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Effect of Different Mulching Materials on Some Growth Parameters of Maize (*Zea maysL*)and Soil Physicochemical Properties.

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Abstract

Effects of different mulching materials on some growth parameters of maize and its influence on soil physicochemical properties were studied under Igbariamagro-ecology, during the rainy season of May to August 2019. The four types of mulches were laid out in a randomized complete Block design (RCBD), with four treatments and four replications. The four mulching treatments are Black polythene, while polythene, elephant grass, and no mulch, 5t/ha of cow dung manure was added to 18 experimental plots as Blank treatments. The growth, agronomic parameters, and soil physicochemical properties were monitored. Results indicated that elephant grass mulch significantly ($P<0.5$) increased the number of leaves, plant height, and stem girth when compared with other treatments. The treatments generally increased total porosity compared with the control. Bulk density and dispersion ratio significantly decreased in all treatments. There was a significant increase in aeration porosity. Field capacity and plant available water were significantly increased ($p = 0.05$). Buffer capacity, cation exchange capacity, and electrical conductivity were significantly increased with the application of treatments ($p = 0.05$). Particularly striking was the effect of Elephant grass mulch treatment on soil electrical conductivity which induced a 78.4±4.1 increase compared with the control 22.1±1.0. There was no significant increase in soluble cation. Therefore, elephant grass mulch could be applied alternatively in inorganic mulch and inorganic fertilizer for improved maize production.

Keywords: Mulching, Soil, Physical, Chemical Properties, Maize

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1.0 Introduction

Mulching is an effective method of manipulating crop growing environments to increase yield and improve product quality by controlling weed growth, reducing soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure, and enhancing the organic matter content of the soil. Mulches are loose coverings or sheet of organic material that is placed on the soil surface. It helps preserve moisture, repression of weeds, improve soil consistency, insect pest assault and guard roots from severe temperature. Organic mulches improve soil, pleasant soil temperature, hinder weed growth, lessen soil moisture evaporation, and improve landscapes' visual qualities. A good layer of mulch will help to preserve moisture and suppress weed germination. Mulch enhanced root and increased maize grain yield by increasing plant N-uptake efficiency, falling N discharge losses and improving nutrient preservation over unmulched plots). Straw mulch is practised successfully in many advanced countries like America and Australia where it improved many soil aspect to support soil moisture retention ability, prevent wind erosion, control of weeds, nutrient return and soil structure improvement.

Mulches are used for various reasons as stated, but water conservation and erosion control are the most critical objective for its use in agriculture in dry regions. Other reasons for mulch use include soil temperature modification, soil conservation, nutrient addition, improvement in soil structure, weed control, and crop quality control. Mulching reduces deterioration of soil by way of preventing runoff and soil loss, minimizes weed infestation, and checks water evaporation. Thus, it facilitates more retention of soil moisture and helps in the control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Bhatt and Kheral, 2006; Ani-

kwe *et al*., 2007; Glab and Kulig, 2008). Inyang (2005) revealed that mulch materials improved soil physicochemical properties, reduced soil temperature and evaporation, and increased the soil moisture content, thereby creating enabling soil microclimatic conditions for crop growth.

Maize (*Zea mays* L.; family Poaceae) ranks second to wheat in the world's cereal production. Wheat, rice, and maize are the most important cereal crops in the world, but maize is the most popular due to its high yields, ease of processing and digestion, and is cheaper than other cereals (Jaliya*et al*., 2008). Ayoola and Adeniyan (2006) reported that the use of inorganic fertilizers was not helpful under intensive agriculture because they were often associated with reduced yield, nutrient imbalance, leaching, and pollution of groundwater (Sridhar and Adeoye, 2003). As the mineral fertilizer alone cannot meet the requirements of crops and cropping systems because of high cost and also environment-related risks involved in its application and usage, integrated use of organic and inorganic is desired to attain the sustainability of a cropping system (Rao *et al*., 2002). Inorganic fertilizer use alone is inadequate to alleviate the physical and biological degradation of soil. The use of organic manure as a fertilizer releases many vital nutrients into the soil and also nourishes soil organisms, which in turn slowly and steadily make minerals available to plants (Erin, 2007). Soil amendment with manures, municipal biosolids, and other organic wastes has been found to improve the physical and chemical properties of soil (Barzegar*et al*., 2002; Mkhabelaa and Warmanb, 2005; Simon *et al*., 2013; Unagwu*et al*., 2013).

Thus, the objectives of this study were to (i) access the use of organic and inorganic mulch on the growth and development of maize under Igbariam agro-ecology. (ii)access the use of organic and inorganic mulch on physicochemical properties of Igbariam soil.

2.0 Materials and methods

2.1 Study Area

The field trial was conducted in the Teaching and Research Farm of Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus. The study area is located at latitudes 5°40' and 6°46' N, longitude 6°40' and 7°20' E. The field experiment was established to evaluate the effect of different mulching materials on the physicochemical properties of Igbariamsoil cropped to maize. The area is characterized by a humid tropical climate with wet and dry seasons (Obi, 1982). The annual average rainfall is between 1800mm and 2000mm and distributed from March to November. The annual temperature is 21^0C with a minimum and maximum of 20^0C and 30^0C, respectively. Igbariam is a sloppy land with its soil acidic in nature which falls in the tropical rainforest zone of eastern Nigeria.

2.2 Field preparation

A land area measuring 9.5m x 11m was mapped out and manually cleared, and beds were made using a hoe. The land area was divided into two equal blocks. Each of the blocks was made up of plots, given a total of 18test plots, and each plot measured 2m x 2m ($4m^2$) with 0.5m between plots and 1m alley between blocks to ensure free movement during the study. The four types of mulches were laid out in a randomized complete Block design (RCBD), with four treatments and four replications. The mulch was laid just before planting, and the planting hole was made of pre-marked points on polythene mulch. The elephant grass mulch was applied to 4cm thickness. A hybrid maize seed Oba super II was planted on the plots two seed were planted per hole with a spacing of 75cm X 25cm and later thin down to one plant per stand. The agronomic parameters studied were plant height, number of leaves, and plant girth at 8WAP.

2.3 Soil sampling and physicochemical analysis

Soil samples before the experiment were analyzed for pH using a digital pH meter with solid to liquid ratio of 1:2:5 and soil electrical conductivity (EC) was analyzed using a digital conductivity meter, field capacity, and plant available water by the method of (Grewal *et al*., 1990). Total porosity and aeration porosity was determined by the method of Dane and Topp (2020). Soil Buffer Capacity was analyzed according to Bloom *et al.,* 2000, CEC was determined by unbuffered Barium chloride ($BaCl_2$) method, according to Nikol'skill, (1959).

2.4 Data analysis

All data were subjected to analysis of variance (one-way ANOVA) using SPSS version 20, and the mean difference of the effects of the mulches on soil properties and plant biomass were compared using the least significant difference ($LSD_{0.05}$) as described by Obi (2002).

3.0 Results and Discussion

3.1 Soil physicochemical properties as affected by mulch types

The effects of the treatments on soil buffer capacity, pH, electrical conductivity, and cation exchange capacity are shown in (Table2). The differences observed were statistically significant ($P<0.05$). The cation exchange capacity at BG and BP, are low while that of EG is high. This increase could be a result of treatment application. Higher cation exchange capacity indicates the stability of soil nutrients. The field trial of Bouajila and Sanaa (2011) showed that the application of manure and compost resulted in a significant increase of structural stability, with the compost treatment being the most efficient. Their results also indicated that the application of 120 t/ha household wastes and manure improved better the structural stability when compared with control. The favorable pH level of the mulched soil reflects resourcefulness of the elephant grass mulch to address the problem of undesirable acidification of the soil particularly the problem of erratic changes in soil pH which can cripple crop growth in the soil of low pH as observed in the control soil. From the data in (Table 1), there is a significant effect among the treatments ($P < 0.05$). The result showed that there was a significantly increased in total soil porosity, aeration porosity, filed capacity, and plant available water when compared with the result obtained where no mulch was used.

However, white polythene (WP), black polythene (BP), and elephant grass (EG) have a similar effect on their reduction in soil dispersion ratio. These indicate that the mulched treatment increased soil organic matter which helps in aggregating the soil colloidal particles together, thereby causing erosion resistance. Elephant grass gave the best result in the reduction of dispersion ratio. Field capacity was significantly increased among the treatments. The result indicates that the three mulches greatly influenced field capacity, which is very useful for plant growth. Also, the result revealed the ability of the amended soil to retain water and make them available for plant growth. Table 3 shows the effects of different mulches on the number of leaves per maize plant at eight weeks after planting. Elephant grass mulch treatment significantly increased the number of leaves produced when compared with other mulch and control after treatment application. There were variations in the number of leaves in their response to treatments. Significant increases in plant height over the control were obtained for all the treatments throughout the growth of maize with the elephant

Table 1 Effect of Elephant grass, White polythene and black polythene mulch on physical properties of Igbariam Sandy loam soil cropped to maize

Treatments	Total porosity (v/v)	Dispersion Ratio (%)	Aeration Porosity (%)	Field Capacity (%)	Plant Available Water %
BG	36.1± 1.6	36.0±1.3	9.1±0.3	11.9±1.6	6.2±0.3
WP	56.1±1.4	17.3±1.4	18.7±1.9	21.2±1.5	26.3±1.1
BP	55.4±1.2	18.8±0.4	21.3±1.3	27.7±1.4	23.5±0.4
EG	71.2±1.8	10.9±0.6	24.6±0.9	34.2±2.3	32.7±1.2
LSD0.05	3.1	2.6	2.3	3.4	2.8

Table 2: Effect of Elephant grass, White polythene, and black polythene mulch on chemical properties of Igbariam Sandy loam soil cropped to maize

Treatment	pH (H_2O)	Buffer Capacity (meq/100g soil)	Electrical Conductivity ($\mu s/cm^{-1}$)	C.E.C (meq/100g soil)
BG	4.1± 0.8	0.2± 0.0	22.1±1.0	8.2±0.1
BP	5.4±0.1	0.6±0.1	68.1±1.6	20.3±1.0
WP	5.6±0.3	1.2± 0.0	48.2± 0.4	18.3±0.3
EG	6.5±0.1	1.8±0.1	78.4±4.1	24.4±1.1
LSD0.05	0.2	NS	8.6	2.8

Table 3: Effect of Elephant grass, White polythene, and black polythene mulch on the growth of maize.

Treatments	Plant height	No of leaves	Plant girth
BG	44.21± 3.8	6.31±0.8	3.20±0.1
WP	66.3±32.1	8.98±1.2	5.81±0.3
BP	58.15±1.5	7.22± 1.5	4.27±1.2
EG	92.05±3.1	10.15±2.0	6.16±0.5
LSD0.05	6.2	2.2	0.09

KEY: BG = BARE GROUND, WP = WHITE POLYTHENE, BP = BLACK POLYTHENE, EG = ELEPHANT GRASS, NS = NOT SIGNIFICANT

grass (EG) produces plants with the tallest height (Table3). All the mulches significantly increased maize stem girth throughout the evaluation period when compared with the control (Table3). The significant increases in stem girth, plant height, and number of leaves obtained with the application of mulches throughout the evaluation period over the control suggests that they constitute an excellent source of mineral nutrients needed for plant growth. This agrees with the finding of Erin (2007), on the use of organic amendment as fertilizers, which releases many vital nutrients into the soil and also nourishes soil organisms, which in turn slowly and steadily make minerals available to plants.

4.0 Conclusion

The results of this study showed the advantages of using mulches for the production of maize in terms of growth and nutrient composition. The trend of events in plant growth observed in this research implies that organic mulch use could compete favorably with inorganic mulch. Plant growth and soil properties monitored in this research work show that Elephant grass and white polythene enhanced the nutrient composition and growth of maize. This suggests that the above materials are a good source of sustainable and efficient organic amendment, which could be recommended to smallholder maize farmers for improving soil properties, optimum growth of maize in the study area.

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