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Effect of pruning intensities of three woody leguminous species grown in alley cropping with maize and cowpea on an alfisol*

B. DUGUMA,[1] B.T. KANG[1] and D.U.U. OKALI[2]
[1]International Institute of Tropical Agriculture, PMB 5320, Ibadan, Nigeria; [2]Department of Forest Resources Management, University of Ibadan, Nigeria

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Abstract. Field trials were carried out on an Oxic Paleustalf in the humid zone of south-western Nigeria with *Leucaena leucocephala* (Lam.) de Wit, *Gliricidia sepium* (Jacq.) Steud. and *Sesbania grandiflora* (L.) Pers. alley cropped with maize and cowpea. The three leguminous woody species were grown in hedgerows spaced at 2 m. Trials were carried out one year after establishment of the hedgerows using a split-plot design with four replications. The *Leucaena* trial had twenty pruning combinations consisting of five pruning heights (25, 50, 75, 100 and 150 cm) and four pruning frequencies (monthly, bi-, tri- and six-monthly). The *Gliricidia* and *Sesbania* hedgerows were subjected to nine pruning intensities consisting of three pruning heights (25, 50 and 100 cm) and three pruning intensities (monthly, tri- and six-monthly).

For the three woody species, biomass, dry wood and nitrogen yield from the hedgerow prunings increased with decreasing pruning frequency and increasing pruning height. Biomass, dry wood and nitrogen yields were in the following order *Leucaena* > *Gliricidia* > *Sesbania*.

The various pruning intensities had no effect on survival of *Leucaena* plants. Pruning frequency had a larger effect than pruning height on survival of *Gliricidia* and *Sesbania* plants. With monthly pruning, about 25 percent of the *Gliricidia* and all of the *Sesbania* plants died within six months of repeated pruning. Even with lower pruning frequency *Sesbania* plants showed lower survival rates than *Gliricidia* or *Leucaena*.

The various pruning intensities of all the hedgerow species had more pronounced effects on the grain yield of the alley cropped cowpea than on maize grain yield. Higher maize and cowpea yields were obtained with increasing pruning frequency and decreasing pruning height.

Introduction

Leguminous species are known to be associated with various farming systems in the humid tropics. They are major sources of food and because of their N-fixing capacity they are also widely used for amelioration and

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maintenance of soil fertility. In recent years there has been an increased interest in the use of leguminous woody species as sources of green manure, animal fodder and firewood [Brewbaker, van den Beldt and MacDicken, 1982; Kang and Duguma, 1985]. Kang, Wilson and Lawson [1984] used *Leucaena leucocephala* and *Gliricidia sepium* in alley-cropping system, as a sustainable low input production technique. In this system food crops are grown in alleys formed by planted hedgerows of woody species. The hedgerows are periodically cut back and pruned during cropping to prevent shading, reduce competition with the associated crops and to provide green manure and mulch. Information on the effect of various pruning intensities on biomass production, nutrient yield and crop performance in alley cropping system is scarce.

Leucaena leucocephala is known to withstand repeated and drastic prunings, producing large amounts of green manure [Schweitzer, 1939]. Schweitzer [1939] also reported, that over 30 tons of green matter can be produced per hectare with six annual prunings. In Hawaii, Takashi and Ripperton [1949] reported forage yield of 60 tons/ha with four cuttings annually. Some of the new *Leucaena* introductions were observed to produce 100 tons/ha of green material/year in Hawaii [Brewbaker, van den Beldt and MacDicken, 1982]. Large quantities of N are produced with these annual prunings [Guevara, Whitney and Thompson, 1978; Kang Wilson and Sipkens, 1981; Rachie, 1983]. Guevarra, Whitney, and Thompson [1978] reported annual N yield of 500 to 600 kg N/ha.

Investigations with *Leucaena* showed that the biomass production is affected by height and intensity of pruning [Das and Dalvi, 1981; Osman, 1981; Pathak and Patel, 1982]. However, information on the effect of pruning intensities on performance of other leguminous species such as *Gliricidia sepium* and *Sesbania grandiflora* that have shown potential for use in alley cropping is still very scanty.

The present study was therefore undertaken to investigate the effect of various pruning regimes on coppicing, biomass production, and nitrogen yield of *Gliricidia sepium* and *Sesbania grandiflora* as compared to *Leucaena leucocephala* and their influence on the performance of alley cropped maize and cowpea.

Materials and methods

Field trials were carried out with *Leucaena leucocephala* (var. K-28), *Gliricidia sepium* and *Sesbania grandiflora* on an Egbeda soil series (Oxic paleustalf)[Moorman et al., 1975]. The trial was carried out from March 1983 till

June 1985 at the IITA main station at Ibadan in southwestern Nigeria. The experimental area has a bimodal rainfall with a mean annual rainfall of 1280 mm. The main cropping season starts in April and ends in July followed by a minor season from mid August to the end of October.

Experiment 1. Field trial with *Leucaena leucocephala*. The trial was carried out using a split-plot design with four replications. Five pruning heights (25, 50, 75, 100and 150 cm) made up the main plots. Subplots consisted of four pruning frequencies (monthly, bi-monthly, tri-monthly and six-monthly prunings). Subplot size was 4 × 8 m.

Leucaena hedgerows were established by direct seeding *Leucaena* in a maize crop in 1983. The maize crop received a basal dressing of 30 N – 30 P_2O_5 – 30 K_2O in kg/ha applied as 15-15-15 compound fertilizer. Hedgerows were spaced 2 m apart. Three to four *Leucaena* seeds were sown in the maize rows spaced at 25 cm between hills. Two months after establishment it was thinned to one seedling per hill. The first pruning of *Leucaena* hedgerows was done in 1984 at 12 months after establishment. Following the first pruning, maize (var. TZPB) was planted in the alleys at 60 cm × 25 cm spacing. This was followed by a cowpea (var. TVU 3236) in the minor season using the same spacing. In 1985, pruning was continued during the dry season for another six months from January till June. Pruning were retained in the plots whereas the wood was removed. Maize and cowpea seed yields were expressed at 12 and 14% moisture content respectively.

Dry matter yield of pruning biomass (leaves ± small green branches) and wood (all materials with brown bark) were determined by drying subsamples in an electric oven at 80 °C. Subsamples of prunings were ground and analysed for total N using the micro Kjeldahl method. Nitrogen yield was expressed as amount of N in the pruning biomass.

Experiment II. Field trial with *Gliricidia sepium*. The trial was carried out using a split-plot design with four replications. The main plots consisted of three pruning heights (25, 50 and 100 cm). Subplots also consisted of three pruning frequencies (monthly, tri-monthly and six monthly).

Gliricidia hedgerows were established using 3 months old seedlings that were grown in bags. The hedgerows were spaced 2 m apart and the seedlings were spaced 25 cm within the hedgerows. The first pruning was done at 12 months after planting of hedgerows. Subplot size was 2 × 8 m.

As in experiment I, the plots were cropped with maize followed by cowpea using the same fertilizer rate. Trial was carried out for six months period during the main growing season of 1984.

Dry biomass and wood yield of prunings, and N yields were determined as in experiment I.

Fig. 1. Alley cropping experiment maize with *Leucaena leucocephala.*

Experiment III. Field trial with *Sesbania grandiflora.* This trial was carried out using the same procedure as in experiment II.

Experimental results

1. Effect of prunings on biomass and wood yield

1a. Leucaena *biomass yield*

The effect of various pruning regimes on biomass (leaves + small green branches) production of *Leucaena* hedgerows is shown in Fig. 2. Data from the rainy season (Fig. 2a) show, that biomass yield increased with increasing pruning height and lower pruning frequency. Monthly prunings irrespective of pruning height resulted in significantly lower biomass production, while lower pruning frequency particularly with six-monthly prunings produced significantly higher biomass. The lowest yield of 1.61 t/ha was observed with monthly pruning at 25 cm height, while the highest biomass yield of 13.3 t/ha was obtained with six-monthly pruning at 150 cm height. With monthly prunings the increases in biomass yield with increasing height of pruning were small. Similarly with bi-monthly prunings, biomass yield differences between 25 cm and 50 cm pruning heights were significant. The low biomass yield with monthly and bi-monthly prunings particularly at low pruning heights may in part be attributed to the shading effect of the companion maize crop. There were large differences in biomass yield between monthly, bi- and tri-monthly pruning regimes. Differences between tri- and six-monthly prunings with the exception of the 150 cm pruning height were smaller.

The pruning-biomass yield during the dry season (Fig. 2b) was lower than that during the main cropping season (Fig. 2a). With six monthly pruning at 150 cm height, the biomass yield during the dry season (Fig. 2b) was less than half that measured during the rain season (Fig. 2a). While during the rainy season the highest pruning biomass yield was obtained with a 150 cm pruning height irrespective of pruning frequencies (Fig. 2a), during the dry season higher biomass yield was observed at lower pruning height. With monthly and bi-monthly prunings, highest biomass yields were obtained with 100 cm and 75 cm pruning heights respectively. In the tri- and six-monthly prunings, highest biomass yield was observed with 100 cm pruning height. This phenomena may be caused by limitations in moisture transport to plant tops during the dry season.

The total biomass yield from the various pruning regimes for the 12 months period is shown in Fig. 2c. High biomass yields were observed with bi-, tri- and six-monthly prunings of the *Leucaena* hedgerows even at 25 cm pruning height.

1b. Leucaena *wood yield*

The various pruning regimes also had a significant effect on the dry wood yield from *Leucaena* hedgerows (Fig. 3). With monthly pruning the sprouts only produced green material. Wood yield increased significantly with lower pruning frequency. The highest wood yield was obtained with six-monthly pruning. Although there were significant differences in wood yield with different pruning heights, the differences were smaller with bi- and tri-monthly prunings than with six-monthly pruning. The wood yield during the dry season was also lower, only about half that produced during the rainy season. Differences in wood yield between bi-, tri- and six-monthly prunings were more pronounced as compared to differences in biomass yield (Fig. 2) for both season (Fig. 3). Unlike the biomass yield, the highest wood yield for the various pruning frequencies in both seasons were observed at 100 cm pruning height. The *Leucaena* hedgerows produced substantial amount of dry wood in one year with two prunings (Fig. 3c).

1c. Gliricidia *biomass and wood yield*

The effects of various pruning regimes on biomass dry matter yield of *Gliricidia* are shown in Fig. 4a. Increasing pruning height and lowering

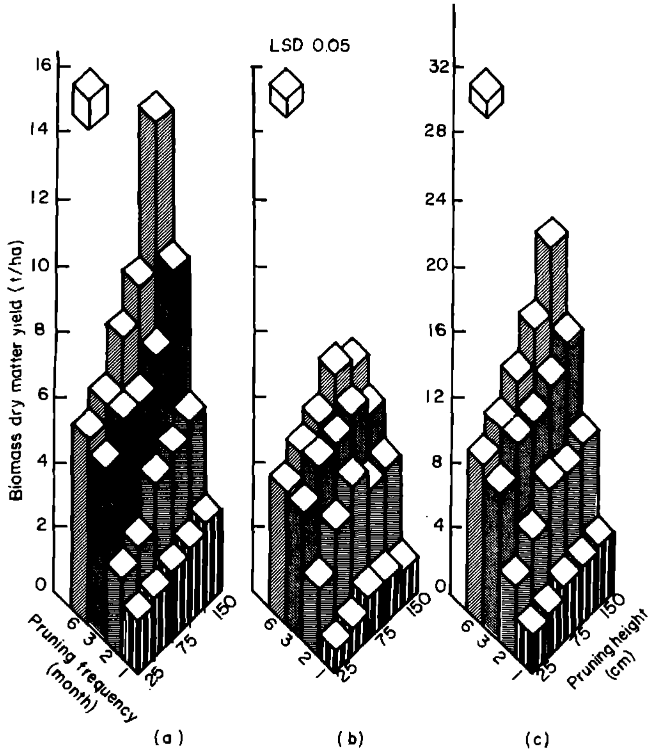

Fig. 2. Effect of pruning regimes on biomass dry matter yield of *Leucaena leucocephala* hedgerows during six months of rainy season (a), six months of dry season (b), and one year total (c).

pruning frequency increased biomass yield. Biomass yield was lowest with monthly pruning, and increased significantly with tri- and six-monthly pruning frequencies (Fig. 4a).

With *Gliricidia* significant wood yields were observed only with six-monthly prunings (Fig. 4b). With tri-monthly prunings there was insignificant wood production. Increasing pruning height from 25 to 50 cm significantly increased wood yield but the difference in wood yield between 50 and 100 cm pruning heights was not significant.

1d. Sesbania *biomass and wood yield*

Sesbania produced low amounts of biomass from the prunings (Fig. 5). Biomass yields with monthly and tri-monthly prunings were about the same and pruning height had little effect (Fig. 5a). Significantly higher biomass yield was obtained with six-monthly pruning, which also showed higher biomass yield with higher pruning height.

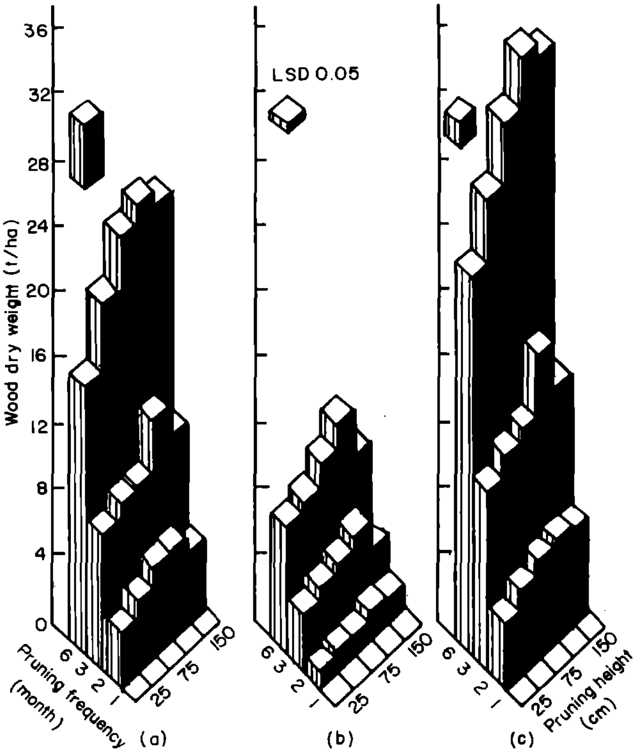

Fig. 3. Effect of pruning regimes on wood dry weight of *Leuceanea leucocephala* hedgerows prunings during six months of rainy season (a), six months of dry season (b), and one year total (c).

Sesbania produced no wood when pruned every month (Fig. 5b) and only small amounts of woody material were produced with tri-monthly pruning. Wood yield increased significantly with six-monthly pruning, particularly with increasing pruning height.

2. Nitrogen yield

The nitrogen content and yield of the *Leucaena* pruning is shown in Table 1. The prunings showed higher nitrogen percentage with higher pruning frequency as seen from the significantly higher nitrogen values with monthly than with tri-monthly prunings. Pruning height had no effect on nitrogen percentage. However, the nitrogen yield of the loppings (Table 1) showed the same trend as that of biomass yield (Fig. 2). The nitrogen yield was significantly higher with tri-monthly than monthly prunings. Increasing pruning height with tri-monthly pruning also significantly increased nitrogen yield from the loppings.

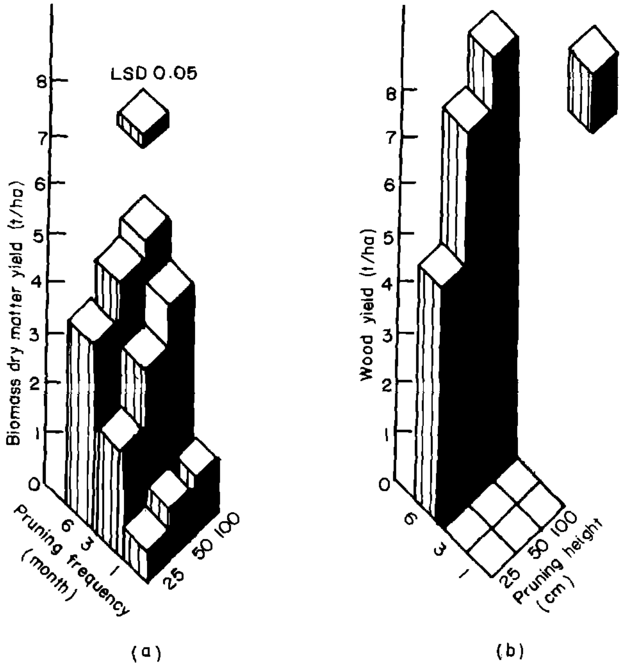

Fig. 4. Effect of pruning regimes on biomass dry matter yield (a) and wood dry weight (b) of *Gliricidia sepium* hedgerows prunings (six months total) during the rainy season.

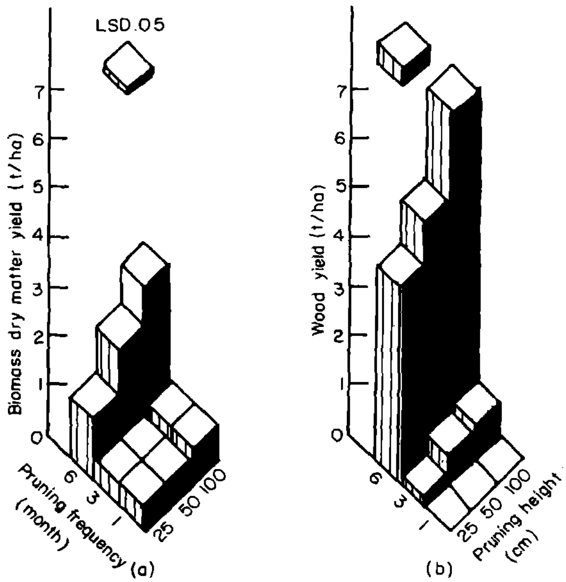

Fig. 5. Effect of pruning regimes on biomass dry matter yield (a) and wood dry weight (b) of *Sesbania grandiflora* hedgerows prunings (six months total) during the rainy season.

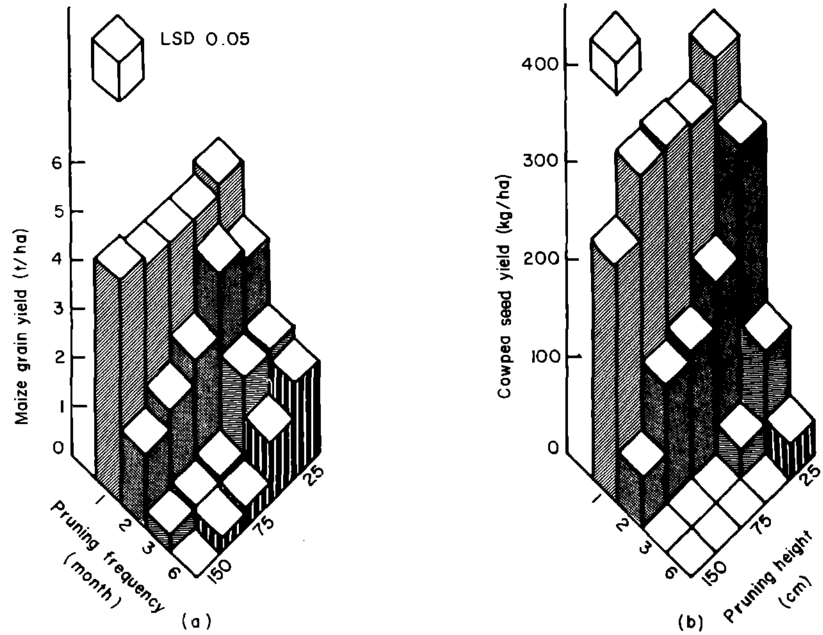

Fig. 6. Effect of various pruning regimes of *Leucaena leucocephala* hedgerows on grain yield of alley cropped maize (a) and seed yield of alley cropped cowpea (b).

The total nitrogen yields from the *Leucaena* loppings as affected by pruning regimes are shown in Table 2, the annual nitrogen yield data was estimated from the total annual biomass yield and the nitrogen percentage

Table 1. Effect of pruning height and frequency on percent nitrogen (A) and nitrogen yield (B) of *Leucaena* tops for three months period during main cropping season.

Pruning height (cm)	Pruning frequency					
	Monthly		Trimonthly		Mean	
	A (%)	B (t/ha)	A (%)	B (t/ha)	A (%)	B (t/ha)
25	4.85	0.11	3.93	0.18	4.38	0.15
50	4.68	0.12	4.47	0.23	4.58	0.17
75	4.82	0.13	4.39	0.22	4.60	0.18
100	4.92	0.13	4.00	0.25	4.46	0.19
150	4.94	0.12	3.97	0.31	4.45	0.22
Mean	4.84	0.12	4.15	0.24	–	–

LSD 0.05	A	B
Between pruning height mean	0.26	0.04
Between pruning frequency mean	0.26	0.02
Between pruning frequency for same height	0.57	0.04
Between pruning frequency for different heights	0.46	0.04

Table 2. Nitrogen yield of *Leucaena* pruning for one year period as affected by pruning regime.

Pruning frequency (months)	Pruning height (cm) 25	50	75	100	150	Mean
	(kg N/ha)					
1	29.6	35.5	49.9	52.7	45.0	42.5
2	84.9	133.9	165.2	142.7	146.1	134.6
3	153.0	190.5	201.2	216.9	197.8	191.9
6	159.2	187.7	199.5	245.1	288.6	216.0
Mean	106.7	136.9	153.9	164.3	169.4	–

LSD0.05	
Between pruning height mean	10.4
Between pruning frequency mean	13.1
Between pruning frequency for same height	29.3
Between pruning frequency for different heights	27.4

of the various loppings. As shown in Table 2 the total annual nitrogen yield showed the same trend as the biomass yield (Fig. 2). The highest nitrogen yield was obtained with six-monthly pollarding at 150 cm, which yielded 757 kg N/ha/year. The lowest nitrogen yield of 114 kg N/ha/year was obtained with monthly pruning at the 25 cm height.

The nitrogen yield of *Gliricidia* (Table 3) and *Sesbania* (Table 4) loppings were calculated using the same procedure as that of *Leucaena*. The nitrogen yield in both species showed similar trends as their biomass production. Lower pruning frequencies and higher pollarding heights increased nitrogen yield.

In this trial the nitrogen yield of the three species, were as follows; *Leucaena* yielded the most, followed by *Gliricidia*, with *Sesbania* yielding the least (Tables 2, 3 and 4).

Table 3. Nitrogen yield (kg/ha) of *Gliricidia sepium* prunings for six months as affected by pruning regime.

Pruning frequency (months)	Pruning height (cm) 25	50	100	Mean
	(kg N/ha)			
1	24.7	36.4	43.8	35.0
3	90.9	137.1	171.8	133.3
6	161.2	194.6	205.6	187.2
Mean	92.3	122.7	140.4	–

LSD 0.05	
Between pruning height mean	7.7
Between pruning frequency mean	6.3
Between pruning frequency mean for same height	10.9
Between pruning frequency mean for different heights	11.7

Table 4. Nitrogen yield of *Sesbania grandiflora* prunings for six months as affected by pruning regime.

Pruning frequency (months)	Pruning height (cm) 25	50	100	Mean
	(kg N/ha)			
1	14.7	14.5	23.9	17.7
3	15.2	15.6	24.8	18.5
6	48.9	81.2	110.8	80.3
Mean	26.3	37.1	53.2	–
LSD 0.05				
Between pruning height mean				26.3
Between pruning frequency mean				19.5
Between pruning frequency mean for same height				33.8
Between pruning frequency mean for different heights				37.8

3. Effect of pruning on survival of plants grown in hedgerows

Differences in survival rates among the hedgerows species were observed. The various pruning regimes had no effect on the survival of *Leucaena*. In contrast increasing pruning frequency and lowering pruning height significantly affected survival of *Gliricidia* (Table 5). Within six months with *Gliricidia* about 25 percent of the plants died by monthly pruning. *Sesbania* showed a more pronounced reaction to the various pruning intensities (Table 6). Within 6 months all the plants with monthly prunings died. Consequently only data from the three- and six-monthly prunings were analysed. Tri-monthly pruning produced a survival rate of about 20 percent, while with six-monthly pruning the survival rate was about 80 percent.

Table 5. Percentage survival of *Gliricidia sepium* in hedgerows as affected by pruning regime monitored at 6 months after initial pruning.

Pruning frequency (months)	Pruning height (cm) 25	50	100	Mean
	(%)			
1	76.3	76.0	71.3	74.6
3	86.7	93.3	92.7	90.9
6	94.3	97.0	97.7	96.3
Mean	85.8	88.8	87.2	–
LSD 0.05				
Between pruning height mean				10.9
Between pruning frequency mean				7.3
Between pruning frequency mean for same height				13.4
Between pruning frequency mean for different heights				15.3

Table 6. Percentage survival of *Sesbania grandiflora* as affected by pruning regime 6 months after initial pruning.

Pruning frequency (months)	Pruning height (cm)			Mean
	25 (%)	50	100	
3	15.7	17.7	26.0	19.8
6	75.0	89.7	76.0	80.2
Mean	45.3	53.7	51.0	

LSD 0.05	
Between pruning height mean	12.8
Between pruning frequency mean	8.0
Between pruning frequency mean for same height	13.3
Between pruning frequency mean for different height	16.1

4. Crop yield

4.1 Effect of Leucaena *hedgerows*

The effects of alley cropping with *Leucaena* on maize and cowpea grain yields were shown in Fig. 6. The effect of pruning regimes on maize and cowpea yields (Fig. 6) showed the opposite trend as those of biomass yield of the loppings (Fig. 2). Highest maize and cowpea yields were obtained with higher pruning frequency and lower pruning height of the hedgerows. With monthly pruning, pruning height had no significant effect on maize grain yield which was over 4 tons/ha (Fig. 6). With bi-monthly prunings maize yields increased significantly, with lower pruning height. At this pruning frequency, the difference in maize yields between 25 and 50 cm pruning heights was non significant. Similar trends of maize yields, were observed in the tri- and six-monthly pruning treatments. With six-monthly pruning at 150 cm height was no maize grain yield.

The influence of various pruning regimes on cowpea grain yield (Fig. 6b) showed the same trend as that of maize, except that the magnitude of the effect on cowpea seed yield was more pronounced. The highest cowpea seed yield (over 400 kg/ha) was obtained with monthly pruning at 25 cm height. With tri- and six-monthly prunings there was no cowpea seed yield with pruning height above 50 cm.

4.2 Effect of Gliricidia *hedgerows*

The effect of various pruning regimes of the *Gliricidia* hedgerows on the associated maize and cowpea grain yields are shown in Fig. 7. Highest maize yield was obtained with monthly pruning of the hedgerows at 25 cm height.

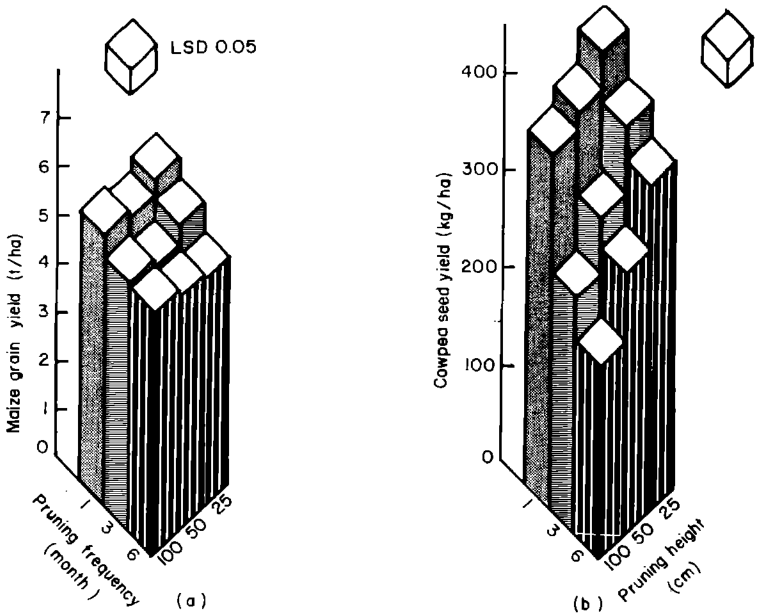

Fig. 7. Effect of various pruning regimes of *Gliricidia sepium* hedgerows on grain yield of alley cropped maize (a) and seed yield of alley cropped cowpea (b).

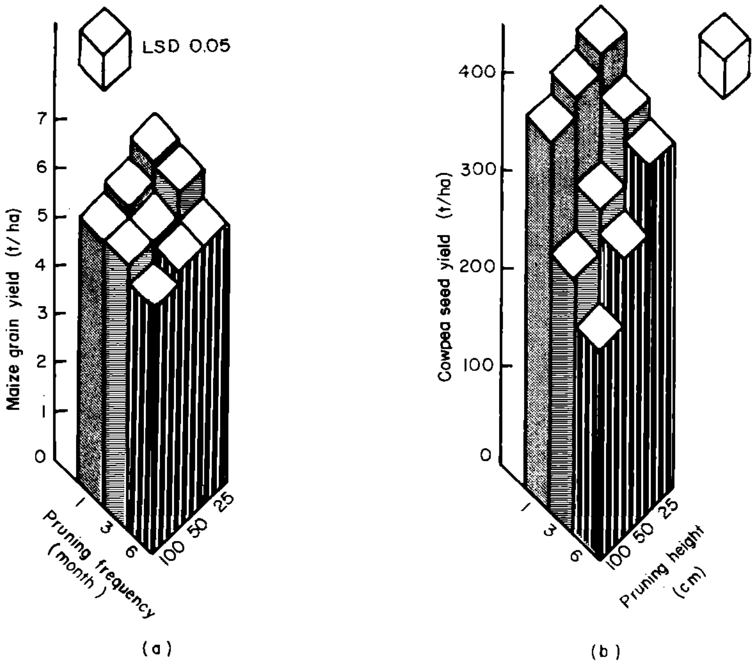

Fig. 8. Effect of various pruning regimes of *Sesbania grandiflora* hedgerows on grain yield of alley cropped maize (a) and seed yield of alley cropped cowpea (b).

Maize yield was significantly reduced with lower pruning intensity and higher pruning height (Fig. 7a).

Pruning intensities of *Gliricidia* hedgerows also had more pronounced effect on cowpea than maize yield (Fig. 7b). Increasing height and lowering pruning frequency significantly reduced cowpea seed yield.

4.3 Effect of Sesbania *hedgerows*

Though maize yield was lowered with increased pruning height and lower pruning frequency of the *Sesbania* hedgerows, yield differences due to various pruning regimes were insignificant (Fig. 8a). Cowpea seed yield was however significantly affected by pruning height and intensities. However, with monthly prunings pollarding height had no significant effect on cowpea seed yield. Increasing height of pruning significantly reduced cowpea seed yield with tri- and six-monthly pruning regimes (Fig. 8b).

5. Discussions

Biomass and wood yields of *Leucaena*, *Gliricidia* and *Sesbania* loppings from the hedgerows were higher with lower pruning frequency and higher pruning heights (Figs. 2, 3, 4 and 5). Similar results were also reported by others working with *Leucaena* [Das and Dalvi, 1981; Osman, 1981 and Krishna Murthy and Mune Godwa, 1982]. Pathak and Patel [1982] also reported doubling of *Leucaena* shoot yield with pruning at 15 to 30 cm height as compared to pruning at ground level. The low biomass yield of loppings with frequent (monthly and bi-monthly) prunings of the hedgerows at low pruning heights ($\leqslant$ 50 cm) may be attributed to several factors such as: (a) Partial shading of the hedgerow regrowth by the alley cropped maize; (b) With tree growth the main capital and periodic dry matter gains take place simultaneously. Newly formed wood automatically becomes part of the capital gain which will contribute to subsequent growth. Intensive prunings cause frequent disruptions in dry matter and wood production and nutrient accumulation which negatively affect subsequent regrowth; and (c) With higher pruning height, there is also more food reserve available in the stem to support coppicing.

Comparing the biomass and wood yields from the *Leucaena* hedgerow prunings (Figs. 2 and 3), the data show a tendency for lower wood to biomass ratio with frequent prunings. With six monthly prunings, lowering pruning height favours higher wood to biomass ratio than higher pollarding height. Similar trends were also observed with *Gliricidia* and *Sesbania* (Figs. 4 and 5). The *Leucaena* data (Figs. 2 and 3) also showed higher wood to biomass ratio during the rainy season (Figs. 2a and 3a) than in the dry season (Figs. 2b and 3b).

Observations made in this trial reconfirmed the ability of *Leucaena leucocephala* to withstand repeated prunings as was reported by other investigators [Schweitzer, 1939; Dijkman, 1950; Guevarra et al., 1978]. Kang et al. [1985] reported that *Leucaena* hedgerows thrive well even with repeated five prunings annually for six consecutive years. Intensive pruning at low pruning height significantly reduced plant stand of *Gliricidia sepium*, which was reduced to about three quarters with monthly prunings (Table 5). High pruning intensity also negatively affected survival of *Sesbania grandiflora* (Table 6). The strong negative effect of high intensity prunings on survival of *Gliricidia* and *Sesbania* in these trials may in part be due to the age of the plants. Chadhokar [1982] observed that frequent cuttings in initial year of establishment had a negative effect on yielding capacity of *Gliricidia* in later years. Further studies need to be carried out to determine if the effect of high pruning intensity is the same for older and more established seedlings than those used in the trials. *Sesbania grandiflora* the most affected species with intensive pruning, is also known to be highly susceptible to stem borer and grasshopper (*Zenoceros varigatus*) attack in the study area. Burbridge [1965] and NAS [1980] did report the susceptibility of *Sesbania* to nematodes and leaf hoppers. The combination of these factors may add to the low survival rates of *Sesbania* with intensive pruning in southern Nigeria.

Both height and frequency of prunings of the *Leucaena* hedges affected yield of alley cropped cowpea and maize (Fig. 6). With monthly prunings the average maize yield was 4.38 t ha^{-1}, while those from six-monthly prunings was 0.76 t ha^{-1}. The low maize yield with low pruning frequency and high pruning height is mainly attributed to shading of the crop by the *Leucaena* hedgerows. Kang et al. [1985] also reported better solar radiation in the alleys with regular pruning of the *Leucaena* hedgerows. The shading effect of the hedgerows with low intensity pruning was also observed to have a more pronounced effect on the yield of the short stature cowpea plants (Fig. 6b).

The lesser effect of pruning intensities of *Gliricidia* and *Sesbania* hedgerows on maize and cowpea yields may be related to: (a) the slower regrowth of these two woody species as compared to *Leucaena*; (b) more sparse foliage of the regrowth particularly with *Sesbania* as reported by Burbridge [1965] which allowed more light to reach the associated crops; and (c) the low survival of the hedgerow plants particularly *Sesbania*.

Although these trials were not designed to determine the optimum pruning regimes for the wooded hedgerows for sustained crop production, a number of components revealed from these trials can be important for alley cropping woody species with food crops in the humid tropics: (a) Despite the fact that with high (monthly) pruning frequency of the *Leucaena* hedgerows, the loppings have higher nitrogen content (Table 1), the amount of nitrogen yield which also depends on biomass yield was significantly lower. For the alley cropping system, where the emphasis is to optimize organic matter yield and nutrient cycling and yield through the hedgerow prunings [Kang et al., 1981], which are necessary for maintaining the productivity of the fragile tropical soils [Kang and Juo, 1983], monthly prunings despite its lesser effect on the associated crop yields is also less satisfactory. In addition frequent prunings will also increase labour input; (b) Further studies need to be carried out with *Leucaena* and *Gliricidia* and other woody legumes suitable for alley cropping to examine the relationships between seedlings age and pruning intensity on survival and biomass production, yield of associated crops and soil amelioration; (c) *Sesbania grandiflora* appears to be unsuitable species for alley cropping in the lowland humid tropics of south western Nigeria.

References

Brewbaker JR van den Beldt and K MacDicken (1982) Nitrogen-fixing tree resources, potentials and limitations. In Graham PH and SC Harris (eds). Biological nitrogen fixation technology for tropical agriculture, CIAT, Cali, Columbia: 413–425

Burbridge MT (1965) The Australian species of *Sesbania scopoli* (Leguminose). Australian Journal of Botany 13: 103–141

Chadhokar PA (1982) Gliricidia maculata a promising legume fodder plant. World Anim Rev 44: 36–43

Das RB and GS Dalvi (1981) Effect of interval and intensity of cutting of Leucaena leucocephala. Leucaena Research Report 2: 21–22

Dijkman MJ (1950) Leucaena — A promising soil-erosion control plant. Econ Bot 4: 337–349

Guevarra AB, AS Whitney and AR Thompson (1978) Influence of intrarow spacing and cutting regimes on growth and yield of Leucaena. Agron J 70: 1033–1037

Kang BT and B Duguma (1985) Nitrogen management in alley-cropping systems. In: Kang BT and J van der Heide (eds) Nitrogen management in farming systems in humid and subhumid tropics. Inst for Soil Fertility (IB) Haren, Netherlands: 269–284

Kang BT, H Grimme and TL Lawson (1985) Alley cropping a sequentially cropped maize and cowpea with *Leucaena* on sandy soil in southern Nigeria. Plant and Soil 85: 267–277

Kang BT, GF Wilson and TL Lawson (1984) Alley cropping — a stable alternative to shifting cultivation. Int Inst Trop Agric Ibadan, Nigeria, 23 pp

Kang BT and ASR Juo (1983) Management of low activity clay soils in tropical Africa. In: Beinroth FH, H Neel and H Eswaran (eds) Proc fourth Int Soil Classification Workshop Rwanda 1981, ABOS-AGCD Brussels: 450–470

Kang BT, GF Wilson and L Sipkens (1981) Alley cropping maize (Zea mays L.) and *Leucaena* (*Leucaena leucocephala* Lam.) in southern Nigeria. Plant and Soil 63: 165–179

Krishna Murthy K and MK Mune Gowda (1982) Effect of cutting and frequency regimes on the herbage yield of Leucaena. Leucaena Research Report 3: 31–32

Moormann FR, R Lal and ASR Juo (1975) The soils of IITA. Technical Bulletin 3, IITA, Ibadan, Nigeria, 48 pp

National Academy of Sciences (1980) Firewood crops. NAS, Washington D.C. 236 pp

Osman AM (1981) Effects of cutting intervals on relative dry matter production of four cultivars of leucaena. Leucaena Research Report 2: 33–35

Pathak PS and BD Patel (1982) Leucaena research at the Indian Grassland Fodder Research Institute. In: Leucaena Research in the Asian-Pacific region. IDRC, Ottawa, Canada: 83–88

Rachie KD (1983) Intercropping tree legumes with annual crops. In: Huxley PA (ed) Plant Research and Agroforestry. ICRAF, Nairobi, Kenya. 103–116

Schweitzer J (1939) Over de functie van het blad bij het cultuurgewas gedurende een vegetatie-periode. De Bergcultures 13: 1628–1639

Takashi M and JC Ripperton (1949) Koa Haole, Hawaii Agr Expt Sta Rpt 1943–1944: 46–48