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Effect of Gliricidia Pruning on Soil and Plant Nutrient Status and Yield of Cowpea

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Abstract: Field trials were conducted in Southwest Nigeria to determine fertilizing effect of pruning of *Gliricidia sepium* on cowpea (*Vigna unguiculata* Walps). Pruning of gliricidia was applied at 0, 2, 4, 6, 8 and 10 t ha^{-1} as mulch. Soil fertility status and nutrient status and yield of cowpea given by the treatments were evaluated. Soil organic matter, N, P, K, Ca Mg and leaf N, P, K, Ca Mg and pod and grain yield of cowpea increased with amount of pruning. Relative to control 2, 4, 6, 8 and 10 t ha^{-1} pruning increased seed weight by 23, 97, 165, 201 and 218%, respectively.

Key words: Fertilizing effects, Gliricidia, pruning, mulch, fertility status, nutrient status and seed weight

INTRODUCTION

The most important food grain legume in Africa is cowpea (*Vigna unguiculata walps*). Farmers do not normally apply fertilizers in cowpea production because of its ability to fix atmospheric N and tolerates low soil fertility. Therefore soils grown to cowpea often have low amounts of N which may be inadequate to satisfy the crop need for N during hunger periods when nodules are developing (Chunke *et al*., 2000). Hence application of starter N at 15-20 kg ha^{-1} has been suggested (Saginga *et al*., 1988; Agbenin *et al*., 1990). Also increases in nodulation and grain yield have been recorded on continuously cropped soils given supplemental P, K and Ca in Nigeria (IITA, 1982). According to Babalola (2000) supplemental N and other essential nutrients such as Zn and Mn essential for nodulation be supplied through organic manure such as plant residues. Investigation into these organic sources is necessitated by high cost and scarcity of chemical fertilizers. A green house study showed that application of soyabean (*Glycine max*) residue to soil improved growth and yield of cowpea and uptake of N, P and K and soil status of organic matter, N, P and K and soil status of organic matter, N, P and K (Babalola, 2000). *Gliricidia sepium*, is a leguminous shrub growing luxuriantly in the tropics where it is grown as shade and fence trees for the supply of stakes in yam production (Budelman, 1990). The leaves and soft stem are pruned and left on soil. These residues on decomposition release nutrients. Hence mulch of pruning of Gliricidia was found to increase yield of yam, maize and cassava (Budelman, 1989; Kang *et al*., 1984; Ano *et al*., 2001). The hypothesis is that as source of N and other nutrients, pruning of gliricidia could be used to improve yield and nutrient status of cowpea. This research investigates the effect of pruning of gliricidia on soil fertility, nutrient status and yield of cowpea at Akure, Southwest Nigeria.

MATERIALS AND METHODS

Field Experiments

Two field trials were conducted at Akure in the rainforest zone of Nigeria on slightly acidic, skeletal, Clay Kaolinitic, Oxic Tropuldalf. The sandy loam soil was manually cleared from three-year

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fallow after being cropped to maize and cassava for six years without fertilizer. Gliricidia pruning was applied to cowpea stands as mulch at 0, 2, 4, 6, 8 and 10 t ha^{-1}. Mulch treatments were replicated three times in a randomized complete block design and used in two trials. Cowpea seeds were planted in June and September 2002 for early and late crops, respectively. Three seeds were planted per hill but later thinned to one seedling. Spacing was 0.60×0.60 m in each 9 m^2 plot. Data on air-dried pod weight and number of pods were accumulated using 7 plants per plot. Weight of 100 seeds (12% moisture content) were taken after final harvest.

Soil Analysis

Surface (0-15 cm) were soil samples collected around plants in each plot after harvest in August, 2002. Samples were air-dried and sieved using 2 mm sieve. Samples were analyzed as described by Tel (1984). Total N was determined by kjeldahal method. Available P was extracted using Bray-P1 solution followed by blue calorimetry. Exchangeable K, Ca and Mg were extracted using ammonium acetate. K was determined using flame photometer and Ca and Mg by EDTA titration. Soil pH in 1:2 soil water suspension was determined. Organic Matter (OM) was determined using dichromate method.

Leaf Analysis

Cowpea leaf samples collected at flowering were oven-dried for 24 h at 700C and milled. Other nutrients were extracted using nitric-perchloric acid mixture (Tel, 1984). P was determined using molybdenum blue colorimetry, K was evaluated using flame photometer and Ca and Mg by EDTA titration.

RESULT AND DISCUSSION

Table 1 has data on soil chemical analysis as influenced by gliricidia mulching treatments. Mulch increased soil OM, total N, available P and exchangeable K, Ca and Mg and pH. These parameters tended to increase with amount of mulch. It is implied that gliricidia pruning added nutrients to soil and reduced soil acidity.

Table 1: Effect of Gliricidia mulch on soil composition in 2002 (Cowpea trial)

Mulch (t ha^{-1})	OM (%)	N	P (mg kg^{-1})	K	Ca (Cmol/kg-)	Mg	pH (water)
0	1.1^a	0.18^a	14.8^a	0.07^a	3.8^a	0.61^a	6.5^a
2	2.5^b	0.26^b	23.1^b	0.09^a	4.7^b	0.90^a	6.8^a
4	2.8^b	0.27^b	28.1^c	0.10^a	5.6^c	1.16^b	7.2^b
6	2.8^b	0.29^b	34.9^d	0.11^b	5.6^c	1.43^b	7.3^b
8	3.0^b	0.32^b	37.3^d	0.14^b	5.8^c	1.46^b	7.4^b
10	3.6^c	0.37^c	39.4^d	0.16^c	5.9^c	2.04^c	7.4^b

Values followed by the same letter(s) are not significantly different at p = 0.05

Table 2: Effect of Gliricidia mulch on leaf composition of cowpea (%)

Mulch	N		P		K		Ca		Mg	
(t ha^{-1})	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
0	2.4^a	2.1^a	0.31^a	0.26^a	2.1^a	2.2^a	0.42^a	0.44^a	0.14^a	0.16^a
2	4.2^b	5.1^b	0.37^b	0.48^b	2.8^b	3.1^b	0.69^b	0.72^b	0.14^a	0.16^a
4	4.6^c	5.2^b	0.39^c	0.48^b	3.1^b	3.4^c	0.79^b	0.98^c	0.26^b	0.32^b
6	4.9^c	5.7^c	0.47^d	0.50^b	3.1^b	3.5^c	0.85^c	1.20^d	0.33^c	0.39^c
8	5.4^d	6.1^c	0.60^e	0.53^b	4.0^c	4.2^d	0.90^c	1.23^d	0.35^c	0.46^d
10	5.9^e	6.1^c	0.90^f	0.59^c	4.7^d	4.2^d	1.07^d	1.40^d	0.46^d	0.51^d

Values followed by the same letter(s) are not significantly different at p = 0.05

Table 3: Effect of Gliricidia mulch on cowpea yield

Mulch ($t\ ha^{-1}$)	Pod weight/plant		Pods/plant		Weight of 100 seeds (g)	
	2001	2002	2001	2002	2001	2002
0	30.4[a]	39.4[a]	15.6[a]	17.6[a]	26.9[a]	29.1[a]
2	43.6[b]	49.7[b]	17.1[a]	27.9[b]	30.1[a]	38.9[a]
4	56.3[c]	70.2[c]	27.1[b]	32.6[b]	50.1[b]	60.1[b]
6	68.7[d]	78.5[c]	36.2[c]	42.4[c]	75.4[c]	72.8[c]
8	70.5[d]	82.3[d]	43.5[d]	47.5[c]	82.4[d]	86.4[d]
10	87.9[e]	90.6[e]	47.2[d]	49.2[d]	89.1[e]	89.1[d]

Values followed by the same letter(s) are not significantly different at $p = 0.05$

Table 2 shows nutrient analysis of cowpea leaf. Leaf N, P, K, Ca and Mg status tended to increase with amount of gliricidia pruning especially as from 4 t ha^{-1}. Hence the highest amount of pruning (10 t ha^{-1}) which gave highest soil OM and nutrient of content, gave highest leaf nutrient status. The 2 t ha^{-1} pruning also improved leaf N, P, K and Ca status.

Table 3 shows data on Cowpea yield components as given by gliricidia mulch treatments. As in case of soil and leaf nutrient content, pod weight, seed weight and number of pods tended to increase with amount of mulch. Hence mulch applied at 10 t ha^{-1} gave the highest number of pods and seed weight. However the 8 t ha^{-1} mulch was optimum for cowpea. Relative to control, it increased cowpea yield significantly ($p = 0.05$). There was no significant difference in yield given by 8 and 10 t ha^{-1} mulch.

Relative to control, the 2, 4, 6, 8 and 10 t ha^{-1} mulch increased mean weight of 100 cowpea seeds by 23, 97, 165, 201 and 18%, respectively.

The finding that soil fertility increased with amount of gliricidia mulch corroborates earlier findings that leguminous shrubs as Gliricidia and Leucaena are source of utilizable N, K and OM for crops Kang *et al*., 1984; Budelman, 1989; Ano *et al*., 2001). Apart from supplying OM, N and K to soil, the present work shows that gliricidia pruning also increased soil P, K, Ca and Mg and their availability to cowpea. Therefore gliricidia pruning is an effective source of nutrients and OM for enhancing yield of cowpea. Analysis of nutrient composition of leaf pruning of Gliricidia grown on sandy loam Oxin Paleostalf at Ibadan, Southwest Nigeria showed that it had 4.2%N, 0.29%P, 3.43%K, 1.40%Ca and 0.40%Mg (Kang *et al*., 1984). The finding that gliricidia pruning also raised soil pH is consistent with increased availability of cations.

The finding that 10 t ha^{-1} pruning gave highest soil and plant nutrient status and yield of cowpea is consistent with that of Mulongoy *et al*. (1993) who found that largest quantity of gliricidia pruning gave highest, aize leaf N content and yield.

CONCLUSIONS

Pruning of *Gliricidia sepium* applied at between 4 to 10 t ha^{-1} was effective in increasing soil pH and nutrient content, yield and plant nutrient status of cowpea. Soil fertility, nutrient status and yield components of cowpea increased with amount of pruning up to 10 t ha^{-1}. Gliricidia pruning applied as mulch was effective in improving nutrient availability and yield of cowpea.

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