mulching on coastal plain soils become necessary as one culture practice. And production limitation.

Types of mulching material;

1) Organic mulches

- Barks
- Leaves
- Grass cutting
- Pine needles
- Cocoa shells etc.

2) Synthesis mulches

- Gravel and stone chips
- Dyed wood mulch
- Black plastic

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- News paper

Both mulches have advantages and disadvantages

Objectives of the study

The general objective of this study was to investigate mulching effects of Zea mays growth and yield on coastal plain sand, the study also seeks to determine:

1. The effect of each mulch type.
2. The effect of mulching materials on zea mays plant growth on coastal plain sand.
3. To provide a preliminary recommendation for the selection of acceptable mulch based on research.

MATERIALS AND METHOD

The Study Area

This study was conducted in Akwa Ibom State University Teaching and Research Farm. Obio Akpa Campus in southern Nigeria. The Area is located between the latitude $4°30^1$N and longitude $70°30^1$ E and 80°0'E (Ekong and Uduak, 2015). The area has a humid tropical climate with an annual rainfall ranging from 2500 to 3000mm, mean temperature of about 27°c and the relative humidity from 75% to 79% (SLUK-Am, 1989). The major soil type is loosed, friable and unconsolidated soil from the coastal plain sands. The Soil is deep and have loamy-sand to sand materials (Ofomata, 1976). Because of their sandy nature, they are fragile and highly susceptible to erosion. The soils around this Area are acidic in nature. The topography of the area is low-lying coastal plain (Udo, 2008). The original rain forest has disappeared because of clearing for farming and developmental activities.

Experimental materials

The experimental crop was maize (Zea mays) seed, the seed was purchased at Abak popular market. The soil was mulched with the following materials, (Calopognium muconoides, saw dust and saim weed.

Experimental design

In the experiment, there was a plot without mulching material to serve as control. There were four (4) treatments. All the treatment was arranged in a complete randomized design (CRD) and replicated three times giving a total of twelve (12) experimental units.

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Table 1

Control	Sawdust A1	Saim Weed A2	Calopogonium mucunoids A3
Saim weed	Calopogonium mucunoids A3	Control A2	Sawdust A1
Calopogonium mucunoids	Control A2	Sawdust A1	Saim weed A3

Fg 3.1 Randomization scheme

SYMBOLS Z = control (zero mulch,) A1 = sawdust, A2 Saim weed, A3 = *Calopogonium mucunoids*

An uncultivated portion of land in Akwa Ibom state University Research Farm measuring 20m x 20m was manually slashed and cleared using cutlass and shovel. The ea was demarcated into 4m x 4m plots with space of 0.5m between each plot and area replicated three times. Plots were mulched with respective mulch using 3kg each, unmulched plots were included to serve as control and left for fifteen (15) days for the soil to equilibrate, then 5(five) seeds of maize gotten from Abak local Market was planted directly into the field plots. The seedlings were thinned to three (3), Nine (9) days after germination in each stand. During the study period, No agro-chemical was applied.

Laboratory analysis

Before treatment and in day 13, soil was sampled, sieved and analysis for the following: organic carbon, available phosphorus, calcium, magnesium, sodium and total Nitrogen. Samples were collected from each of the treatment units using sterile plastic tube. Composite soil samples were taken to the Soil Science laboratory of UNIUYO for analysis. At the UNIUYO laboratory, soil samples were air-dried at room temperature, crushed and passed through 2mm sieve and stored in labeled polythene bags for various analysis. All analytical determinations were carried out in duplicate, blank determination was also done to eliminate any sources of impurities in the reagent used. The following analysis were done: H-Soil reaction was determined in water with glass electrodes in 1.2.3 (Ogunwale, 1978) using electrometer method.

Organic carbon

Organic carbon was determined by the dichromate wet oxidation method of walkley and Black (1934) as described by Nelson and Sommers (1982).

Total Nitrogen

Total Nitrogen in the soil was determined by macro kjeldahl digestion and distillation method of Jackson (1970).

Available Phosphorus

Available phosphorus was determined by Sparks (1996).

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Determination of Exchangeable Bases

Calcium (Ca) and magnesium (mg) was determined by titration method (ETDA) of Jackson (1970) as modified by Nelson and Sommers (1982).

Exchangeable Acidity

Exchangeable Acidity (Al plus H) was extracted with molar KCl and acidity determine by titration method of MC clean (1965)

Particle Size Analysis

Mechanical analysis of soil was done by hydrometer method by Klute (Ed) 1986.

Moisture Content

Soil sample was air-dried and put into oven to dry at 105°c to a constant weight to determine the moisture content of the soil thus. Moisture content A- B x 100=% Where A=Air dried soil + moisture content, B=Oven dried soil

Effective Cation Exchange Capacity (ECEC)

ECEC was calculated by the summation of total exchangeable cation and acidity as outlined by Udo et al. (2009).

Proximate analysis

Maize Seed (fruit) was harvested on the day 90 after planting. Grains were manually removed taking care not to allow foreign particles to enter. The various grains samples were ground using agate mortar. The mortar was decontaminated by washing with distilled water and soap after each sample was ground. The proximate and mineral analysis were done accurately to standard procedure of AOAC (2000). All the chemicals used in this analysis were of analytical grade. The proximate compositions were determined using atomic absorption spectrometer and flame emissions spectrometer.

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STATISTICAL ANALYSIS

Descriptive statistics were used to interpret the results while analysis of variance (ANOVA) was used to test the level of variability among treatment.

Result

Table 2: Physicochemical properties of the soil used for the study

	Control	**Sawdust**	**Saim weed**	**Calopogonium mucunoides**
pH(H20)1:25	5.12	5.09	6.10	6.45
Organic matter	3.19	2.82	4.11	5.16
Total N (%)	1.60	1.12	1.96	2.16
Available phosphorus (mg2)	2.67	1.99	3.23	318
Exchangeable Bases				
Ca (cmolkg^{-1})	3.07	2.22	4.65	3.58
Mg (cmolkg^{-1})	1.30	1.09	3.56	1.95
Na (cmolkg^{-1})	0.73	0.68	1.00	0.83
K (cmolkg^{-1})	0.16	0.11	0.73	1.00
Exchangeable Acidity				
ECEC (cmolkg^{-1})	6.55	5.60	10.26	10.35
BS (%)	80.31	72.21	89.77	91.11
Moisture content (%)	28	35	32	33
Sand (%)	874.20	874.50	873.30	829.90
Silt	52.50	57.10	53.10	64.11
Clay	73.30	68.30	83.60	77.0
Textural class	Sandy	Sandy	Sandy	Sandy
	10am	**10am**	**10am**	**10am**

Symbol pH = soil reaction, Ca = Calcium, Mg = Magnesium, Na = Sodium, K = Potassium, ECEC = Effective cation exchange capacity, BS = Base Saturation

The physicochemical properties of the soil used for the study are presented in the **Table 2.** After treatment the soil pH increased from 5.12 to 6.10 and 6.45 in the soil with sawdust, soil mulched with *Calopogonium mucunoides* leave, respectively. While decrease was noted in the soil mulched with sawdust (5.09). Thus the soil was acidic in nature with pH value of 5.12, 5.09, 6.10 and 6.45 in the unmulched soil, Soil mulched with sawdust, soil mulched with saim and *Calopogonium mucunoides* respectively. The highest organic carbon of 5.16% was obtained in the soil mulched with *Calopogonium mucunoides* leaves. This was followed by the saim weed the least was obtained in soil mulched with sawdust. Total Nitrogen gradually increased in all treatment options compared to unmulched soil option except in the soil Mulched with sawdust. In this treatment, option percent total Nitrogen (%total N) decrease from 1.60-1.12% in day 80. The highest nitrogen present was (2.16) following by 1:96% while the least was recorded in the soil mulched with saw dust saturation The highest moisture content (35%) was recorded in the sawdust mulched soil at day 80 follow by soil mulched with Calopogonium leaves which had 33%, ECEC of 10.35cmolkg^{-1} was recorded in the soil mulched with *Calopogonium mucunoides* leaves as the highest.

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This was followed by the soil Mulched with saim weed. Available phosphorus (323mgkg^{-1}) was recorded in the saim weed soil as the highest, followed by the soil mulched with *calopogonium mucunoides* (318mgkg^{-1}). Exchangeable bases, 3.07, 2.22, 4.65 and 3.58 total cmol kg^{-1} were recorded in the control soil, soil mulched with sawdust, soil mulched with Saim weeds and *calopogonium mucunoides* respectively. Thus the soil mulched with saim weed had the highest exchangeable bases. On base saturation, 80.13,73.21, 89.77 and 91.11% were observed in the control soil, soil mulched with sawdust, soil mulched with Saim weed and *calopogonium mucunoides* respectively. The highest base saturation was observed on the *calopogonium mucunoides* mulched soil. Moisture content, 28, 35, 32 and 33 were observed. The highest moisture content was recorded in sawdust mulched soil. The studied soil contain more than 700% sand. It is described as sandy loam (Esu1999) which give rise to Typic paludult, characteristics of soil derived from coastal plain sand.

Table 3: Maize plants germination, leaf area parameters

Measured	Control	Sawdust A1	Saim Weed A2	Calopogonium mucunoids A3
%Germination (EDP	70	80	90	100
Leaf area(SPD)cm	4.50cm	3.60cm	6.27cm	7.77cm

Key: EDP = days after planting, SFD = seventy five days after planting

Sharp increase of the soil pH of the soil Mulched with calopogonium leaves in the soil on day 75 of the study period as compared to other treatment, option may have been due to improved soil creation leading to increase in microbial population and activities as earlier reported by Isirimah *et al*, (2003). The rise in soil pH, in soil amendments soil indicate the richness of those mulching materials with Nitrogen while decreasing of pH e.g. in sawdust mulched soil indicate nitrogen deficiency. More organic (See Table 2) matter present in the *Calopogonium mucunoides* mulch soil indicate that more plant residues are returned to the soil and they will go through the decomposition and mineralization processes to provide nutrients and habitat to living organisms in the soil, present organic carbon decrease in the sawdust treatment option resulted from the immobilization resulting from the use of available Carbon material as energy source by the soil microbes as a result of spontaneous increase in microbial population due to the shortage of nitrogen in the mulching material, hence the decrease in the nitrogen as earlier reported by Cary and sausage (1995). The greater seed emergence in the soil mulched with *Calopogonium mucunoides* and they are good mulching material, regulate the soil temperature, aided seed emergence and encourage faster growth. Thus, Calopogonium mucunoides are better mulching materials. It has a higher ECEC valve (10.35cmol kg^{-1}).

Moisture content of 35% was recorded in the soil mulch with sawdust at 75days. This therefore means that sawdust can retain soil moisture as compared to other mulches under consideration. It can also suppress weeds growth as earlier reported by Alfred *et al.*, (2009). The studies soil contain more than 70% sand it is described by Esu (1999) as sandy loam which give rise to typic paludult a characteristics of soil derived from coastal plains sand. From Table 4.2, the highest perimeter seed emergence was observed in the *Calopogonium mucunoides* leaves mulched soil. Seed emergence increase with time and the maximum record on day 8 (eight) after planting for each treatment option, the lowest seed emergence was recorded in the sawdust mulched soil while the highest was recorded in the *Calopogonium mucunoides* leaves mulch

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soil, treatment options. The studied soil contained more than 700% with the highest 874.50 in the control soil.

Table 4: Carbohydrates content at 80 days after planting

	Control	Sawdust	Saim weed	Calopogonium mucunoides	Total
R1	61.30	62	61.01	60.20	244.51
R2	59.89	61.11	61.50	58.22	240.72
R3	61.72	62.53	62.50	59.15	246.04
Total	182.91	182.65	185.16	177.25	731.27

Since fcal>ftab (Table 4): alternative hypothesis is accepted and conclude that there is significant difference between mulching materials at 80 days of planting (ANOVA 4).

Table 5: Protein content at 80 days after planting

	Control	Sawdust	Saim weed	Calopogonium mucunoides	Total
R1	22.20	24.36	22.73	21.77	19.06
R2	21.80	52.08	23.02	19.99	29.89
R3	19.90	23.19	21.51	21.72	86.32
Total	63.9	72.63	67.26	63.48	367.27

Since fcal<ftab (Table 4.6): null hypothesis is rejected and conclude that there is not significant difference in protein content in Zea Mays between mulching materials at 80 days of planting.

Table 6: Bacterial counts ($x10^5 cfu/g^{-1}$ Soil) at 75 days after mulching

	Control	Sawdust	Saim weed	Calopogonium mucunoides	Total
R1	18	28	30	36	112
R2	11	27	38	35	108
R3	20	26	37	40	123
Total	49	81	102	111	343

Soil bacteria count are shown in table 4.6 at day 75, the highest bacteria (40×10^5 cfu/g soil) was recorded in the soil Mulched with *calopogonium mucunoides* leave followed by the Siam weed mulch soil which has $37x10^5$ cfu/g^{-1} soil In treatment options, expect in the control (Z), There were sharp increase in Bacterial counts with the highest counts recorded in the *calopogonium mucunoides* leave mulched soil at day 75 of the study period. Since Feal > ftab: null hypothesis is rejected and conclude that there is significant difference between bacterial counts under difference mulching material at day 75 after treatment. (ANOVA Table 7)

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Table 7: Fungi counts ($x10^3 cfu/g^{-1}$ Soil) at 75 days after mulching

	Control	Sawdust	Saim weed	Calopogonium mucunoides	Total
R1	19	38	41	51	149
R2	24	47	36	48	155
R3	20	44	37	39	140
Total	63	129	114	138	444

Since F calculated is greater than F tabulated, null hypothesis at 5% probability level is rejected and conclude that mulching materials differ in their ability to sustain fungi in the soil (ANOVA Table 4.9). After treatment at day 75, table 4.8the highest fungi count (51×10^3 cfu/g soil) was recorded in the soil mulched with *calopogonium mucunoides* leave followed by that Siam weed mulch soil which has $47x10^3$ cfu/g^{-1} soil.

DISCUSSIONS

Sharp increase soil pH in the soil mulched with *calopogonium mucunoides* on day 75 of the study period as compared to the other treatment options may have been due to improved soil aeration leading to increase in microbial population and activities as earlier reported by Isirimah et al., (2003) increased in the soil pH mulched with calopogonium leaves indicate the richest of all those mulching material while decreasing in soil Mulched with sawdust indicate Nitrogen (N) deficiency. Organic matter present in calopogonium mulch indicated that more plant residue were returned to the soil and this would have gone through the decomposition and mineralization processes to provide nutrients and habitat to microbe.

Percent organic carbon decreased in sawdust mulched soil may have resulted in immobilization resulting from the use of available carbon materials as energy source by the soil microbe as a result of spontaneous increase in microbial population due to the decrease in Nitrogen as easier reported by Carry and Sawage (1998). The greater seed emergence in the soil mulched with *calopogonium mucunoides* leave confirm the finding of Louise and Bush-Brown (1996) that good mulching material regulate the temperature of the soil, aid seed emergence and encourage faster growth. Soil Mulched with *Calopogonium mucunoides* leaves also has the largest leave areas. This also resulted in high microbial population hence more biochemical activities and mineralization. Thus *calopogonium mucunoides* and Siam weed are better mulching. Soil microbe may not have put greater demands on soul limited Nitrogen because nutrients in the better mulching materials mineralized and are made available as compared to sawdust. The highest moisture content $35_g/100_g$ in the soil was recorded in the soil mulched with sawdust in the day 75.This therefore means that sawdust mulch can retain soil water, regulate soil temperature, suppress weed growth as earlier reported by Alfred *et al.*, (2009).

Percent seed emergence increased with time with the maximum percent recorded on the day 8 after planting from each treatment options. The lowest seed emergence was recorded in sawdust mulched soil, while the highest (100%) was recorded in *calopogonium mucunoides* mulched.

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CONCLUSION AND RECOMMENDATION

Mulches save the soil surface, prevent soil erosion on slopes, help reduce soil moisture loss through evapotranspiration, control weed germination and growth, improve soil biology, aeration, improve soil structure and drainage over-time, improve fertility as certain mulch decay to provide. Nutrients, inhibit certain plant diseases, give plant uniformity to planting bed etc. On the other hand some Mulched has the capacity of introducing new weed species into the farm. Mulching can be expensive to apply especially in a large farm. This means that it will require a lot of labour and materials.

Mulching is also capable of harboring certain harmful diseases and pests because it can provide a very conducive breeding environment for harmful pests and disease causing organism o live and multiply and can end up invading the whole farm. There are also certain instances where applying mulches can end up releasing toxic chemicals into the soil after decomposing. It is therefore recommend that mulching should be done with care.

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