COMPARATIVE ANALYSIS OF THE LEAF MULCHES OF *GLIRICIDIA SEPIUM. SENNA SIAMEA, DELONIX REGIA* AND *AZAD1RACHTA INDICA* ON MAIZE PERFORMANCE

K. Okunomo, B.O. Bosah, and E.C. Enujeke

Abstract

A study was carried out to show the_comparative analysis of the leaf mulches of *Gliridia sepium, Delonix regia, Senna siamea* and *Azadirachta indica* on maize performance at the Teaching and Research Farm of Faculty of Agriculture, Delta State University, Asaba Campus, Asaba, Delta State University, Nigeria. There were five treatments in all namely: *G. sepium* leaf mulch, *D. regia* leaf mulch, *S. siamea* leaf mulch, *A. indica* leaf mulch and control (top soil). The statistical design adopted was a completely randomized design with three rcpiiciUes. Subsamples of the leaf mulches were analyzed for N,P_3K My and Ca. the parameters considered for maize plants were; height, leaf number, leaf area collar diameter, fresh and dry weight maize plant, and number of cobs. The result indicated that *Gliviadia septum* leaf mulches significantly withered the height of maize plant more than other treatments. At the final week of assessment. *G. sepium* produced maximum height of 220.50cm, which D. *regia. S. siamea, A. indica* and control treatments gave 175.20cm, 210.10cm, 165.20cm and 190.40cm respectively. They were significantly different from each other at $P<0.05$. other parameters followed similar trend except for maize collar diameter where no significant difference was observed. *G. sepium* also gave the highest dry mailer accumulation for leaf (10.2g), stem (19.8g) and Root 8.8g. this was followed by *Senna siamea* which gave leaf (7.9g); stem (14.3g) and root (8.0g). The results obtained showed that *G. sepium* and *S. siamea* performed better than (he rest treatments. It is therefore recommended that they should be adopted by our local farmers to increase food production.

Keywords: fertilizer, leguminous tree, leaf mulch, maize plant, plant analysis

Introduction

Forestry plays a vital role in global food security, providing food, fodder, fuel and medicine (Kio, 2000). Trees and forest influence both their immediate surroundings and to help provide the stable environmental condition on which sustainable agriculture depends.

Nigeria as a country has not reached the level of food sufficiency. Food sufficiency is a state of affair in which a nation or household is able to satisfy its food requirement from their own food production activities without recourse to augmentation through food import, transfers or other external supply facilities. If the increasing need for food and fibre in this country is to be met, more land must be cleared for agricultural use. This has often led to high rate of deforestation, reduction in soil fertility and a decline in the yield of crops. At this stage, soil may no longer have the capacity to sustain long term agricultural production. The use of commercial fertilizer to replenish nutrients in cultivated soil is minimal on the Africa continent because most fanners cannot afford the cost. In addition, most tropical soils have low cation exchangeable capacities. In this context, management of residues is critically important in keeping the soil supplied with essential nutrients.

Fertilizers are the only viable alternatives in this case. They are however costly and continued high rates of use led to environmental problems. Also, large numbers of poor farmers imply cannot afford high levels of fertilizers and other purchased input nor do they have the capital to take on the risk, which these involve. Growing trees most especially the leguminous ones as green manure for incorporation into the soil in rotation with other crops can have several beneficial effects (Webster, 1992). Due to their ability to fix nitrogen, and their high content of essential elements, legumes are more effective than non-legumes. There is evidence that some tree leave mulches increase the availability of other elements in the soil especially phosphorus. Ojeniyi, *et al* (1980), stated that when maize, yam and cassava was, alley cropped with *Gmelina arborea*, soil nitrogen and phosphorus increased while the total exchangeable base was not affected. Little or no attempt has been made to empirically determine the influence of the tree mulches of these various species - *Gliviadia sepium, Delonix regia, Azadirachta indica* and *Senna siamea* on crop performance in this part of agro ecological zone in Nigeria. Consequently, this study is set out to accomplish this task.

Materials and Methods

The experiment was conducted at the Teaching and Research farm of faculty of Agriculture, Delta State University, Asaba Campus, Asaba. Delta State, Nigeria. Asaba is in Oshmili South local government area and it is located at latitude 06°46 E, longitude 06°49'E, of the equator. Asaba has in the tropical rain forest zone of Nigeria, a region with moderate rainfall. Rainy season is usually between April and October, with an annual range of 1,500m to 1849.3mm. The mean temperature is 23.3°C. The mean monthly soil temperature at 100cm depth is 28.3°C and monthly sunshine is 4.8 hours (Asaba meteorological station, 2004).

Procedure

Topsoil collected from Delta State University, Asaba campus was sieved and 10kg of the soil samples were weighed into polyethene pots with the aid of a weighing balance. There were five treatments in all as follows: (1) *Gliricidia sepium* leaf mulch, (2) *Delonix regia* leaf mulch (3) *Senna siamea* leaf mulch; (4) *Azadirachta indica* leaf mulch and (5) control (without leaf mulch). The experiment was arranged in a completely randomized design with three replicates. Each replicate had five treatments making a total of 15 pots distributed in the site. Sowing was done using the composite variety of maize (Downy mildew resistant variety - Yellow) with three seeds per pot, which were later thinned to two per stand after germination was noticed. There were 30 maize plants in all the pots.

Soil Analysis

Soil samples were randomly collected from different location of the sampled area with a soil auger. The soil samples were bagged for air-drying and crushing. Air-dried and crushed soil samples were sieved through less than 2mm mesh and packed in labeled airtight bags for analysis.

Analytical Procedure

Analytical procedure was according to IITA (1979). The soil samples were analyzed for particle size distribution by the hydrometer method, organic carbon by the modified wet oxidation procedure of Walkey and Black (1934). Soil pH was measured with glass electrode after making a 1:1 soil (water ratio suspension and determined electrometrically with a pH meter. Total Nitrogen was determined by Semi-micro kjehdal procedure. Cation Exchange Capacity (CEC) and Exchangeable cation were determined by the procedure described by the IITA analytical procedure 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 as described by KTA analytical procedure and the extractant read on specfromic 70 at 882nm.

Plant Analysis

Sub-sample of the leaf mulches of all the tree species that were adopted in this study were ground and analyzed for N.P.K Mg, Ca following the analytical procedure used by IITA (1979).

Mulching

Mulching with the leaves vv-is done one week after germination using 6 kilograms of each of [he green leaves of G. *sepium, A. indica, S. siamea* and *D. regia* on different pots chosen at random from the study area. Samples of leaf of mulch of the four different species were applied on four pots and the fifth pot was without mulch, which w;;s used as the control. The pots were watered immediately after planting and every other day Tor a period of six weeks, which aided the decomposition of the mulch samples.

Data Collection

Data were collected at one week after germination and from the time of mulch application; .The maize plants were harvested ?.,; 13 weeks old by carefully destroying the polythene bags and avoiding damage to the roots and shoot. The root to shoot ratio was also determined by measuring the length of the root and the shoot.

The parameters measured were plant height (cm); leaf area (cm^2); leaf numbers, collar diameter(mm), fresh and dry weight (g). The data collected were subjected to analysis of variance and the treatment means were separated using Duncan Multiple range Test.

Results

Plant

Height

The. variation in height of maize plant as influenced by the leaf mulches of all these species can be seen in Table 3.

In the first week after planting, no significant difference was observed in the effects of leaf mulches of *G. sepium* and *S. siamea* on maize height as they gave 11.82cm and 10.93cm respectively but were significantly different from 9.73cm recorded by control, 9.20cm given by *D. regia* and 8.77cm by *A. indica.* At 3 WAP, *G. sepium* gave the best performance of 24.33cm followed by 5. *siamea* which gave 22.93cm. There was no significant difference between them. The positive response of maize plant to nitrogen contribution from *G. sepium* leaf mulch became more pronounced at 5th to 9th WAP. The values obtained under *G. sepium* mulch were much higher than those of other treatments. This trend continued throughout the study period.

Leaf Area

From the results shown in Table 4, it is evident that the mean leaf area of values of maize plants grown in *G. sepium, S. siamea* and control treatments were not significantly different from those grown in *D. regia* and *A. indica* leaf mulches at 1 WAP. This trend continued till the 4WAP. At 6 and 10 WAP, the mean leaf area values of maize plants under G. sepium treatments were significantly different from those of other treatments. At 10 WAP planting the mean values were in this order I47.0cm2 > 128.9cm^2 > 123.9cm^2 > 120.7cm^2 > 118.8cm^2; given by *G. sepium. Senna siamea,* control, *D. regia* and *Azadirachta indica* treatments respectively. At 11 to 13 WAP, the trend still remained the same.

Leaf Number

The results in Table 5 indicated that there was no significant difference among the treatments in their respective leaf numbers at 1 - 2 WAP. At 3 WAP, there was a significant different between the leaf numbers of *G, sepium* and other treatments. *G. sepium* leaf mulch gave the highest mean leaf number values of maize plant which was 7.3 at this time. There was no significant difference among all the other treatments in this week. From the fourth week after planting to the eight weeks after planting significant differences were observed among all the treatments. However, *G. sepium* leaf mulch still gave the highest value of 12.7; while *D. regia* had 1 1.0; *S. siamea* 12.0; A *indica* 10.3; and the control treatment 11.3.

Collar Diameter

Table 6 shows the mean collar diameter values of maize plant. As expected, addition of leaf mulches significantly increased the collar diameter of maize plants. However, G. *sepium* treatment produced 1.0mm and l.lmm collar diameter at 1 and 2 WAP respectively and were significantly different from the other treatments. *S. siamea* at 1WAP gave a value of 0.9mm which was the same with the control. The analysis of variance indicated that there was no significant difference among the treatments. There were significant differences among the treatments from 2 - 6 WAP, however G. *sepuim* gave the highest values of 2.1mm. Finally, from 7-13 WAP, the analysis of variance showed that there was no significant difference among the treatments.

Fresh weight of Maize Plant

Table 7 shows the mean fresh weight of maize plant. Statistical analysis revealed that there was no significant difference among G. *sepium* and *S. siamea* leaf fresh weights. They gave 59.4g and 56.4g respectively. As regards the stem fresh weight. G. *sepium* gave the highest value of 150g followed by *S. siamea* treatment with 116.5g, next to this was *A. indica* with a value 112.7 g. The control treatments gave 86.8g while the least value of 76.3g fresh weight of maize stem was recorded under *D. regia* treatment.

The highest accumulation of root fresh weight of maize plant was observed under *S. siamea* leaf mulch with a value of 84.3g. This was followed by G. *sepium* leaf mulch which recorded 60.Og. The control and *A. indica* treatments gave 34.7g and 30.0g respectively, while the lowest root fresh weight of 24.2g was given by *D. regia* leaf mulch.

Dry Weight of Maize Plants

Table 8 gives the Mean Dry Weight of Maize Plants. Analysis of variance showed that there was no significant difference between G. *sepium* and control treatment, but was significantly different from *D. regia, A. indica* and *S. siamea* treatment which gave the lowest value of 2.7g.

Analysis of variance for stem dry weight showed that G. *sepium* treatment was significantly different from the other treatment as it gave the highest value of 19.8g. However, *S. siamea* and control treatments did not differ significantly from each other but were significantly different from *D. regia* and *A. indica* treatments.

As regards the root dry weight, analysis of variance showed that there was no significant difference between G. *sepium* and *S. siamea* leaf on their influence on dry matter production by maize plants, but were significantly different from the other treatments. The values are 8.5g > 8.0g > 3.1g >2.Sg > 2.7g for *(j. septum, S. siamea, A. indica, I), regia* and control treatments respectively.

Discussion

The result obtained in this study indicated that *Gliricida septum* has some soil improvement characteristics as there was a steady increase in plant height throughout the growing period. This increase proved superior to the *S, siamea* leaf mulch even though there were insignificant differences in height. This result is in agreement with Kamara (1995), that maize plant height is not significant!}" affected by mulch management but generally maize height is better in the mulched treatment than in the unmulched (control) plots. Surprisingly, the control treatment was significantly different from *D. regia* and *A. indica* leaf mulches ;v; control recorded higher values. The higher value given by the control treatment could be due to the fact that the top soil contained high amount of phosphorus which probably contributed to the height of maize plants. This is in line with the findings of Budelman (1995), that a mulch layer in a cropping system behaves in a similar fashion as litters found in an ecosystem, li follows that the organic material slowly decomposes and partly becomes introduced into the soil. Nutrient in the decomposing leaf mass area are released in that process and added to the nutrient stock in the upper strata of the soil. If the release is fast, nutrient may become lost through leaching or volatilization (e.g. nitrogen in the form of ammonia). On the other hand, if the nutrients release is slow, annual crops may not be able to profit from the nutrients available in a mulch layer applied at the beginning of the cropping cycle, which, was probably the case *of A. indica* and *D. regia.*

From the result in table 4, the G. *sepium* leaf area showed a more positive variation from the other treatments as it was significantly different from them by having the highest value throughout the study period. Although, from the first to the third week after planting, there was no significant difference between *G. sepium, S. siamea* and control- Plant leaves pay a paramount role in photosynthesis which in turn depend on a rich well drained fertile soil. For all elements except carbon. Dale and Millthorp (1989), 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. According to them. Leaf growth will therefore be affected by root growth and performance; so that condition which affect root function, such as low soil temperature, soil moisture and nutrient stress also influence leaf expansion. The fact that there was no significant difference between the control treatment, *S. siamea, D- regia* and *A. indica* treatments could be due to the slow rate at which already accumulated ions are made available in order to buffer the effects of shortfall from the roots. Similar reasons could be adduced for the non-significant difference observed between *S. siamea* and G. *sepium* leaf mulches on their effect on leaf numbers of maize plants.

Plants grow in height and diameter through the activity of the meristematic tissue which in turn is a function of nutrient availability through the soil. The highest collar diameter recorded under *G. sepium* leaf mulch treatments could be due to the high nutrient contents of its leaf bioinass which must have positively influenced the growth of the maize plant.

As regards fresh weight of leaf in maize plants, G. *sepium* recorded the highest value as usual, followed by *S. siamea.* The relatively high performance recorded under G. *sepium* treatment is an indication of the effectiveness of these species in an agroforestry system as also confirmed by Tonye (1995).

A better index of the effect of leaf mulch on growth is probably dry matter accumulation as confirmed by Arnon (1994), that the first prerequisite for high crop yields is a high production of total dry matter per unit area. The amount of dry matter produced can therefore be said to depend on the effectiveness of photosynthesis of the crop and on the efficient functioning of other vital activities which includes nutrient availability. The higher maize dry weights recorded under the influence of *G. septum* leaf mulches lend credence to the above assertion.

The highest number of cobs were recorded for maize plants given in G. *sepium* and *S. siamea* treatments. However, maize plants that could not produce cobs as at the time of harvesting tasseled. This implies that there was every tendency that they probably would have produced cobs if they were left for a longer period.

The higher plant height, leaf area, leaf number, collar diameter, fresh weight of leaf, stem and root and dry weight of leaf, stem and root values observed under *G. sepium* treatment than other treatments is an indication of the potential of this species to improve fertility of the soil and eventually enhance crop productivity. This is in consonance with the findings of Polthanee and Wannapat (2000), that leaf mulch application significantly increased the leaf area per plant, total top dry weight, root dry weight per plant and seed yield of cowpea.

Conclusion

It is evident from this study, that the role of G. sepmm~leaf mulches in enhancing food production is apparently undebatable judging from the quantitative result presented. Leaf mulch of G. *sepium* significantly affected the performance of maize plants and in most of the parameters measured. In other words, G. *sepium* is potentially suitable as a multipurpose tree. Also, the performance of maize recorded under *S. siamea* is enough justification of its capability to boost food production. These trees are leguminous trees which are known to be nitrogen fixing as they achieve efficient nutrient cycling and a degree of sustainability through decomposition of leaf letter produced by them in considerable quantity.

References

Arnon, I. (1994). Mineral Nutrition of Maize. International Potash Institute. Switzerland. 385pp

Asaba Meteorological Station (2004). National Meteorlogical Report. In Meteorological Bulletin, (2004) Lagos Nigeria.

Budelman, A. (1998). The Decomposition of the Leaf Mulches of *Leucaena leucociphala Gliricidia sepium* and *Flemingia macrophylla* under Humid Tropical Conditions. Agroforestry System 7(1) 35-45.

Dale, I.E. and F.L. Milthorpe (1999). General Features of the Production and Growth of Leaves. In J.E. Date and F.L. Milthorpe (eds.). The Growth and Functioning of Leaves. Cambridge University Press, Britain.

HTA. (1979). Selected Methods for Soil and Plant Analysis. International Institute of Tropical Agriculture (1979). 70p.

Kamara, A.V. (1995). Role of Mulches from Some Selected Nitrogen Fixing Trees, Effects on Weeds, Crop Growth Yield, in a Maize Based Cropping System in Sierra Leone. Institute of Agricultural Research. Freetown Sierra Leone.

Kio, P.R.O. (2000). Forestry and Sustainable Agricultural Development. Paper Presented at a 'National Workshop on Enhancing Research and Development in Agriculture and Forestry Toward Poverty Alleviation and Rural Development in Nigeria. FRIN, Feb 2000.

Ojeniyi, S.O.; Agbedc, O.O. and Foghenro, J,A. (1980). Increasing Food Production in Nigeria. Effect of Agriculture on Soil Chemical Properties. Soil Science !30(2) 76-82,

Polthanee, A. and Wannapat S. (2000). Tillage and Mulch Effects on Growth and Yield of Cowpea. Natural Science. 34:197 - 204.

Tonye, J.K. (1995). Effects of Plant Density on *Leucaena* and *Gliricadia* Productivity and Alley Cropped Yields, In Alley Farming Research and Development. B.T. Kang, A.O. Osiname and A. Larbi (eds) A Proceeding of the International Conference on Alley Farming. Ibadan Nigeria.

Walkey, A. and I.A. Black *(1934';*. An Examination of the Degtjareff Method for Determining Soil Organic Matter and a Propose;, Chronic Acid Titration Method. Soil Sci. 37:29-34.

Webster, C. and Wilson P.M. (19!'2). Agriculture in the Tropics. Longman, Singapore Publisher? PTC. Ltd. 209-2I2p.

Table 1: Initial Soil Nutrient Status

Particle size distribution (%)		
Sand		73.0
Silt	-	11.1
Clay		15.9
Texture - Sand clay		
Soil pH	4.9	
Organic matter	0.12kg"^{1}	
Total nitrogen	0.05gkg"^{1}	
Available P		9.36 mgkg"^{1}
Exchangeable cations (cmolkg"^{1})		
Ca^		1.86
Mg^{Jf}		1.43
K+		0.18
Na+		0.12
CEC		8.65
Micro - Nutriutiori (mg/g)		
Zn^{+H}*	-	5.56
Cu^{iA}		1.2
Fe^{f+}		5.92
Mn^{t+}		5.06

Table 2: Nutrient Status ofMulch Samples

Leaves (Treatments)	(gkg-IDm) Nutrient Concentration				
	N	P	K	Mg	Ca
G. sepium	1.75	5.37	0.08	1.75	6.34
D. regia	0,53	6.43	0.05	1.26	4.88
S. siamea	1.68	6.27	0.04	1.65	7.24
A. indica	0.42	4.52	0.06	0.75	4.60

	Weeks After Planting												
	1	2	3	4	5	6	7	8	9	10	11	12	13
G. sepium	13.7a	24.4a	34.3a	59.8a	80.5a	93.6a	106.4a	117.2a	128.4a	147.0a	169.0a	182.5a	200.4a
D. regia	101b	20.5b	28.4b	41.2c	63.2b	73.4b	82.9b	92.6b	107.3b	120.7b	120.9c	137.2c	158.4c
S. siamea	11.6b	23.1a	31.5a	49.4b	67.1b	78.8b	86.2b	98.4b	112.1b	128.9b	146.7b	167.0b	179.9b
A. indica	7.50b	14.4b	28.7b	43.4c	54.3a	73.5b	83.4b	94.9b	106.7b	118.8c	132.2bc	155.7bc	177.2b
Control	13.4a	21.9a	30.8c	46.2b	66.6b	79.9b	84.5b	92.5b	107.4b	123.9b	142.6b	162.7b	175.7b

Means of the same letters are not significantly different from each other at P = 0.05 level of significant.

Table 5: mean values of leaf numbers of maize plants

Treatment	Weeks After Planting												
	1	2	3	4	5	6	7	8	9	10	11	12	13
G. sepium	5.0a	5.3a	7.3a	8.0a	9.0a	10.0ab	11.7a	12.7a	14.7a	16.0a	16.7a	17.0a	17.7a
D. regia	3.7a	4.0a	5.3b	6.3a	7.3ab	8.3ab	9.7ab	11.0ab	11.7b	13.3b	13.3a	13.7b	14.3b
S. siamea	4.3a	5.0a	5.3b	7.3a	8.3a	9.7a	11.0a	12.0a	13.7a	15.7a	16.3a	17.3a	18.3a
A. indica	3.3a	4.7a	4.7a	5.3a	60b	8.0b	9.3b	10.3b	11.0b	12.3b	12.7a	13.3b	14.0b
Control	4.3a	4.7a	5.0b	6.7ab	7.7ab	8.7ab	10.0a	11.3ab	12.7ab	14.7ab	15.3a	16.0ab	16.7ab

Means of the same letters are not significantly different at P = 0.05

Table 6: Mean values of collar diameter of maize planting

Treatment	Weeks After Planting												
	1	2	3	4	5	6	7	8	9	10	11	12	13
G. septum	1.0a	1.1.a	1.4a	1.7a	2.0a	2.1a	2.2a	2.2a	2.4a	2.6a	2.7a	3.0a	3.1a
D. regia	0.7b	I.0a	1.2b	1.5b	1.6b	1.96b	2.1a	2.1a	2.3a	2.5a	*2.6s*	3.0a	3. la
S. siamea	0.9ab	i.0a	13a	1.5b	1.7b	1.9b	2. la	2.! a	2.3a	2.5a	2.7a	3.0n	3. la
A. indie a	0.7a	0.9a	1.1b	1:3c	1.56	].9b	2.1a	2.!a	2.3a	2.5a	2.6a	3.0a	3. la
Control	0.9ab	I.0a	1.3a	1.5b	1.7b	1.9b	2.1a ,	-	2.3a	2.5a	2.6a	3.0a	3. la

Means of the same letters are not significantly different at P = 0.05

Table 7: Mean fresh weight of maize plant

Treatments	Leaf	Stem	Root
G. sepiiun	59. 4a	150.0a	60.0b
D. regia	43.4b	76.3c	24.2c
S. siamea	56.4a	116.5b	84.3a
A. indie a	47.7b	112. 7b	30.0c
Control	38.4c	86.8c	34.7c

Table 8: Mean *Dry* weight of Maize Plants

Treatments	Leaf	Stem	Root
G. sepium	10.2a	19.8a	8.5a
D. regia	6.7b	8.8c	2.8b
S. siamea	7.9a	14.3b	8.0a
A. indica	6.4b	17.7c	3.16
Control	7.8a	12.6b	2.7b

Mean of the same letters are not significantly different.