Potential use of *Flemingia macrophylla* as mulch for managing weeds in young cocoa in Ghana

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SUMMARY

The prospects for using *Flemingia macrophylla* and *Mucuna pruriens* in combination with manual weeding during the establishment of young cocoa was investigated. The following treatments were compared: Clean weeding three times/annum + *F. macrophylla* planted in the inter-rows of cocoa and biomass used as mulch; clean weeding of cocoa lines (1 m wide) three times/annum + *Mucuna* cover crop; and clean weeding four times/annum. The use of *Flemingia* mulch in combination with manual clean weeding three times/annum resulted in large girths and taller cocoa plants than in plots where *Mucuna* was used as cover crop. The girth and height of the young cocoa seedlings in the *Flemingia* plots were, however, not significantly different from those in plots where weeds were manually clean-weeded four times/annum. Seedling mortality was lower in the plots with *F. macrophylla* (7 per cent) than in plots which had *Mucuna* cover crop (13 per cent). Flowering and jorquette formation occurred earlier in the *Flemingia* plots than in the other treatments. The potential biological benefits of using *F. macrophylla* in an integrated weed management programme in young cocoa and the application cost are discussed.

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RÉSUMÉ

OPPONG, F. K., OSEI-BONSU, K., AMOAH, F. M. & ACHEAMPONG, K.: *L'utilisation possible de* Flemingia macrophylla *en tant que paillis pour le contrôle de mauvaises herbes entre les cacaos jeunes au Ghana.* Les possibilités pour l'utilisation de *Flemingia macrophylla* et *Mucuna pruriens* en combinaison avec le désherbage manuel, au cours de l'enracinement de cacao jeune, étaient enquetées. Les traitements suivants comparées. Les traitements suivants étaient comparés: Désherbage propre trois fois par an + *F. macrophylla* planté entre les interrangées de cacao et la biomasse se servait comme paillis; déherbage propre des rangées de cacao (1m de large) trois fois par an + *Mucuna* la plante de couverture; et désherbage propre quatre fois par an. L' utilisation du paillis de *Flemingia* en combinaison avec un désherbage manuel propre trois fois par an se résultait en circonférence plus large et en plante de cacao de plus haute taille que dans les lots où *Mucuna* s'était servi comme une plante de couverture. La circonférence et la taille des semis du cacao jeune dans les lots de *Flemingia* n'étaient pas, cepedant, considérablement différentes de ceux dans les lots où les mauvaises herbes étaient proporement désherbées manuellement quatre fois par an. La mortalité de semis était inférieure dans les lots avec *F. macrophylla* (7 pour cent) que dans les lots qui avaient la plante de couverture de *Mucuna* (13 pour cent). La floraison et la formation de jorquette se trouvait plus tôt dans les lots de *Flemingia* que dans les autres traitements. Les bienfaits biologique possible d' utilisation de *F. macrophylla* dans un programme intégré du contrôle de mauvaise herbe entre les cacaos jeunes et le coût d' application sont discutés.

Introduction

Weed control in young cocoa is one of the most expensive and time-consuming cultural operations during establishment. To enhance vigorous growth and early yield of young cocoa, Ghanaian farmers have to weed their farms between four and six times per annum. However, most cocoa farmers manage to weed their farms only two or three times per annum due to the high cost of labour. This situation often results in poor growth

of young cocoa, thus prolonging the establishment phase and consequently reducing yield. Although chemical weed control by paraquat (Bonaparte, 1981; Osei-Bonsu, Oppong & Amoah, 1991) or glyphosate (Oppong *et al.*, 1995) has been recommended as an alternative to manual weeding, adoption of this technology has proceeded at a slow rate due to the initial high investment in chemicals and spraying equipment.

An alternative method of weed control which has been successfully used in other crops is the use of alley or cover cropping to suppress weed growth (Akobundu, 1980; Kang, Wilson & Lawson, 1984; Kang & Ghuman, 1991). For example, *Flemingia macrophylla* (Willd) Merr. (sny. *Flemingia congesta* Roxb), a leguminous shrub used as an alley crop in coffee (*Coffea canephora*) was more superior as a soil cover and also promoted higher yield than other legumes such as *Thithonia* spp., *Stylosantes* spp., *Pueraria* spp., *Leucaena* spp., and *Mimosa* spp. (Coste, 1992). Similarly, *Mucuna pruriens* (L.) DC var. *utilis* has also shown great potential as an *in-situ* mulch in cereals (Anonymous, 1989; Akobundu, 1993).

Apart from suppressing weeds, most of these leguminous alley or cover crops have been used to control soil erosion, improve soil physical and chemical properties, increase water infiltration, add organic matter to the soil, and fix atmospheric nitrogen (Lal, Wilson & Okigbo, 1978, 1979; Wilson, Lal & Okigbo, 1982). Opoku (1967) compared the effects of several leguminous and non-leguminous cover plants on weed control in young cocoa and reported higher yield increases of 30 per cent or above in plots with *Flemingia congesta, Indigofera sumatrana, Tephrosia* spp., *Desmodium asperum,* and *Pennisetum purpureum* than in plots where plant cover was made up of natural regeneration. However, the comparative costs of establishment and maintenance of the individual treatments were not indicated. There is, therefore, the need to further study the exploitation of leguminous crops as a means of reducing the cost of weed control during cocoa establishment.

The objective of this study was to investigate the feasibility of using *F. macrophylla* and *M. pruriens* in an integrated weed management programme with a view to reducing cost of weed control during cocoa establishment.

Materials and methods

The trial was established at the Bunso sub-station of the Cocoa Research Institute of Ghana. The Bunso soils are classified as Rhodic Ferralsols (FAO/UNESCO, 1968), and Table 1 shows some of its physico-chemical properties.

The land was prepared, lined, and pegged at 3 m × 3 m. Uniform 5-month-old cocoa seedlings were transplanted in May 1993. Plots each measuring 324 m² (18 m × 18 m) containing 36 cocoa plants per plot were demarcated and the following treatments were assigned to the plots:

TABLE 1

Some Physico-chemical Properties of the Soil (0 - 6 cm) at the Experimental Site at Bunso, Eastern Region, Ghana

Texture and characteristics	*pH*	*N (percent)*	*Carbon (percent)*	*Available P μg g⁻¹ soil*
Loamy, deep	6.2	0.214	1.880	1.162

1. Clean weeding, three times per annum + *F. macrophylla* planted in the inter-rows of cocoa.
2. Clean weeding (1 m wide) along the cocoa lines three times per annum + *M. pruriens* (late maturing variety) cover crop.
3. Manual clean weeding, four times per annum (control).

Two rows of 2-month-old *F. macrophylla* and *M. pruriens* seeds were transplanted at 1.0 m × 1.5 m and 1.0 m × 1.0 m, respectively, in the inter-rows of the cocoa in June 1993. Foliage of *F. macrophylla* was pruned twice per year to mulch the plot. Plantains and *Glyricidia sepium* were planted at 3 m × 3 m and 20 m × 20 m, respectively, throughout the plots to provide shade. The trial

was designed as randomized complete block with five replications. The initial girth at 10 cm from the soil level and height of the cocoa seedlings were recorded 3 months after transplanting and repeated thereafter at 10, 15, and 22 months after transplanting. Data on seedling mortality after the dry season, amount of pruned *F. macrophylla* foliage returned to the soil, flowering, jorquette formation, moisture content of the soil in the dry season, nitrogen content of the soil, and mandays used in each treatment were also recorded.

Results and discussion

Growth of cocoa seedlings

The growth of the cocoa seedlings was influenced by the treatments. Clean weeding three times per annum in combination with mulching with *F. macrophylla* foliage resulted in larger girth and taller cocoa plants at 10, 15 or 22 months after transplanting as compared to cocoa plants in plots where *M. pruriens* was used as cover crop (Tables 2 and 3). However, no significant differences were observed in the growth of the cocoa plants in plots where *F. macrophylla* was used and those in the control plots (clean weeding, four times per annum).

The vigorous growth of cocoa in the plots with *F. macrophylla* may partly be attributed to the prolonged periods of weed suppression as a result of pruning of *F. macrophylla* foliage used as mulch as well as the shade provided by the same plant.

TABLE 2

Mean Girth (cm) of Cocoa Plants at 3, 10, 15, and 22 Months after Transplanting

Treatments	*Months after transplanting*			
	3	*10*	*15*	*22*
Clean weeding 3 times + *F. macrophylla*	1.17	1.71	2.38	2.98
Clean weeding of cocoa lines 3 times + *M. pruriens*	1.05	1.44	1.91	2.31
Manual clean weeding 4 times per annum	1.10	1.58	2.25	2.48
s.e.d (8 d.f)	0.046	0.082	0.147	0.140

TABLE 3

Mean Height (cm) of Cocoa Plant at 3, 10, 15, and 22 Months after Transplanting

Treatments	*Months after transplanting*			
	3	*10*	*15*	*22*
Clean weeding 3 times + *F. macrophylla*	61.4	101.3	131.2	148.6
Clean weeding of cocoa lines 3 times + *M. pruriens*	63.8	80.1	102.7	120.4
Manual clean weeding 4 times per annum	66.4	91.9	115.3	128.0
s.e.d (8 d.f)	3.31	6.61	8.93	10.74

Higher levels of nitrogen and available phosphorus were recorded in the plots with *F. macrophylla* than in the other treatments 2 years after establishment (Table 4) and this might have contributed to the vigorous growth of the cocoa plants. The addition of *F. macrophylla* foliage to the soil has previously been shown to improve soil organic matter, water infiltration and percolation, and the nitrogen status of the soil (Lal, Wilson & Okigbo, 1978, 1979; Wilson, Lal & Okigbo, 1982). In this study, about 6 and 7 tonnes/ha of *F. macrophylla* foliage were returned to the soil in May 1994 and October 1994, respectively. This might have considerably improved soil moisture, thereby enhancing the growth of the cocoa.

TABLE 4

Levels of Nitrogen, Carbon, and Phosphorus in the Soil (0 - 6 cm) 2 Years after Cocoa Establishment

Treatment	*N (percent)*	*Carbon (percent)*	*Available P $\mu g\ g^{-1}$ soil*
Clean weeding 3 times + *F. macrophylla*	0.215	1.567	2.510
Clean weeding of cocoa lines 3 times + *M. pruriens*	0.171	2.133	1.390
Manual clean weeding 4 times per annum	0.165	1.717	1.730

Although *M. pruriens* established well initially, its subsequent growth was retarded as soon as the plantains and *Glyricidia* in the plots began to provide shade. *M. prüriens* could, therefore, not grow vigorously to smother weeds in the plot, thus resulting in competition between the cocoa seedlings and the weeds; hence, the poor growth of the cocoa. In a few areas where light penetration was adequate, the growth of *M. pruriens* was vigorous, which in some cases entangled the cocoa seedlings. Cunningham & Smith (1961) made similar observations when they compared *Crotalaria striata* and *Stylosanthes gracilis* as soil covers in young cocoa. They reported that although both legumes formed good soil covers initially, they died out as soon as the intensity of shade from tree cassava increased and hence suggested the screening of other cover crops for use in young cocoa.

Seedling mortality

Seedling mortality was higher in the *M. pruriens* plots than in the other treatments (Table 5). This may be attributed to the lower mean moisture content of the soil recorded during the second dry season in *M. pruriens* plots as compared to those of the other treatments (Table 6). With the inability of *M. pruriens* to suppress weeds over longer periods, the cocoa plants might have been stressed, due to competition for moisture and nutrients, with the loss of some of the plants during the dry seasons. On the other hand, the mulch provided by *F. macrophylla* was able to suppress the weeds and conserve soil moisture during the dry season; hence, the low seedling mortality.

TABLE 5

Percentage Seedling Mortality after Two Dry Seasons

Treatment	*Percentage seedling mortality*
Clean weeding 3 times + *F. macrophylla*	6.96
Clean weeding of cocoa lines 3 times + *M. pruriens*	13.10
Clean weeding 4 times per annum	7.25
s.e.d (8 d.f)	3.32

TABLE 6

Mean Moisture Content in 0-15 cm Layer of Soil during the Second Dry Season (December - February) after Transplanting

Treatment	*Moisture content in soil (g/100 g oven dry soil)*
Clean weeding 3 times + *F. macrophylla*	15.62
Clean weeding of cocoa lines 3 times + *M. pruriens*	13.33
Clean weeding 4 times per annum	14.52

The low mortality of cocoa seedlings in the control plots which were clean-weeded four times per annum might also be attributed to less competition between the weeds and the cocoa for soil moisture in the dry season. Other researchers have also demonstrated low seedling mortality in plots which received clean weeding six (Bonaparte, 1981) or four times (Osei-Bonsu, Oppong & Amoah, 1991) per annum.

Flowering and jorquetting

Flowering occurred much earlier in plots with *F. macrophylla* and those which were clean-weeded four times per annum than in plots which had *M. pruriens* cover crop (data not presented). Jorquette formation followed a similar pattern. Twenty-two months after transplanting, 50 per cent of the trees in the plots with *F. macrophylla* had formed jorquettes, compared to 36 per cent in the control and 32 per cent in the plots with *M. pruriens* cover crop, respectively. This early flowering and jorquetting in the *F. macrophylla* plots might be due to the initial vigorous growth of the cocoa in this treatment. Glendining (1960) and Moses & Enriquez (1979) have reported high positive correlations between trunk diameter, tree vigour, and yield of cocoa plants. The bigger girths and early flowering and jorquetting observed in

cocoa plants in the *F. macrophylla* plots in the study may eventually result in early and high yields of cocoa. Opoku (1967) reported high yields of cocoa in plots where *F. congesta* was used as soil cover.

Comparison of the cost of application of the treatments

Table 7 shows data on labour requirements and cost of each of the treatments in the 1994/95 season.

TABLE 7

Cost of Cocoa Establishment in 1994/95

Treatment	*No. of applications*	*Mandays/treatment*	*Mandays/hectare*	*Cost in cedis/ha*
Clean weeding		1.32 planting	8.2	
3 times + *F. macrophylla*	3	1.85 pruning	11.4	
		5.61 weeding	34.6	81,300.00
Clean weeding of cocoa lines		0.81 planting	5.0	
3 times + *M. pruriens*	3	7.08 weeding	43.7	73,050.00
Manual clean weeding 4 times per annum	4	9.54	58.9	88,350.00

1 Manday = 5 man hours = ¢1,500.00
1USD = ¢1,200.00 (Exchange rate in 1994/95)

Clean weeding three times per annum in combination with *F. macrophylla* was cheaper than clean weeding four times per annum. Although using *M. pruriens* as a cover crop incurred the least cost, the high seedling mortality and poor growth of the cocoa plants in this treatment made it relatively unsuitable for use in an integrated weed management programme in young cocoa.

Conclusion

This preliminary investigation has shown that *F. macrophylla,* when used in an integrated weed management programme, could contribute to the suppression of weeds, leading to the rapid growth of cocoa seedlings at lower costs than the traditional method of manual clean weeding four times per year.

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