

Evaluation of Potential Allelopathic relationship between Velvet bean (*Mucuna cochinchinensis* (Lour.) A. Chev) and Speargrass (*Imperata cylindrica* (L.) Raeushel) with Selected methods

ABSTRACT

Velvetbean [*Mucuna cochinchinensis* (Lour.) A. Chev] has been reported to smother the growth of Speargrass [*Imperata cylindrica* (L.) Raeushel.] through competition and potential allelopathic effect on speargrass.

Greenhouse experiments involving three methods were conducted at International Institute of Tropical Agriculture (IITA), Ibadan Nigeria in 2009. The aim of the trials was to establish if *Mucuna* exhibits allelopathic effect on speargrass, besides smothering effect. These methods included: (1) *Mucuna* fresh parts [(Leaves (L), leaves + vine (L+V), vine (V) and roots (R))] incorporation into pot planted to speargrass rhizome and a control pot without *Mucuna* part incorporation; (2) *Mucuna* plant part extracts (of leaves, leaves + vines, vines and roots) and control with ordinary water; and (3) *Mucuna* seed and speargrass rhizome interplant (One *Mucuna* seed-interplant, Two *Mucuna* seeds interplant and Three-*Mucuna* seeds interplant).

Results showed that every *Mucuna* part has the potentials of being allelopathic to speargrass. Incorporating *Mucuna* parts into pot with speargrass reduced both speargrass shoot height and number by ≥ 20 % and ≥ 50 % respectively. Similarly *Mucuna* parts extract on the average, reduced shoot and rhizome biomass by ≥ 60 % and ≥ 50 % respectively when compared to the control. The pot interplant method on the average showed a reduction of speargrass shoot and rhizome biomass by ≥ 20 % and ≥ 16 % respectively. The effect of speargrass and *Mucuna* interplant on speargrass shoot height was not variable between the speargrass-*Mucuna* interplant and the sole speargrass control except at 12 WAP.

This investigation revealed that *Mucuna* also exhibits allelopathic effect on speargrass, and this could serve as a bio-control method for speargrass. All the *Mucuna* parts studied have the potentials of exhibiting allelopathy effect on neighboring and susceptible plants. The allelopathy effect appears to be greater with the leaves or the vines or both.

Key words: Allelopathy, *Mucuna*, *Imperata*, extract, incorporation

INTRODUCTION

Velvetbean [*Mucuna cochinchinensis* (Lour.) A. Chev] is an annual legume that grows vigorously to provide early ground cover. This attribute of *Mucuna* spp has numerous agronomic advantages. The advantages of velvetbean ranges from providing green manure, nitrogen fixation, smothering of weed growth to reduction in the population of

plant-parasitic nematodes [1, 2]. According to [3,4], velvetbean increases the yield of its companion crops reduces the population of nematodes, and smothers or suppresses the growth of noxious weeds such as speargrass (*Imperata cylindrica*(L.)Raeuschel.[5]. The aspect of suppression of speargrass is of great importance in tropical production systems. This is because speargrass interference is a major challenge for crop production in sub-Saharan Africa with a great cost in both financially and physically resources. Speargrass is a strong competitor with crops. Crop yield losses vary as a function of crop type, cultural practices and environmental conditions. In corn, grain yield reductions of 80% [5, 6] have been reported. Velvetbean mechanism of suppression of noxious weeds such *Cyperus* spp, and *Imperata cylindrica*, is yet to be fully understood. Past studies with speargrass have implicated shading effect and competition for nutrient as the possible effect of smothering or suppression of this weed [7]. Others have suggested possible allelopathic effect of mucuna on speargrass and other weeds [8, 9].

. Hence, the objective of this present study was to explore three different methods to establish the potential allelopathic effect of *Mucuna cochinchinensis* on speargrass (*Imperata cylindrica*)

2.0 MATERIALS AND METHODS

2.1 Study Location

This was a greenhouse experiments conducted twice at the International Institute of Tropical Agriculture (IITA)(7° 30'N, 3° 54'E) Ibadan, in the forest/savanna transition zone of Nigeria; during the 2009 planting season.

2.2 Allelopathy Methods Studied

Three methods were used in determining the allelopathic effect of velvet bean (*Mucuna cochinchinensis* (Lour.) A. Chev on Speargrass (*Imperata cylindrica* (L.) Raeuschel).

2.2.1 Fresh mucuna parts incorporation method

Referring to [8], five treatments including mucuna leaves, (L), vines, (V), mucuna leaves + vines, (L+V) and roots, (R) (1.0% WW in dry weight equivalent) were incorporated into the soil containing one speargrass stand per pot and replicated five times. The control treatment was without mucuna plant part incorporation. The incorporation of the fresh mucuna plant parts was done at 6 weeks after planting speargrass (WAP) and this practice was carried out weekly until 12 WAP. Four parameters of speargrass shoot height, shoot number, shoot and rhizome dry weight were recorded monthly (4 WAP) till 4 months after planting (16 WAP).

2.2.2 Mucuna Extracts

Velvet bean was grown out-of-doors in pots containing 35kg of river sand at the International Institute of Tropical Agriculture, Ibadan, Nigeria. Three months after planting, the main stem of each plant was cut at ground level, and the soil was washed gently from the roots. The mucuna plants harvested were partitioned into main and fine roots, leaf blades only (L), Leaf blade + vines (L+V), and vines (V) only and root only (R). The mucuna plant parts (L, V, L + V and R), were air-dried for 24 hours and 25g of each mucuna part was soaked in 1 liter of water in a flask for 48 hours at room temperature. The extract was strained through two layers of cheese cloth. The liquid extract of the mucuna plant parts (1L) were used in wetting the speargrass shoots in the pots [10]. Hundred percent stock solution of each mucuna plant part was used undiluted, and this was compared with ordinary water as control. The wetting was done every two days till 12 WAP. The treatments including the control were replicated five times. Four parameters of speargrass: height, shoot number, shoots and rhizome dry weights were recorded at 12 and 16 WAP.

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94 2.2.3: Pot interplant

95 This was achieved by growing speargrass and mucuna together in one pot (donor and
96 receiver plant together in control environment)^[11]. Speargrass rhizome segment 5 cm long
97 with one visible bud and node were planted at one segment per pot. The pots were filled
98 with sterilized soil and planted with mucuna and speargrass to constitute the treatments as
99 follows: treatment one (T1) had one mucuna seed planted with speargrass rhizome;
100 treatment two (T2) had two mucuna seeds planted around one speargrass rhizome segment;
101 treatment three (T3) had three mucuna seeds planted to one *Imperata* rhizome segment
102 and the control had only one speargrass rhizome segment planted in it. These four
103 treatments were replicated six times. The mucuna vines were staked so as to prevent the
104 plant(s) from growing on the speargrass shoot. Thus the only access or contact of mucuna
105 parts to the pot was through litter fall and possibly by the root or root exudate

106 Statistical Analysis

107 The experiment was repeated for each evaluation method, and the means of the
108 experiments were treated as replicates in a completely randomized design for analysis of
109 variance, and the means were compared using the protected LSD test at the 5% level of
110 significance.

111 3. RESULTS

112 3.1 Effect of fresh mucuna parts incorporation on speargrass

113 The results showed no significant difference between the mean values of speargrass
114 height, numbers of shoots in studied treatments as compared to the control at 4WAP,
115 before applying treatments (Table 1 and Fig. 1). However, after incorporation of the
116 mucuna treatments at 6WAP, the effect of the mucuna incorporation began to show at
117 8WAP where the numbers of speargrass shoots at the control were significantly higher

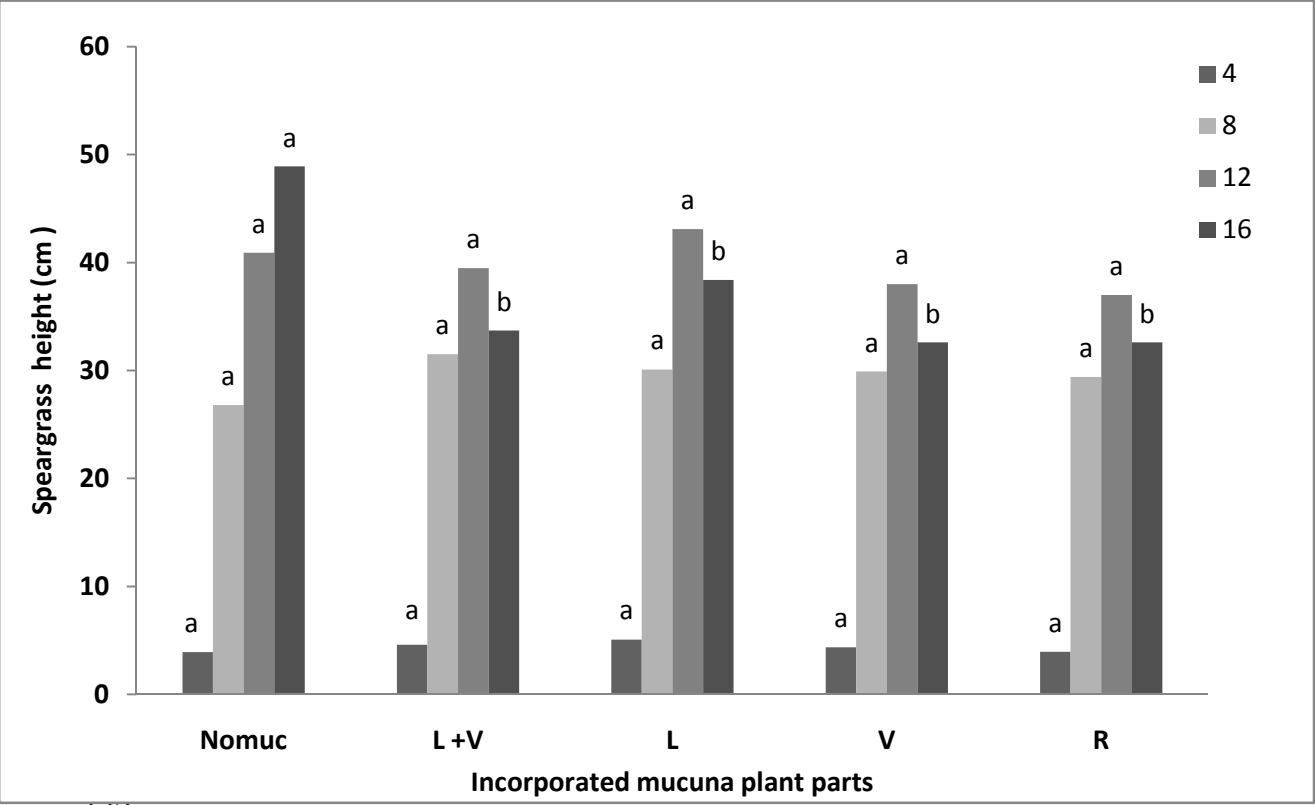
than the number of shoots in the treatments that received mucuna parts. The effect on plant height did not differ significantly among the treatments (Figure 1). At 12WAP, speargrass in no mucuna were not significantly ($P \leq 0.05$) taller than the other treatments contrasting with the number of speargrass shoots characterized by significant lower values in the mucuna incorporated pots when compared to the control pot. At harvest (16WAP), shoot and rhizome dry biomass of speargrass were significantly ($P < 0.05$) higher in the control pots without mucuna than in the mucuna parts incorporated treatments. Mucuna parts did not differ significantly on their respective effect on the speargrass growth parameters measured. Fresh mucuna parts reduced speargrass shoot number to about 60% and the rhizome by $\geq 50\%$ (Table 1). Although there were no differences between mucuna parts on their effect on speargrass but mucuna leave + vine incorporation appeared to have a greater effect on speargrass shoot and rhizome (Table 1). There were no significant ($P > 0.05$) plant height differences between treatments before mucuna plant parts were incorporated at 4WAP. Similarly, there were no significant height differences among the treatments at 12 WAP, although mucuna plant parts were incorporated which was 6 weeks ago. However, at 16 WAP, which was 10 weeks after the mucuna parts were incorporated, significant height differences were observed between the control pot and the mucuna treatment pots. In terms of speargrass height, the mucuna parts incorporation reduced speargrass height as follows: mucuna root and vine by 33.3%; mucuna leaves + vine by 31.1% and mucuna leaves by 21.5% when compared to the control without mucuna. The result here indicates that fresh mucuna plant parts incorporation reduced speargrass height to $\geq 20\%$ of the control without mucuna (Figure 1).

141 **Table 1. Effect of soil incorporated mucuna plant parts on speargrass shoot number and**
 142 **biomass**

Mucuna plant part	Speargrass					
	Shoot number per pot (WAP)				Dry biomass per pot (g) at 16 WAP	
	4	8	12	16	Shoot	Rhizome
No mucuna(Nomuc)	1.0a	2.0a	2.0a	3.0a	2.175a	2.450a
Leaf + Vine(L+V)	1.0a	1.0b	1.0b	1.0b	0.475b	0.700b
Leaf (L)	1.0a	1.0b	1.0b	1.0b	0.575b	0.750b
Vine(V)	1.0a	1.0b	1.0b	1.0b	0.675b	1.175b
Root (R)	1.0a	1.0b	1.0b	1.0b	0.625b	0.925b
LSD(P=0.05)	0	0.5	0.5	0.8	0.684	0.917

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 147 **Figure 1: Effect of soil incorporated mucuna plant parts on speargrass height from**
 148 **4 to 16 weeks after planting (WAP) (Mean values for height with the same**
 149 **letter on a bar are not significantly different at P <0.05)**

3.2 Effect of mucuna extracts on speargrass

The effect of mucuna extract on speargrass height, number of shoots, shoot dry weight and rhizome dry weight were determined. At 4WAP, speargrass shoot height in the control treatment was significantly ($P \leq 0.05$) taller than all the mucuna extract treatments except the mucuna root extract treatment (R) ($P > 0.05$). In terms of speargrass shoot number there were not significant ($P > 0.05$) differences between the control and the various mucuna part extracts at 4WAP (Figure 2). The treatment effect started showing at 8WAP when speargrass height, and shoot number as recorded in the control treatments were significantly ($P \leq 0.05$) higher than those from the mucuna extract treatments. At 12 WAP, speargrass in the control plots were significantly ($P \leq 0.05$) taller than all the mucuna extract treatments except mucuna leaf (L) + Vine (V) extract. Mucuna leaf extract at 12WAP had a significant ($P < 0.05$) effect in lowering speargrass height compared to the other mucuna part extract (Figure 2). Speargrass shoot number on the other hand, did not differ significantly with the mucuna extract treatments but had significantly higher number of speargrass shoot than the mucuna extract treatments (Table 2). At 16 WAP, both speargrass shoot height and number were significantly ($P < 0.05$) lower in the mucuna extract treatments than in the control treatments without mucuna. Mucuna extract treatments did not differ significantly from each other in terms of their effect on shoot height and number, except for mucuna leaf extract that had a significantly short speargrass shoot than the other extract treatments (Figure 2). Shoot and rhizome dry weight were ($P < 0.05$) higher in the control treatments compared to the mucuna extract treatments, but mucuna extracts did not differ significantly on their effect on shoot and rhizome dry weight (Table 2). The effect of the mucuna part extracts on speargrass shoot/rhizome biomass reduction were in the following order of efficacy mucuna leaf (L) 75.7%/62.5% > mucuna vines (V) (68.6%/61.3%) > mucuna leaves + vine (L+V) (68.6%/55.3%) > mucuna root (R) (62.9%/51.8%) (Table 2). Thus averaged over mucuna extract parts, speargrass shoot and rhizome biomass were reduced by $\geq 60\%$ and $\geq 50\%$ respectively when compared to the control without mucuna (Table 2).

Table 2.Effect of mucuna plant part extracts on speargrass shoots number and biomass

Mucuna plant part	Speargrass					
	Shoot number per pot (WAP)				Dry biomass per pot (g) at 16 WAP	
	4	8	12	16	Shoot	Rhizome
No mucuna (Nomuc)	1.0a	1.8a	1.3a	2.0a	1.750a	2.53a
Leaf + Vine(L+V)	1.0a	1.0b	1.0a	1.0b	0.550b	1.13b
Leaf (L)	1.0a	1.0b	1.0a	1.3b	0.425b	0.950b
Vine(V)	1.0a	1.0b	1.0a	1.0b	0.550b	0.980b
Root (R)	1.0a	1.0b	1.0a	1.0b	0.650b	1.22b
LSD(P=0.05)	0	0.34	0.35	0.35	0.29	1.10

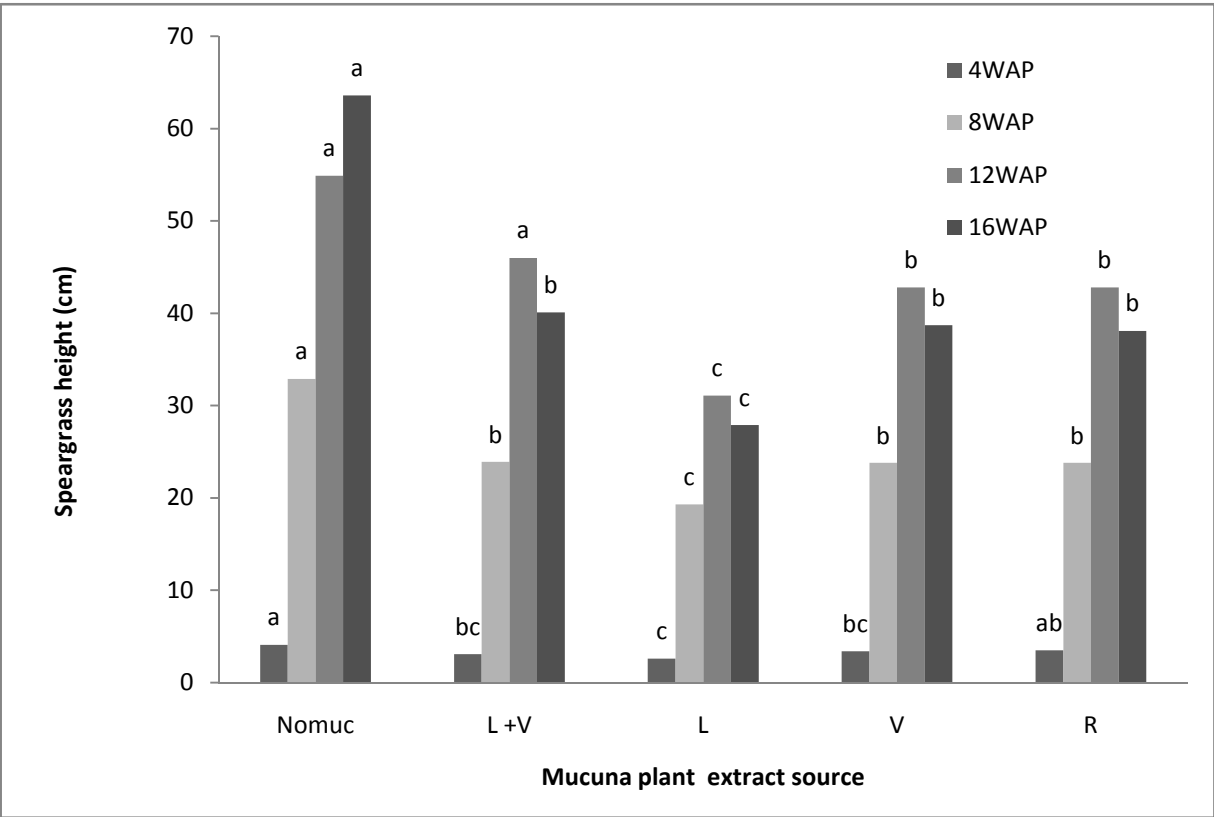


Figure 2: Effect of mucuna plant parts extracts on speargrass height from 4 to 16 weeks after planting (Mean values for height with the same letter on a bar are not significantly different at P <0.05)

1903 Effect of Mucuna and speargrass interplant on speargrass

191 The effect of mucuna and speargrass interplant on speargrass height, number of shoots, at
 192 4WAP were not significantly ($P \leq 0.05$) different from the control treatment without
 193 mucuna interplant (Table 3). However, at 8WAP (Table 3), speargrass shoots were
 194 significantly shorter (about 13%) in the mucuna-speargrass treatments compared to the
 195 control without mucuna but there were no significant differences between shoot number in
 196 the control treatment and the mucuna-speargrass inter-planted treatments. The treatment
 197 effect was conspicuous at 12WAP where the control was significantly ($P \leq 0.05$) higher
 198 than other treatments for plant height, and number of shoots, except one mucuna seed-
 199 speargrass interplant treatment. The mucuna treatments on the other hand did not differ
 200 on their effect on speargrass (Table 3). The effect of the mucuna-speargrass interplant on
 201 speargrass dry biomass at 16WAP was not significantly different from the control without
 202 mucuna. However, both speargrass shoot and rhizome dry weight were about 10-36 %
 203 and 17 % higher respectively in the control treatment than in the mucuna interplant
 204 treatment (Table 3).

205 Table 3. Effect of mucuna and speargrass interplant on speargrass height, shoot number and biomass

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Mucuna + Speargrass interplant	Speargrass									
	Plant height (cm)				Shoot number per pot (WAP)				Dry biomass per pot (g) at 16 WAP	
	4	8	12	16	4	8	12	16	Shoot	Rhizome
No mucuna interplant	4.8a	37.4a	60.3a	65.2a	1a	1.0a	2.5a	2.5a	2.05a	2.40a
T1(One mucuna seed interplant	4.8a	32.6a	41.8ba	37.5b	1a	1a	1b	1b	1.85a	2.00a
T2(Two mucuna seed interplant	5.0a	32.7a	38.8b	35.8b	1a	1a	1b	1.0a	1.85a	2.00a
T3(Three mucuna seed interplant	4.8a	32.7a	41.0b	34.5b	1a	1a	1b	1b	1.30a	2.00a
LSD($P=0.05$)	0.86	2.60	18.77	10.60	0	0	1.13	1.13	1.11	1.11

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DISCUSSION

This study provides evidence of competitiveness of mucuna on speargrass growth of which allelopathy potentials is suspected. All speargrass attributes measured (shoot height, number, dry biomass and rhizome dry biomass) were inhibited to a varying degree by the various mucuna either by incorporation into soil, extract of parts or by inter-planting with speargrass. Our result showed that parts of mucuna used for treatment had significant effects on all studied germination attributes of speargrass. This is evidenced in the fact that the treatment without mucuna parts produced the highest shoot height, shoot number and dry biomass. Similar effect of mucuna on weeds and speargrass suppression, biomass reduction has been reported by various researchers (Chikoye et al., 2006^[12]; Innocent et al., 2006^[13]; Udensi et al., 2005^[14]). This inhibition is a sign of the effect of mucuna on speargrass and similar effect have been reported by other research^[8]. The effect of the incorporation of the mucuna plant parts started showing two weeks after incorporation into the sand and by 16WAP; the speargrass shoot had turned brown (loss of chlorophyll content). The effect of soil incorporated cover crops residues on reduced germination and emergence of weed species have been reported (Kruidhof et al., 2009^[15]; Teasdale et al., 2007^[16]) and our result is in agreement with this report. It was also observed in the mucuna extract method, that the growth of speargrass was reduced after the addition of the liquid content from the mucuna plant parts. Unlike, the first method, the treatment effect started showing loss of chlorophyll content around 10WAP (or 4 weeks after incorporation (WAI)). The Pot screening method (mucuna-speargrass interplant), showed little or no difference from the control. This may be due to the experiment being in controlled environment and /or the duration of the experiment which may not have been enough for the mucuna root exudates to have negative effect on the growth and

development of the speargrass shoot. Growth suppression effect of mucuna on *Sphenostylis sternocarpa* and the evidence of its allelopathic interaction with this species in an intercropped situation has been reported (Nwaichi and Ayalogu, 2010^[17]). Though our result showed little differences between the intercropped with mucuna and the control for some of the speargrass parameters recorded but there is an indication of potential allelopathy effect. It is also possible to assume that mucuna allelopathy may be a function of both root exudates and leaf litter accumulation and decomposition. Thus the duration of the experiment may not have been enough to allow for sufficient interplant interaction and litter effect for the interference to manifest properly. It is reported that allelochemicals could be released to the environment as volatiles from leaves, stems, flowers, root exudation and leachates from aerial part and decomposition of residues (Kalinova, 2010^[18]). It has also been reported that incorporated cover crop residues mainly contribute to weed suppression by physical impediment and release of allelopathic compounds^[19]. In all the methods adopted for the present study, the fresh mucuna plant part incorporation and extract methods were observed to be more effective in determining the allelopathic potentials of mucuna on speargrass. In these methods, the fresh mucuna plant parts were able to retard the growth of speargrass and the extracts inhibited the formation of shoots and roots of *Imperata* rhizomes. This observation is supported by earlier research which reported that the main effect of allelopathic compound is delaying of radical and shoot growth^[20]. It has also been reported that most of the growth inhibitory effect of mucuna is associated with compound *L*-DOPA in both the plant parts and seed^[8, 9]. The concentration in mucuna parts tends to vary, but mucuna seed have been reported to contain more between 6-9% of *L*-DOPA^[21]. Our result here have

confirmed earlier report that weed suppression ability of mucuna may be as a result of competition for light and nutrients, as well as allelopathy. This result indicates that every part of mucuna plant has some allelochemicals with the potentials of being allelopathic to sensitive neighboring plants.

CONCLUSION:

This study has further provided evidence of mucuna competitiveness on the growth of speargrass of which allelopathy potentialis suspected. The results also point to the fact that the allelopathic effect may be more with the leaves and vines.

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