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Contributing *to* Sustainable Agriculture

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Une contribution *à* *l'*agriculture durable

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D. Buckles, A. Etèka, O. Osiname, M. Galiba and/et G. Galiano

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Contents / Table des matières

Papers / Éxposés

❧ ❧ ❧

Abstracts and short reports / Résumés et abrégés

Using polythene bags to control the growth of *Mucuna* vines

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Résumé

Une plante de couverture de type *Mucuna* utilisée dans un système de cultures intercalaires peut causer des ravages en recouvrant la culture constituante, en lui faisant de l'ombre et en l'étouffant. Une expérience a été réalisée en 1997 à la station expérimentale du Crops Research Institute à Ejura, au Ghana, afin de voir si l'on pouvait empêcher les lianes de *Mucuna* de grimper en créant des obstacles avec des sacs en polythène. Des piquets recouverts de sacs en forme de cône (1) noirs et non perforés, (2) transparents et non perforés ou (3) transparents et perforés ont été plantés dans le *Mucuna*. Le traitement de contrôle s'est fait avec des piquets sans sac. Tous les sacs ont effectivement empêché le *Mucuna* d'atteindre le haut des piquets jusqu'à 96 jours après qu'ils ont été plantés. Cent vingt jours après qu'ils ont été plantés, le *Mucuna* de contrôle formait une voute d'un diamètre de 90 cm en haut des piquets. Les sacs faisaient obstacle en « piégeant » les lianes qui grimpaient le long des piquets. Bien que cette méthode soit probablement peu économique pour des cultures de récolte annuelle comme le maïs, elle est prometteuse pour les cultures de plantations.

Introduction

Velvetbean (*Mucuna* spp.) is one of the most widely used cover crops in the tropics. Its benefits include fixation of atmospheric N (Osei-Bonsu and Asibuo 1997), improvement of the soil's physical properties (Hulugalle et al. 1986), and weed control (Versteeg and Koudokpon 1990). *Mucuna* is a vigorous, climbing annual legume (Wilmot-Dear 1984), and it can become a pest in an intercropping system by climbing and shading the component crop and reducing the yield (Osei-Bonsu and Asibuo 1997). If *Mucuna* is intercropped with short-season crops such as maize, *Mucuna* planting can be delayed to allow the crop to be harvested before the *Mucuna* attains maximum growth and causes damage. This strategy cannot, however, be used with perennial crops, such as mangoes and oranges. With a perennial crop, *Mucuna* vines would have to be constantly pruned to prevent them from climbing, but pruning is tedious and time consuming.

It was hypothesized that a barrier, such as a polythene bag, could prevent *Mucuna* from climbing, either by diverting its direction of growth or by trapping it. The direction of growth would be diverted if *Mucuna* "detected" the bag (through the mechanism of tropism) and bent away from it. If conditions in the bag, such as temperature, darkness, and relative humidity (RH), were unfavourable, detection would occur. *Mucuna* vines could, on the other hand, be trapped by the bag if they failed to detect it in the absence of the unfavourable conditions mentioned above. Based on this hypothesis, we conducted a study to determine whether *Mucuna* vines could be physically prevented from climbing if polythene bags were used as a barrier.

Materials and methods

The study was conducted at the Crops Research Experimental Station, Ejura, Ghana, in 1997. The study area falls within the forest–savannah transition zone, with a bimodal rainfall pattern. The major season begins in April and ends in July, and the minor season begins in September and ends in mid-November. Mean total rainfall for the major season is 1 200 mm; for the minor season, 800 mm. The experimental treatments were *Mucuna* staked with poles fitted with (1) black unperforated (black), (2) transparent, unperforated (transparent), or (3) transparent, perforated (perforated) polythene bags. Poles without bags were used as the control. The experimental design was a randomized complete block, replicated three times. Each plot had three poles spaced 3 m apart. Each bag, with open ends, was fitted to form a conical structure around a pole: the vertex of the cone (bag) was tightly tied to the pole with twine, and the base of the cone remained open. With this arrangement, vines had entry into the bags through the bases but no exit through the vertexes (Figure 1).

The polythene material used was about as thick as ordinary paper. Holes for the perforated bags were made with a penknife and were about 1 cm long and 3 cm apart. *Mucuna pruriens* var. *utilis* was planted on 20 May at a spacing of 80 cm × 40 cm and was staked 10 d after emergence. The central pole of each plot was used for data collection. Temperature and RH were measured (the latter with a hygrometer) within the bags and also at 120 cm above the ground for the control. Photosynthetically active radiation (PAR) was measured with a Sunfleck Ceptometer™ (Decagon Devices Inc., Pullman, WA, USA), and fractional light interception (FLI) was calculated with the following formula:

$$f = (A - B) \times 100/A$$

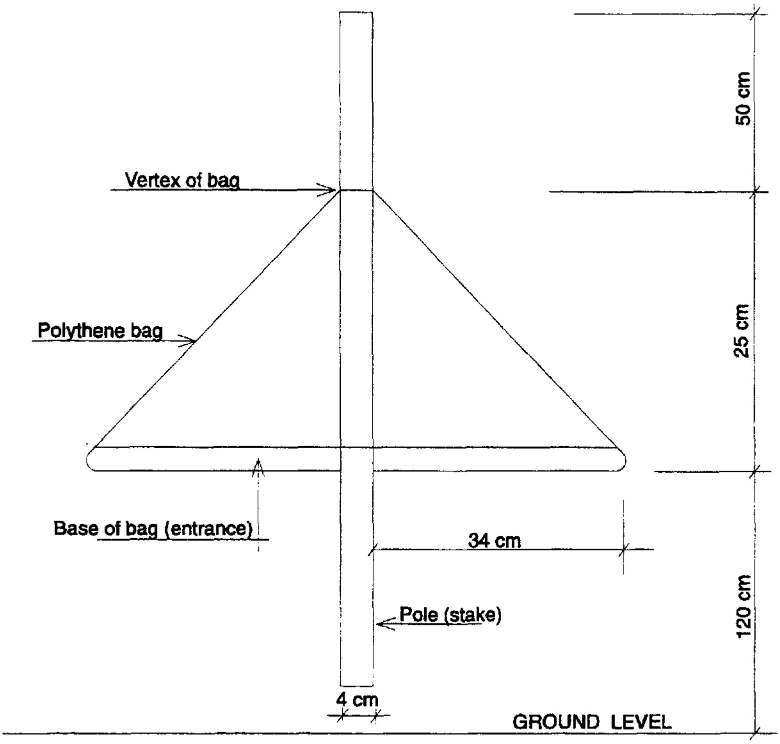

Figure 1. A pole fitted with a polythene bag. Note: Not to scale.

where f is FLI; A is ambient PAR; and B is canopy PAR (Monteith 1977).

PAR for FLI at 0 d after staking (DAS) was measured at the base of the bags immediately after staking, but subsequent PAR was measured above the vertex.

For biomass assessment at 160 DAS (at full-podding stage), the *Mucuna* vines on each pole were cut into three parts: bottom (from ground level to 120-cm height); middle (120–145 cm height); and top (above 145-cm height). The biomass was oven dried for 72 h at 105°C and then weighed.

Results and discussion

Temperature and RH within the bags and around the control poles at the start of the experiment did not differ significantly (data not shown). However, FLI did differ significantly ($p < 0.01$) and was highest for the black bag (32%) and lowest (2%) for the control (Table 1).

Table 1. RH and FLI within *Mucuna* canopy and polythene bags.

Treatment	RH (%)	FLI (%)			
		0 DAS	60 DAS	120 DAS	160 DAS
Transparent	73.5	20	2	4	59
Perforated	70.8	21	4	5	38
Black	72.5	32	3	4	58
Control	69.3	2	46	56	98
CV (%)	1.1	10.9	9.3	8.4	9.3
$LSD_{(0.05)}$	2.4	7	3	3	2

Note: CV, coefficient of variation; DAS, days after staking; FLI, fractional light interception; LSD, least-significant difference; RH, relative humidity.

Mucuna vines were first observed climbing the poles 17 DAS, irrespective of treatment. By 32 DAS the vines in the control group had reached the top of the poles, and by 120 DAS they had formed a canopy 90 cm wide on top of these poles. Although the number of vines at the base of the poles did not differ significantly at 120 DAS (Table 2), no vine reached the top of the poles with bags during this period. FLI of the *Mucuna* canopy on top of the poles in the control group was 46% at 60 DAS and 56% at 120 DAS; the highest FLI for the other treatments at 120 DAS was only 5% (see Table 1). Absence of foliage on top of the poles with bags explains the low FLI recorded in these treatments. All the vines that climbed the poles with bags entered the bags and were trapped at the vertex, as hypothesized.

Table 2. Number of vines at 120 DAS and DW of biomass at 160 DAS per pole.

Treatment	Number of vines		DW of biomass (g)			
	Bottom	Top	Bottom	Middle	Top	Total
Transparent	78	—	550	225	150	925
Perforated	84	—	701	373	125	1 202
Black	81	—	500	175	126	801
Control	87	73	875	400	349	1 625
CV (%)	7.5	—	18.5	14.9	15.8	12.4
$LSD_{0.05}$	NS	—	NS	150	100	451

Note: CV, coefficient of variation; DAS, days after staking; LSD, least-significant difference; NS, not signifucant. Totals are rounded.

Inside the bags, development and growth of new leaves occurred, but we observed that growth occurred at a lower rate in the black and transparent bags than in the perforated ones. As the quantity of biomass increased in the bags, drops of water appeared and remained inside the black and transparent bags, which might have caused the increased RH recorded in Table 1. With time, the tips of the vines and leaves began to burn and rot, probably as a result of the high humidity. Of the vines that entered the bags, virtually none reemerged, and about 60% were wilted by the end of the experiment.

The vines reached the top of the poles with bags in the same period (between 128 and 132 DAS) by climbing over the bags. This became possible when *Mucuna* foliage formed around the poles up to the base of the bags and blocked the entrance.

Vines from different directions tended to bend toward an upright-growing vine or vines (in one observation, we counted up to 68 vines intertwined). Consequently, once a vine had climbed over a bag, many more also climbed over the bag, using the first vine for support.

Understanding the mechanism underlying this process of bending (which is likely to be linked with tropism) may help researchers find a solution to the problem of climbing and shading.

The quantities of biomass that accumulated at the bottom, middle, and top of the poles at 160 DAS are presented in Table 2. Statistically, the dry weight (DW) of the biomass did not differ among treatments at the bottom of the poles but did differ at the middle and top (see Table 2). The least biomass was formed at the middle of the poles with black and transparent bags, indicating suppressed growth in these bags. Shade (in the black bag) and poor aeration might have contributed to the suppressed growth. Vines in the control group accumulated 349 g DW of biomass on top of the poles, whereas those in the treatments with bags accumulated a maximum of 150 g DW.

The total biomass accumulated per pole was lowest (801 g DW) with the black bags and highest (1624 g DW) for the control. There were no significant differences among bag treatments, but these groups accumulated a significantly lower total biomass per pole than the control group (see Table 2).

At 160 DAS, FLI of the *Mucuna* canopy on top of the poles reached 98% in the control group, whereas that for the other treatments ranged between 38 and 59% (see Table 1).

Conclusions

The study showed that *Mucuna* vines can be prevented from climbing if a barrier is placed against the direction of their growth. Although this method is unlikely to be economical for *Mucuna* intercropped with annual crops such as maize, it holds promise for use with plantation crops. Further studies are required to determine the effect of the bags on crop growth and to determine the optimum size of bags that would prevent any climbing whatsoever.

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