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Succeeding-Season Effect of Mulching on the Performance of Maize (*Zea mays*) in Makurdi, Benue State, Nigeria

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Research Article

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ABSTRACT

This study was carried out during the 2017 cropping season as a follow-up research from the 2015 trials, at the Teaching and Research Farm of the University of Agriculture, Makurdi. The objective was to evaluate the residual effect of mulching on the growth and yield of maize in the study area. It involved the re-use of an experimental layout, which had five treatments, 2 and 4 t/ha of both dead grasses (majorly *Ageratum conyzoides* and *Imperata cylindrica*) and saw dust (mostly hand held chain power saw wood shavings) as well as a control (no mulch application), which were replicated three times in a randomized complete block desigh (RCBD). Data was taken on number of leaves, plant height, stem girth, dry matter and grain yields. They were subjected to analysis of variance (ANOVA) using Gen Stat statistical package and means were separated using Fisher's least significant difference (F-LSD) at 5% level of probability. Results revealed that the residual effect of mulching significantly increased both maize growth and dry matter yield, with the highest grain yield obtained at 4 t/ha of saw dust.

INTRODUCTION

Maize (*Zea mays*) is a member of the Poacea family. Its importance is apparent in daily life food stuff as it is a source of edible oil and high valued food for human beings, feed revealed that for livestock and poultry, and a raw material for various agro-based industries [1]. It ranks second to wheat in the world's production due to its high yields, ease of processing and digestion, and being cheaper than other cereals [2]. Although maize is one of the most important crops in Nigeria [3], there are several factors militating against profitable production of maize in Nigeria [4]. The most important are high evaporation losses and low soil organic matter which results in low soil fertility status.

Mulching is an effective method of manipulating crop growing environments in order 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 organic matter content of the soil [4]. Mulching reduces deterioration of soil by way of preventing runoff and soil loss, minimizes weed infestation and checks water evaporation [5]. Thus, it facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately significantly increases yield [6,7]. Inyang [8] revealed that mulch materials improved soil physicochemical properties, reduced soil temperature and evaporation, and increased the soil moisture content, thereby creating enabling soil microclimatic condition for crop growth.

Use of organic materials as mulching also has a fertilization effect upon decomposition as it releases many important nutrients into the soil and also nourishes soil organisms, which in turn slowly make minerals available to plants [9]. Soil amendment with manures, municipal biosolids, and other organic wastes has also been found to improve the physical and chemical properties of the soil [10-13].

Saw dust and farm debris serve dual purposes, as mulching materials and they are also good sources of organic fertilizer

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materials. However, they take time to gradually decompose, releasing nutrients in the soil. The need to evaluate their residual effect after a year of application as mulch material is highly desirable in order to enlighten farmers on the benefits derivable from the application of mulching in the present and succeeding farming season(s). The objective of this trial is to evaluate the residual effect of mulching on the growth and yield of maize in the study area.

MATERIALS AND METHODS

This study was carried out at the Teaching and Research Farm of University of Agriculture Makurdi located in the southern Guinea Savanna Agro ecological zone of Nigeria on latitude 7° 41' N to 7° 42' N and longitude 8° 37 E to 8° 38 E at altitude of 97 m above mean sea level. The experimental area witnessed an annual rainfall of about 1,250 mm and a mean temperature of 25-30°C. The slope of the area ranged from 1 – 5%. The soil is classified as Typic ustropepts (USDA) [14].

Experimental treatments, design and procedure

The experiment consisted of 5 treatments, namely T_1= control (without mulch application), T_2= 2 t/ha dry grass, T_3= 4 t/ha dry grass, T_4= 2 t/ha saw dust and T_5= 4 t/ha saw dust, replicated 3 times in a randomized complete block design (RCBD), as adapted from the layout of the preceding season. Sawdust and dead grasses used as mulching material the preceding cropping season (2015) were incorporated into the soil in the succeeding season (2016) to serve as manure to support maize production. The vegetative cover was manually cleared. Ridges were prepared 50 cm high and 75 cm wide on previously mulched plots. Planting was done on the 29th of May, 2017 at an inter-row spacing of 75 cm and intra-row spacing of 50 cm. No other fertilizer was applied. Insecticide known as Best (*Lamba cyhalotrin*) was sprayed at 2, 4 and 6 weeks after planting to control pests. Data on number of leaves was collected by counting, plant height was measured with a meter rule, stem girth was determined with a veneer caliper, weight of dry matter and grain yield were measured with a weighing scale in the Advanced Analytical Soil Science Laboratory of the Department of Soil Science, University of Agriculture, Makurdi.

Data collection

Data was collected on following crop parameters: Number of leaves, Plant height, Stem girth, dry matter and grain yield.

Data analysis

All data collected on the crop parameters were subjected to analysis of variance (ANOVA) using Gen Stat Release version 14 [15] and means were separated using Fisher's least significant difference (F-LSD) at 5% level of probability.

RESULTS

Number of leaves

The residual effect of mulching on number of leaves of maize at Makurdi in 2017 is presented in **Table 1**. It indicated that mulching did not significantly influence the number of leaves at 2 Weeks After Planting (WAP), but at 8 WAP the treatment 2 t/ha dry grass, 4 t/ha dry grass, 2 t/ha saw dust and 4 t/ha saw dust were significantly different from the control at 5% level of probability. While at 4 WAP, though all the treatments were significantly different from the control, 4 t/ha dry grass and 2 t/ha saw dust were significantly different from themselves. The highest numbers of leaves were obtained by 4 t/ha sawdust, 4 t/ha dry grass, 2 t/ha saw dust, 2 t/ha dry grass and no mulch application, in decreasing order.

Table 1. Effect of Mulch residue on number of leaves of maize in Makurdi during the 2017 season.

Treatment	Weeks After Planting 2 4 8		
Control	3.10	7.10	13.20
Dry grass (2 tons/ha)	3.40	7.10	15.10
Dry grass (4 tons/ha)	2.80	9.40	17.30
Sawdust (2 tons/ha)	3.00	9.90	16.90
Sawdust (4 tons/ha)	3.00	10.80	18.40
$F\text{-}LSD_{(0.05)}$	1.30 (NS)	1.44	1.50

Plant height

The residual effect of mulching on plant height of maize as presented in **Table 2** indicated that 2 t/ha dry grass, 4 t/ha dry grass, 2 t/ha saw dust and 4 t/ha saw dust were significantly different from the control at 3, 8 and 14 WAP. At 14 WAP, the highest plant height was obtained at 4 t/ha sawdust, followed by 2 t/ha saw dust, 4 t/ha dry grass, 2 t/ha dry grass and no mulch application in decreasing order. 2 t/ha sawdust and 4 t/ha sawdust were not significantly different from each other, but both were significantly different from 4 and 2 t/ha dry grass at 5 % level of probability.

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Table 2. Effect of Mulch residue on plant height (cm) of maize in Makurdi during the 2017 season.

Treatment	Weeks After Planting 2 8 14		
Control	6.20	45.10	91.30
Dry grass (2 tons/ha)	8.40	48.80	97.50
Dry grass (4 tons/ha)	8.70	54.90	111.40
Sawdust (2 tons/ha)	9.40	57.50	119.90
Sawdust (4 tons/ha)	9.30	57.40	121.20
F-LSD$_{(0.05)}$	1.90	2.80	4.60

Stem girth

The residual effect of mulching on stem girth as presented in **Table 3** showed that at 2 WAP, the treatments were not significantly different from each other and even the control at 5% level of significance. At 8 WAP, no mulch application and 2 t/ha dry grass were not significantly different, but 4 t/ha dry grass, 2 t/ha sawdust and 4 t/ha sawdust were significantly higher than 2 t/ha dry grass and no mulch application (control).

Table 3. Effect of mulch residue on stem girth (cm) of maize in Makurdi during the 2017 season.

Treatment	Weeks After Planting 2 8 14		
Control	2.40	5.20	6.10
Dry grass (2 tons/ha)	2.10	5.80	7.10
Dry grass (4 tons/ha)	2.30	6.60	8.40
Sawdust (2 tons/ha)	1.90	7.86	9.20
Sawdust (4 tons/ha)	1.90	7.84	9.10
F-LSD$_{(0.05)}$	1.60(NS)	1.20	0.90

Dry matter yield (t/ha)

The residual effect of mulching on dry matter yield as presented in **Table 4** showed that all the treatments were significantly higher than the control. 4 t/ha dry grass and 2 t/ha sawdust were significantly higher than 2 t/ha dry grass and no mulch application, though 4 t/ha dry grass was not significantly different from 2 t/ha sawdust mulch application. The highest dry matter yield was observed at 4 t/ha sawdust mulching.

Table 4. Effect of Mulch residue on Dry Matter Yield (t/ha) of Maize in Makurdi during the 2017 season.

Treatment	16 Weeks After Planting
Control	3.10
Dry grass (2 tons/ha)	3.70
Dry grass (4 tons/ha)	4.20
Sawdust (2 tons/ha)	4.20
Sawdust (4 tons/ha)	4.60
F-LSD$_{(0.05)}$	0.30

Grain yield (t/ha)

The residual effect of mulching on grain yield as presented in **Table 5** which revealed that the highest grain yield was obtain at treatments 2 and 4 t/ha sawdust mulching. But they were not significantly different. 4 t/ha dry grass and 4 t/ha sawdust mulching were significantly different from no mulch application and 2 t/ha dry grass, though the no mulch application and 2 t/ha dry grass were not significantly different.

Table 5. Effect of Mulch residue on Grain Yield (t/ha) of Maize in Makurdi during the 2017 season.

Treatment	16 Weeks After Planting
Control	**0.70**
Dry grass (2tons/ha)	**0.80**
Dry grass (4 tons/ha)	**0.90**
Sawdust (2 tons/ha)	**1.10**
Sawdust (4 tons/ha)	**1.10**
F-LSD$_{(0.05)}$	**0.20**

DISCUSSION

In addition to soil surface protection, Lal [16] observed that when mulches decompose in the soil, they improve soil physical properties like bulk density, and porosity and increase chemical properties such as pH, organic matter, N, P, cation and base saturation. Tian et al. [17] confirmed that when organic mulches decompose, they increase soil organic matter content, CEC, enhance biological activity, improve soil structure and increase plant nutrients. Wuese [18] obtained higher soil nutrients when saw dust

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much was applied at the rate of 4-8 tha-1 in Makurdi under open and tied ridges as well as flat cultivation. There was decreased soil pH (tending towards neutrality), increased organic matter, Nitrogen, Phosphorus and cations as well as base saturation in the succeeding season. This means increased soil fertility which will eventually lead to higher crop yield when compared to unmatched plots. Lal [16] again observed higher soil fertility status and cation exchange capacity in mulched plots. He concluded that mulched plots usually have higher concentration of divalent cations on the exchange complex, more total nitrogen and available phosphorus than unmulched plots.

The decomposition of applied mulch materials such as chipped wood has been observed to increase soil fertility and maintain soil organic matter [19,20], and improve soil physical properties [21]. Antopegba et al. [22] confirmed that when mulches decompose, they release their inherent nutrient elements as seen in increased residual phosphorus in the succeeding season. They went further that mulch from *Gliricidia sepium* at 5 t/ha significantly increased crude protein, carbohydrates, nitrogen, phosphorus and ash content of maize grain in both years of cropping, thereby improving nutritional content of maize grain. This means that decomposition of mulch leads to higher crop performance in the following seasons.

CONCLUSION

This study has demonstrated that the residual effect of mulching either with saw dust or dead grasses goes beyond the first season after it is applied on the farm. That when biodegradable mulches decompose, they release their constituent nutrients in to the soil and these can be made available in the succeeding season(s) for crop use. 4 t/ha of sawdust mulch produced the highest number of leaves, plant height, stem girth and yield (biomass and grains) of maize in the study area, hence recommended. In the alternative, 4 t/ha of dry grass could serve the same purpose.

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