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EFFECT OF TAKING A FODDER CROP ON MAIZE GRAIN YIELD AND SOIL CHEMICAL PROPERTIES IN LEUCAENA AND GLIRICIDIA ALLEY FARMING SYSTEMS IN WESTERN NIGERIA

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SUMMARY

The effect of managing hedgerow foliage for mulch and fodder in *Leucaena leucocephala* and *Gliricidia sepium* alley farming systems on maize grain yield and soil chemical characteristics was studied in on-station and on-farm experiments in southwestern Nigeria. Yields increased as the proportion of mulch applied increased but the extra increases obtained when more than half the foliage was applied as mulch were relatively small, suggesting that half the foliage may be removed as feed without detrimental effect. Soil organic carbon, nitrogen and available phosphorus tended to increase with increasing proportion of prunings applied as mulch.

Follaje para 'mulch' y forraje en la agricultura de sendero

RESUMEN

En experimentos efectuados en la estación y en fincas del sudoeste de Nigeria se estudió el efecto de utilizar el follaje de seto vivo para 'mulch' y forraje en sistemas agrícolas de sendero con *Leucaena leucocephala* y *Gliricidia sepium* en el rendimiento de grano de maíz y las características químicas del suelo. El rendimiento aumentó con el aumento de 'mulch' aplicada, pero el incremento activo obtenido cuando más de la mitad del follaje se aplicó como 'mulch' fue relativamente pequeño, lo cual sugiere que la mitad del follaje puede utilizarse como forraje sin efectos adversos para el cultivo. El carbono orgánico, nitrógeno y fósforo disponible en el suelo tendieron a aumentar con una mayor proporción de ramas podadas usadas como 'mulch'.

INTRODUCTION

Alley cropping, an agroforestry system in which food crops are grown in alleys formed by hedgerows of multi-purpose trees or shrubs, was developed to reduce or eliminate the long fallow periods characteristic of traditional shifting cultivation systems, by sustaining soil fertility and crop yields under continuous cultivation (Kang *et al.*, 1984; Atta-Krah and Kang, 1990). Agronomic and soil fertility aspects of alley cropping have been extensively studied (Kang *et al.*, 1981, 1990; Atta-Krah, 1990; Siaw *et al.*, 1991). Okali and Sumberg (1986) suggested that a proportion of the hedgerow foliage in alley cropping might be used as feed for livestock. If this is done, the package of crops, trees and livestock is referred to as alley farming, rather than alley cropping (Kang *et al.*, 1990). Thus in alley farming, tree foliage can be used either for soil fertility maintenance or as feed for livestock.

The removal of foliage for animal feed means there is less mulch available for soil fertility maintenance and consequently reduced crop yields. The extent of crop yield reduction depends on the proportion of the total hedgerow foliage retained as mulch. This paper reports on-station and on-farm studies of the changes in maize grain yields and soil chemical properties that result when different proportions of prunings from *Leucaena leucocephala* and *Gliricidia sepium* alley farming are applied as mulch.

MATERIALS AND METHODS

Two on-station experiments were conducted, one with hedgerows of *Leucaena leucocephala* and the other with *Gliricidia sepium*, from 1985–1987 at Ibadan, Nigeria (latitude 7°30′N, longitude 3°54′E). The soil of the experimental site was an Alfisol, classified as an Oxic Paleustalf, with a pH of 6.1 (H_2O), 1.18% organic carbon, 0.16% total nitrogen and 10.6 ppm available phosphorus. The experiment was laid down as a 3 × 3 factorial treatment arrangement in a randomized block design with four replications and a plot size of 8 × 10 m. The treatments were 0, 40 and 80 kg N ha^{-1} applied as urea, in combination with a mulch of 0, 50 and 100% of the total foliage from each hedgerow pruning.

The on-farm experiment was conducted on four farms located in three villages near Oyo in southwestern Nigeria in 1988, 1989 and 1990. Mean chemical characteristics of the soil from the farm were: pH 5.9 (H_2O), 0.78% organic carbon, 0.064% total nitrogen and 5.1 ppm available phosphorus. The plots were laid out using a randomized complete block design with four replicates on each farm. The treatments were 0, 50 and 100% of the total foliage from alternate hedgerows of *L. leucocephala* and *G. sepium* applied as mulch to a plot size of 8 × 10 m. Plots received 60 kg N ha^{-1} as urea each year in two splits, one at planting and the other four weeks after planting. Samples of surface soil (0–15 cm depth) from each farm were air dried, sieved and analysed for pH (H_2O), organic carbon, and total nitrogen and phosphorus in April each year using procedures described by Juo (1979).

Scarified seeds of *L. leucocephala* (var. K-28) and a local variety of *G. sepium* were planted in rows 4 m apart at a spacing of 0.25 m within rows in May 1982 for the on-station experiments and May 1986 for the on-farm experiments. The hedgerows were first cut 12 months after planting in the on-station experiments and 22 months after planting in the on-farm experiments. The trees were pruned six times each year to a height of 0.5 m above the soil and the prunings spread uniformly on the surface of the soil between the hedgerows. At each pruning, samples of foliage were taken for dry matter determination.

Maize (var. TZSR-W) was sown at a spacing of 0.75 m between rows and 0.25 m within rows with two plants per hill during the major (April to July) and minor (August to November) rainy season each year. All the plots were clean weeded. Grain yield (14% moisture) was determined from 8 × 10 m plots.

Table 1. *Total monthly rainfall (mm) at Ibadan during the growing seasons 1985–1990*

	1985	1986	1987	1988	1989	1990
April	142	95	68	165	62	185
May	163	149	133	86	161	169
June	151	262	224	294	195	82
July	379	152	202	168	234	207
Aug.	230	33	314	57	189	74
Sept.	303	215	329	275	200	208
Oct.	170	179	226	256	137	131
Nov.	37	1	0	14	0	4
Total	1575	1086	1496	1317	1315	1060

Rainfall records for the on-station site at the time of the trials are shown in Table 1.

RESULTS AND DISCUSSION

Maize grain yields increased with increasing levels of applied mulch (Table 2). There was also a significant response to nitrogen fertilizer, even at the highest level of mulch application, confirming that some external input in the form of organic or inorganic fertilizer may be needed to sustain crop yields under alley cropping (Evensen *et al.*, 1991). As chemical fertilizers are not readily available to farmers, organic manure from sheep and goats fed supplements of leguminous browse may be a viable option (Cobbina *et al.*, 1989).

As expected, soil organic carbon, nitrogen and available phosphorus increased as more of the total prunings were applied as mulch (Table 3). The lower maize yield obtained when some of the tree foliage was used as feed confirmed earlier results (Atta-Krah and Sumberg, 1988). However, the opportunity cost of using a proportion of the tree foliage as feed can be more than offset by gains in animal productivity (Jabbar and Cobbina, 1992).

The yield response of maize to different rates of mulching on-farm showed trends similar to those on-station (Table 4). Compared with unmulched maize, grain yield increased by 54% when 50% of the prunings were used as mulch and by 89% when all the prunings were applied. These results indicate that there is a tailing off in yield response when all the prunings are used as mulch. Thus, provided a farmer used 50% of all prunings for mulch, the rest could be used for fodder if necessary and if justified by the relative market prices for grain and mutton.

Our results clearly demonstrate that the application of increasing levels of hedgerow foliage as mulch in combination with increasing levels of nitrogen fertilizer improved on-station and on-farm maize grain yields. The additional grain yields obtained when more than half of the total pruning was applied as

Table 2. *Effect of mulch application (% of total hedgerow prunings) and nitrogen application (kg ha^{-1}) on maize grain yield (t ha^{-1}) from on-station trials with hedgerows of* Leucaena *and* Gliricidia, *1985–1987*

	N	1985	1986	1987	SE
			Leucaena		
Mulch applied (%)					
0	0	4.14	2.41	1.38	0.21
	40	5.40	3.84	2.58	0.43
	80	5.46	4.47	3.44	0.37
	SE	0.91	0.43	0.22	—
50	0	5.57	4.27	2.23	0.29
	40	7.20	4.94	3.56	0.56
	80	7.25	5.06	3.90	0.31
	SE	0.51	0.30	0.13	—
100	0	5.98	4.40	2.80	0.41
	40	6.47	5.52	3.61	0.51
	80	7.43	6.59	4.54	0.47
	SE	0.88	0.75	0.14	—
			Gliricidia		
0	0	3.15	1.51	0.60	0.21
	40	5.96	3.28	2.12	0.37
	80	6.20	4.40	2.78	0.41
	SE	0.51	0.31	0.19	—
50	0	3.99	2.41	1.66	0.19
	40	6.15	3.73	2.85	0.47
	80	6.24	4.97	3.64	0.54
	SE	0.31	0.24	0.18	—
100	0	5.25	2.69	2.06	0.32
	40	6.76	5.01	3.58	0.43
	80	7.11	5.44	4.17	0.31
	SE	0.91	0.52	0.39	—

mulch were not so large, suggesting that half the prunings may be used as feed for livestock without seriously affecting the crop. Under farm conditions, soil organic carbon, nitrogen and available phosphorus increased as the proportion of the prunings applied as mulch increased.

Table 3. *Changes in chemical properties of surface soil (0–15 cm depth) on* Leucaena *and* Gliricidia *alley farms as affected by mulch application after three years of cultivation (mean of four farms)*

Mulch applied		Soil characteristics			
(%)	(kg ha^{-1})	pH (H_2O)	Organic C (%)	Total N (%)	Available P (meq 100 g^{-1})
0	0	5.3	0.70	0.078	9.4
50	3.88	5.4	0.87	0.082	14.3
100	7.89	5.4	0.99	0.097	19.7
SE	—	0.14	0.09	0.006	2.3

Table 4. *Effect of mulch application on maize grain yield (t ha^{-1}) from on-farm trials with alternate* Leucaena *and* Gliricidia *hedgerows, 1988–1990 (mean of four farms)*

Mulch applied		Year		
(%)	kg ha^{-1}	1988	1989	1990
0	0	1.20	2.09	1.76
50	3.88	2.15	3.12	2.09
100	7.89	3.04	3.63	2.19
SE	—	0.19	0.28	0.21

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