

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

Comment [t1]: *Mucuna cochinchinensis* is
synonym of *M. pruriens*

5 **ABSTRACT**

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

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

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

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

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

35 **INTRODUCTION**

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

plant-parasitic nematodes^[1, 2]. According to^[3, 4] velvet bean 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.^[3, 54].

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. Velvet bean mechanism of suppression of noxious weeds such *Cyperus* spp, and *Imperata cylindrical*, 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.

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65 2.2 Allelopathy Methods Studied

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

68 2.2.1 Fresh mucuna parts incorporation method

69 This method was taken from the author's reference indicated ^[8]. The experiment
70 comprise of five treatments that were replicated five times. With this method mucuna
71 leaves, (L), vines, (V), mucuna leaves + vines, (L+V) and roots, (R) (1.0% WW in dry
72 weight equivalent) were incorporated into the soil containing one speargrass stand per
73 pot. The control treatment was without mucuna plant part incorporation. The
74 incorporation of the fresh mucuna plant parts was done at 6 weeks after planting
75 speargrass (WAP) and this practice was carried out weekly until 12WAP. Four
76 parameters of speargrass shoot height, shoot number, shoot and rhizome dry weight were
77 recorded monthly (4 WAP) till 4 months after planting (16 WAP).

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78 2.2.2 Mucuna Extracts

79 Velvet bean was grown out-of-doors in pots containing 35kg of river sand at the
80 International Institute of Tropical Agriculture, Ibadan, Nigeria. Three months after
81 planting, the main stem of each plant was cut at ground level, and the soil was washed
82 gently from the roots. The mucuna plants harvested were partitioned into main and fine
83 roots, leaf blades only (L), Leaf blade + vines (L+V), and vines (V) only and root only
84 (R). The mucuna plant parts (L, V, L + V and R), were air-dried for 24 hours and 25g of
85 each mucuna part was soaked in 1 liter of water in a flask for 48 hours at room
86 temperature. The extract was strained through two layers of cheese cloth. The liquid
87 extract of the mucuna plant parts (1L) were used in wetting the speargrass shoots in the
88 pots ^[10]. Hundred percent stock solution of each mucuna plant part was used undiluted,
89 and this was compared with ordinary water as control. The wetting was done every two
90 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.

2.2.3: Pot interplant

This was achieved by growing speargrass and mucuna together in one pot (donor and receiver plant together in control environment) ^[11]. Speargrass rhizome segment 5 cm long with one visible bud and node were planted at one segment per pot. The pots were filled with sterilized soil and planted with mucuna and speargrass to constitute the treatments as follows: treatment one (T1) had one mucuna seed planted with speargrass rhizome; treatment two (T 2) had two mucuna seeds planted around one speargrass rhizome segment; treatment three (T 3) had three mucuna seeds planted to one *Imperata* rhizome segment and the control had only one speargrass rhizome segment planted in it. These four treatments were replicated six times. The mucuna vines were staked so as to prevent the plant(s) from growing on the speargrass shoot. Thus the only access or contact of mucuna parts to the pot was through litter fall and possibly by the root or root exudate

Statistical Analysis

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

3.0 RESULTS

3.1 Effect of fresh mucuna parts incorporation on speargrass

The results obtained showed that speargrass plant height, numbers of shoots were not significantly different from the control at 4WAP, (that is before the treatments were

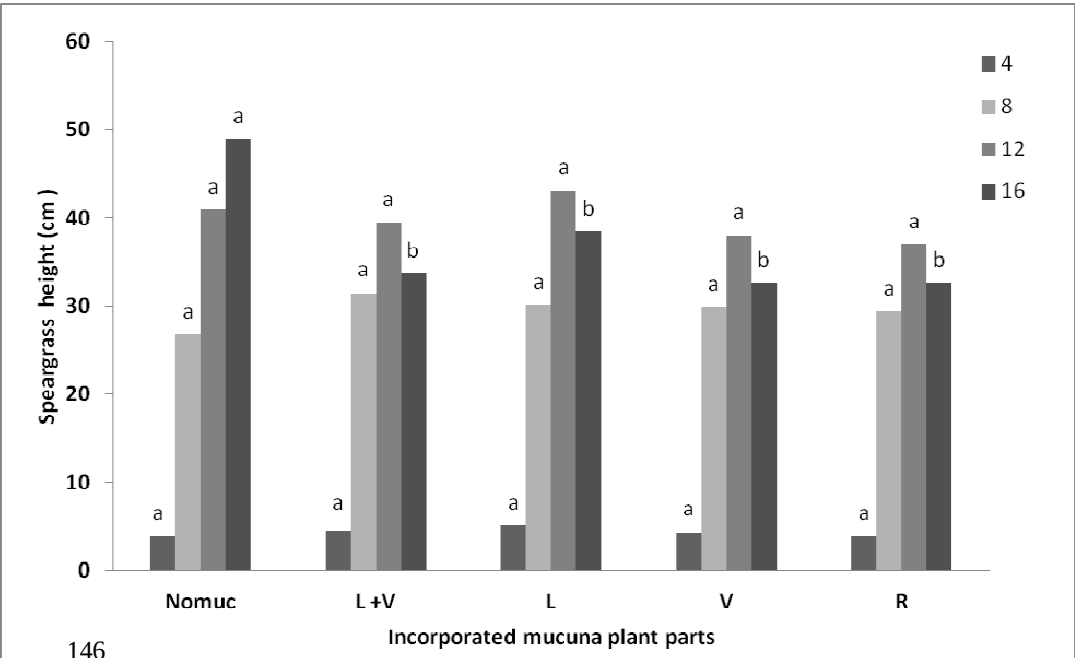
117 applied at 6 WAP) (Table 1 and Fig. 1). However, after incorporation of the mucuna
118 treatments at 6WAP, the effect of the mucuna incorporation was visible at 8WAP where
119 the numbers of speargrass shoots at the control were significantly higher than the number
120 of shoots in the treatments that received mucuna parts. The effect on plant height did not
121 differ significantly among the treatments (Figure 1) .At 12WAP, speargrass in no mucuna
122 were not significantly ($P \leq 0.05$) taller than the rest of the treatment but numbers of
123 speargrass shoots were significantly lower in the mucuna incorporated pots when
124 compared to the control pot without mucuna. At harvest (16WAP), shoot and rhizome dry
125 biomass of speargrass were significantly ($P < 0.05$) higher in the control pots without
126 mucuna than in the mucuna parts incorporated treatments. Mucuna parts did not differ
127 significantly on their respective effect on the speargrass growth parameters measured.
128 Fresh mucuna parts reduced speargrass shoot number to about 60% and the rhizome by $\geq$
129 50% (Table 1). Although there were no differences between mucuna parts on their effect
130 on speargrass but mucuna leave + vine incorporation appeared to have a greater effect on
131 speargrass shoot and rhizome (Table 1). There were no significant ($P > 0.05$) plant height
132 differences between treatments before mucuna plant parts were incorporated at 4WAP.
133 Similarly, there were no significant height differences among the treatments at 12 WAP,
134 which was 6 weeks after mucuna plant parts were incorporated. However, at 16 WAP,
135 which was 10 weeks after the mucuna parts were incorporated, significant height
136 differences were observed between the control pot and the mucuna pots. In terms of
137 speargrass height, the mucuna parts incorporation reduced speargrass height as follows:
138 mucuna root and vine by 33.3%; mucuna leaves + vine by 31.1% and mucuna leaves by
139 21.5% when compared to the control without mucuna. The result here indicates that fresh

140 mucuna plant parts incorporation reduced speargrass height to ≥ 20 % of the control
 141 without mucuna (Figure 1).

142 | **Table1. Effect of soil incorporated mucuna plant parts on speargrass shoot number and**
 143 **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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Figure 1: Effect of soil incorporated mucuna plant parts on speargrass height from 4 to 16 weeks after planting (WAP) (Mean values for height with the same 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 spear grass 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 shoots number there were not significantly ($P > 0.05$) differences between the control and the various mucuna part extracts at 4WAP (Figure 2). The treatment effect started showing at 8WAP where speargrass height, and shoot number measured from the control treatments were significantly ($P \leq 0.05$) higher than those from the mucuna extracts. At 12 WAP, speargrass in the control plots were significantly ($P \leq 0.05$) taller than all the mucuna extract treatments except mucuna leaves (L) + Vine (V) extract. Mucuna leaves 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 extracts treatments did not differ significantly from each other in terms of their effect on shoot height and number, except for mucuna leaves 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 leaves (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

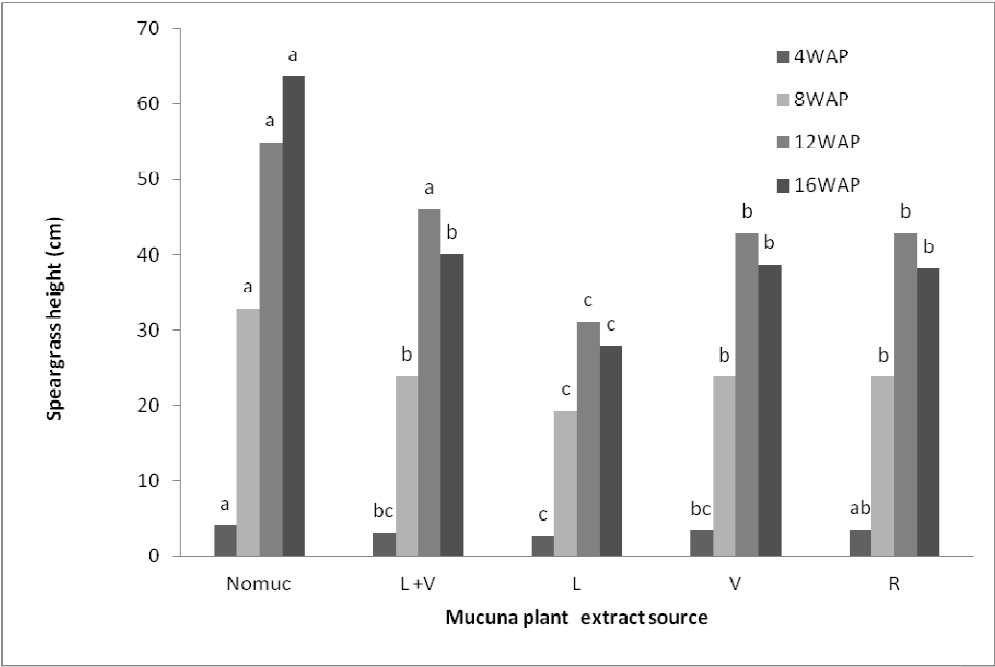
179 extract parts, speargrass shoot and rhizome biomass were reduced by $\geq 60\%$ and $\geq 50\%$
 180 respectively when compared to the control without mucuna (Table 2). .

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182 **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

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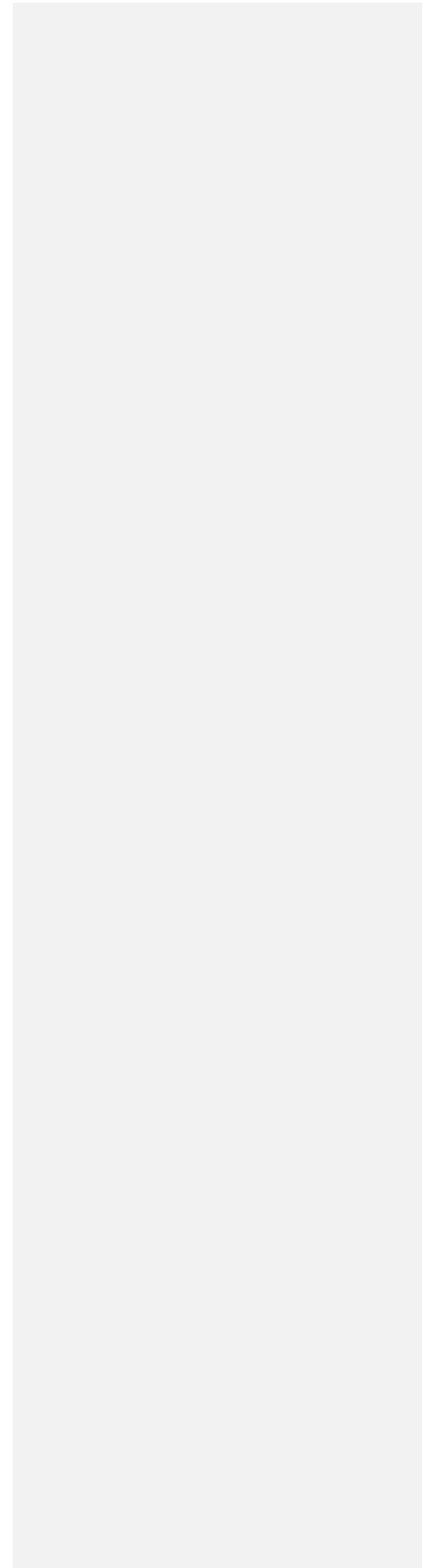


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Figure 2: Effect of mucuna plant parts extracts on **speargrass** height from 4 to 16 weeks after planting (Mean values for height with the same letter on a bar are not significantly different at $P < 0.05$)



ALLELOPATHY=REGENERATION METHODS

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203 speargrass dry biomass at 16WAP was not significantly different from the control

204 without mucuna. However, both speargrass shoot and rhizome dry weight were about 10-

205 36 % and 17 % higher respectively in the control treatment than in the mucuna interplant

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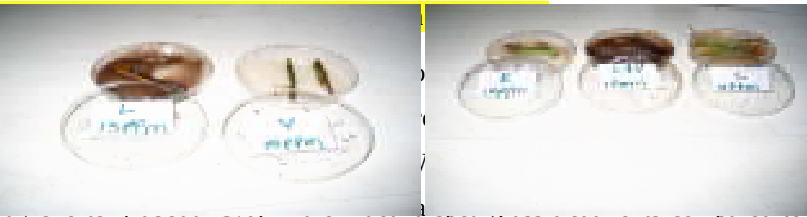


Fig 3a. Extract concentration= 15 ppm



Fig 3b. Extract concentration= 30 ppm

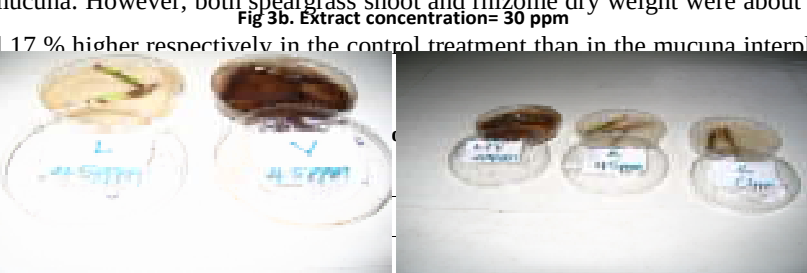


Fig 3 c. Extract concentration= 45 ppm

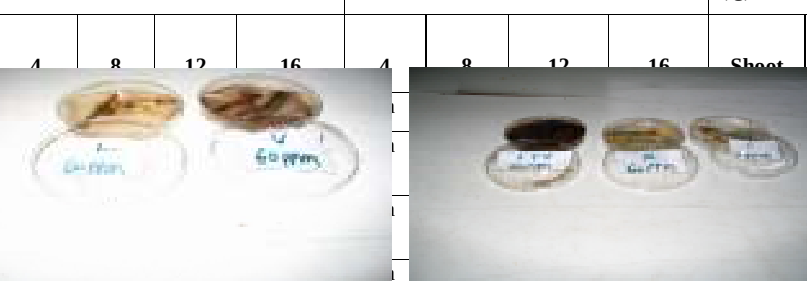


Fig 3 d. Extract concentration= 60ppm

Mucuna + Speargrass interplant	Plant height (cm)				Shoot number per pot (WAP)				Dry biomass per pot (g) at 16 WAP	
	Fig 3 c. Extract concentration= 45 ppm								Shoot	Rhizome
	4	8	12	16	4	8	12	16		
No mucuna interplant										2.40a
T1(One mucuna seed interplant										2.00a
T2(Two mucuna seed interplant										2.00a
T3(Three mucuna seed interplant										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 on the allelopathic potentials of mucuna on speargrass growth. 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. 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). 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 significant 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. It is also possible to assume that mucuna allelopathy may be a function of both root exudates and leave 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. 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 [12]. 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 [13]. 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 through the three methods of assay used has provided evidence of the potential allelopathic effect of Velvet bean (*Mucuna cochinchinensis* (Lour.) A. Chev on the growth of speargrass (*Imperata cylindrica*). The results also point to the fact that the allelopathic effect may be more with the leaves and vines.

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