

EFFECT OF MULCHING WITH LEAVES OF *TREMA ORIENTALIS*, *GMELENA ARBOREA* AND *TERMINALIA CATAPA* ON MAIZE PERFORMANCE IN AN ACIDIC SOIL

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Abstract

This study is to assess the contribution of the leaf mulches of *Trema orientalis*, *Gmelina arborea* and *Terminalia catapa* to food productivity in an agroforestry system. It was conducted at the Teaching and Research Farm of Faculty of Agriculture, Delta State University, Asaba Campus. A completely randomized design with three replicates was employed. The following treatments were adopted; *T. orientalis* leaf mulch, *G. arborea* leaf mulch, *T. catapa* leaf mulch and control (topsoil). Results showed that there existed significant differences between the treatments vis-a-vis the height, collar diameter, leaf number and leaf area. The maximum maize plant heights of 120.8cm, 79.4cm and 65.1cm were given under the influence of *T. orientalis*, *G. arborea* and *T. catapa* leaf mulches respectively. The diameter and leaf number values also benefited greatly from the leaf mulches of these species. Also, the fresh weight values for maize plant under *T. orientalis* leaf mulch was higher than the rest. However, the root dry weight values for *T. orientalis* (6.8g) and *G. arborea* (5.9g) were not significantly different. It is recommended that our local farmers should utilize the leaf mulches of these species to enhance productivity where inorganic fertilizers are not available.

Keywords: Mulching, maize plant, soil sample, green manure

Introduction

Feeding the rapidly growing population in sub-Saharan African has become major development concern. Population is increasing in a region where paradoxically, the soils have low inherent fertility and are fragile, highly weathered and characterized by low activity clays with a low cation exchange capacity. They are also highly susceptible to crusting and compaction, run off, erosion and the leaching of plant nutrients. These limitations are aggravated by adverse weather condition, crop losses and pest damage (Okunomo, 1997).

Intensive farming in the western world relies heavily on pesticides and fertilizers. In contrast, traditional African farmers tackle the problems of fertile soils and pest attack essentially by practicing the shifting cultivation of mixed crop. This traditional system is stable and biologically efficient, provided that there is sufficient land to allow the long fallows that would restore soil fertility. Today however, because of demographic and economic changes, the cultivated area has expanded into marginal soil types and fallow periods are being reduced. This has resulted in the systemic degradation of target area of land and decline of yields.

Consequently, there is a need for integration of trees most especially the leguminous ones as green manure for incorporation into the soil in rotation with other crops and these can have several beneficial effects (Webster, 1992). Researchers are in agreement that leaf mulches improves soil chemical properties. The fertility status of the soil is usually improved when organic mulch material rot (Salan *et al* 1992). Bhaatt *et al* (2004), in submountaneous rain fed region of Punjab found that mulch spread on the whole plot increased the grain yield of maize by 60.50% as compared to unmulched control plots. Kluchinske *et al* (2004), in a three-year study found that a 7.5cm leaf depth incorporated twice with a chisel plough provided 40% surface residue. This according to them improved soil structure aggregation, retained more moisture in the spring and after rainfall. They added that crops in mulched plots showed reduced drought stress.

This study focuses on leaf mulches of *Trema orientalis*, *Gmelina arborea* and *Terminalia superba* as they affect growth and development of maize.

Materials and Methods

Study Area

The experiment was conducted behind the department of Forestry and Wildlife in Delta State

University, Asaba Campus. Asaba is under Oshimili South Local Government Area and it is located at latitude, 06°45'E, longitude 06°49'E, of the equator. Asaba lies in the tropical rainforest zone of Nigeria, a region with a moderate rainfall. Rainy season is usually between April and October, with an annual range of 1500mm to 1849.3mm. The mean temperature is 23.3%. The mean monthly sunshine 4.8 hours (Asaba meteorological station, 2003).

Procedure

The leaf mulches of *Trema orientalis*, *Terminalia catapa* and *Gmelina cirboreci* were collected from mother trees at different locations in Asaba Campus of Delta State University. The mulch samples (0.5g) from each species were incorporated into the soil, mixed thoroughly and left to decompose. This was examined periodically for about three weeks to ensure complete decomposition. The soil samples used were randomly collected from different location of the sampled area with a soil auger. They were sieved and 10kg of the sample were weighed into polythene pots using a weighing balance. Two maize seeds were sown and later thinned to one after emergence. There were four treatments in all namely: (1) *T. orientalis* leaf mulch; (2) *T. catapa* leaf mulch and (3) *Gmelina arborea* leaf mulch and (4) Control without leaf mulch. The experiment was arranged in a completely randomized design with three replicates and watered daily. The parameter of the maize plant assessed were height, collar diameter, leaf number and leaf area. The standing biomass of maize plants was also determined for all the treatments

Soil Analysis

Soil samples were randomly collected from different locations of the sampled area with a soil auger. The soils were bagged for air drying and crushing. Air dried and crushed samples were sieved through less than 2mm mesh and packed in well labeled air-tight bags for analysis. This analytical procedure was according to IITA (1979) monograph. The soil samples were analysed for particle size distribution by the hydrometer method, organic carbon by the modified wet oxidation procedure of Walkey and Black (1935). Soil pH was measured with glass electrode after making a 1:1 soil/water ratio suspension and determined electro-metrically with a pH meter. Total Nitrogen was determined by semi-micro Kjeldhal procedure. Cation exchange capacity(CEC) and exchangeable cation were determined by the procedure described by the IITA (1979), and the quality of Na⁺, k⁺ and Ca⁺⁺ determined by flame photometer while the contents of Mg, Zn, Cu, Fe and Mn were done using atomic absorption spectrophotometer. The available phosphorus was determined by Bray No 1 method and the extractant read on spectonic 70 at 882mm.

Plant Analysis

Sub sample of the leaf mulches of all the species adopted in this study were ground and analyzed for N, P, K, Mg, Ca following IITA analytical procedure.

Results and Discussion

Initial Nutrient status of soil samples are shown in Table 1. The soil is acidic as indicated by the pH of 4.8. Total N appears to be low while phosphorus is high. The Nutrient status of leaf mulch samples is shown in Table 2. Table 3 shows the variations in height, diameter, leaf number and leaf area of maize plants due to applications of leaf mulches of *Trema orientalis*, *Gmelina arborea*, and *Terminalia catapa*.

Height

In the second week after planting (WAP) no significant difference was observed in the effect of leaf mulches of *T. orientalis* and *G. arborea* on maize height as they gave 18.64cm and 18.42cm respectively but were significantly different from those of *T. catapa* and control treatment. The trend continued till about 8 WAP, however, the maximum height of 82.7cm at 8WAP was given by *T. orientalis*. Budelman (1988) opined that nutrients in decomposing leaf mass are released into the soil

and added to the nutrient stock in the upper strata of the soil. This is probably the case with *T. orientalis* as the rate of mineralization is very fast. The minimum height growth of maize was however recorded in the control, which could be due to lack of external source of nutrient. (Tillander, 1993).

Collar Diameter

At 2WAP, the highest diameter was recorded under *T. orientalis* leaf mulch treatment though not significantly different from the rest of the treatments. This could be due to the high nutrient content of its leaf biomass, which must have positively influenced the growth of the maize crop. The lowest diameter was given by the control treatment throughout the period of the study. This was probably as a result of a reduced assimilates contributing to vegetative growth which was enough to suppress vertical growth (Young 1997). There was no significant difference observed between the influence of leaf mulch application of *T. catapa* and that of control treatment on maize. The slower rate of leaf decomposition of *T. catapa* must have been responsible as also observed by Kramer and Kozowski, (1979), that if the rate of nutrient release is slow, annual crops may not be able to profit from the nutrients available in a mulch layer applied at the being of the cropping cycle.

Leaf Number

Significant differences were observed among the treatments from two weeks after plant to 6 WAP with the highest leaf number of 8.5 and lowest of 7.1 given by leaf biomass of *T. orientalis* and the control treatments respectively. Plant leaves play a paramount role in photosynthesis, which in turn depends on a rich well drained fertile soil; this probably explains better performance by maize plants under *T. orientalis* than other treatments. As also confirmed by Dale and Millthorpe (1983). For all elements except carbon, they opined that the development of leaf is totally dependent upon supply of nutrients from other parts of the plant, and ultimately on uptake from the soil. The insignificant differences observed between the control and treatments with *T. orientalis* and *G. arborea* mulches at 7 and 8WAP could be due to slow rates at which already accumulated ions are made available in order to buffer the effects of shortfall from the roots (Dale and Millthorpe (1983).

Fresh Weight of Maize Plant

Table 7 revealed that significant differences occurred only between *T. orientalis* leaf mulch treatment and other treatments including the control. The performance of maize plant under the leaf mulch of *T. orientalis* 40.2g (leaf); 96.8g (stem) and 42.1g (root). This is still an indication of its faster rate of leaf decomposition and mineralization.

Dry Weight of Maize Plant

A better index of the effect of leaf mulch on growth is probably dry matter accumulation as confirmed by Arnon (1974), that the first prerequisite for high crop yield is a high production of total dry matter per unit area. The amount of dry matter produced will depend on the effectiveness of photosynthesis of the crop and on the efficient functioning of other vital activities, which includes nutrient availability. The greater dry matter accumulation recorded for maize plant under influence of leaf mulches of *T. orientalis*, *G. arborea* and *T. catapa* might not be unconnected with more nitrogen released through decomposition.

Conclusion

The decomposition trials in this study provided weight into the agroforestry potentials of these species most especially the relatively unknown *Trema orientalis* of the four treatments considered only *T. orientalis* and *Gmelina arborea* showed promise in improving the growth and development of maize crop. *T. catapa* leaf mulch on the other hand did not contribute significantly to the growth and development of maize plants. The lower rate of mineralization was considered to be responsible for this. Its suitability for agroforestry is however, not in doubt as its high rate of litter production aptly satisfied the conditions required for agroforestry.

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Table 1: Initial Nutrient Status of the Soil Used for this Study

pH	Total N	Bray-1 Org. C	K	Ca	Mg	Na	Mil P	Zn	Cu	Fe	
4.8	0.05	-93.6	0.0	0.19	1.87	1.44	0.13	5.07	633	L2	L24L

Table 2: Nutrient Status of Mulch Samples

Leaves (Treatments)	(g/kg-IDin) (Nutrient concentration)				
	N	P	K	Mg	Ca
<i>Trema orientalis</i>	0.91	4.38	0.07	1.45	4.82
<i>Gmelina arborea</i>	0.82	5.42	0.09	1.32	5.27
<i>Terminalia superba</i>	0.61	4.82	0.03	0.91	4.21

Table 3: Mean Height Values of Maize Plants under Leaf Mulches of *T. orientalis*, *Gmelina arborea*, *Terminalia superba* and Control

Treatment	Weeks after sowing				
	2	4	6	8	10(cm)
T. orientalis	18.64 a	29.1a	43.1a	82.7a	120.8a
<i>G. arborea</i>	18.42a	28.1a	41.0a	68.2b	79.4b
T. catapa	12.48b	24.2a	38.7a	58.1b	65.1b
Control	12.12b	18.9b	18.7b	49.8c	55.4c

Means followed by the same letters are not significantly different

Table 4: Mean Collar Diameter Values of Maize Plants as Affected by Various Trees Leaf Mulches

Treatment	Weeks after sowing				
	2	4	6	8	10
<i>T. orientalis</i>	8.5a	14.2a	14.7a	15.1a	15.8a
<i>G. arborea</i>	7.5ab	12.8a	13.1a	13.8b	14.1b
T. catapa	7.3ab	10.6b	11.8b	12.4b	13.2b
Control	7.4ab	11.2b	11.7b	12.0b	12.9b

Means followed by the same letters are not significantly different.

Table 5: Mean Leaf Numbers of Maize Plants as Affected by Tree Leaf Mulches

Treatment	Weeks after sowing				
	2	4	6	8	10
<i>T. orientalis</i>	7.2a	8.2a	8.5a	9.2a	11.4a
<i>G. arborea</i>	7.0a	7.4b	7.9ab	8.4a	9.9 a
T. catapa	6.7ab	6.9b	7.4b	7.6ab	9.3ab
Control	6.4b	6.8c	7.1b	7.3ab	8.1ab

Means followed by the same letters are not significantly different.

Table 6: Mean Leaf Area Values of Maize Plants as Affected by Tree Leaf Mulches

Treatment	Weeks after sowing				
	2	4	6	8	10
<i>T. orientalis</i>	25.2a	60.1a	102.4a	125.1a	143.5a
<i>G. arborea</i>	28.1b	45.2b	85.1b	102.2a	132.1a
T. catapa	18.5c	43.1b	78.2b	96.1b	101.2b
Control	16.8c	35.8b	71.1b	84.2b	98.6b

Means followed by the same letters are not significantly different.

Table 7: Mean Fresh Weight of Maize Plant

Treatments	Leaf	Stem	Root
T. orientalis	40.2a	96.8a	42.1a
<i>G. arborea</i>	30.4b	72.4b	30.1b
T. catapa	31.2b	69.8b	• 28.2b
Control	28.9b	68..2b	21.0c

Table 8: Mean Dry Weight of Maize Plant

Treatments	Leaf	Stem	Root
T. orientalis	8.5a	9.4a	6.8a
<i>G. arborea</i>	6.2b	7.2b	5.9a
T. catapa	5.1b	6.8b	5.26
Control	4.8c	6.2b	4.1c