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Suppression of *Imperata cylindrica* (Speargrass) and Changes in Weed Flora in Yam and Cassava Fields

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Abstract: Experiments were conducted on farmers' fields in the forest-savannah transition zone of Ghana to assess the effectiveness of glyphosate, land preparation and mucuna alone or in combination to smother speargrass. The aim was to reclaim lands that have been abandoned because of speargrass to produce yam and cassava. A randomized complete block design with three treatments in one experiment and four treatments in another was used. The density of speargrass on the plots that were ploughed before mucuna was planted were 0.6-0.7, 0.3-0.4 and 0.2% that of the fallow plot at 3 Months After Treatment (MAT). The density of speargrass at 6 MAT was 0.35% that of the fallow plots when glyphosate was sprayed before planting mucuna. When glyphosate alone was sprayed, the density at 6 MAT had increased from 2 to 13% that of fallow whilst mucuna planted on hoed plots resulted in a reduced density from 54 to 22% of that of the fallow plot. Thus hoeing plots before planting mucuna enhanced the effectiveness of mucuna to smother speargrass. However, mucuna could not smother speargrass on plots which were slashed before planting. When the initial population of speargrass was controlled with glyphosate, mucuna effectively smothered the regrowth of speargrass and associated weeds. The most dominant weed that could not be smothered by mucuna or killed by glyphosate are *Commelina* sp. The results show that lands that have been abandoned because of speargrass can be reclaimed in about seven months by planting mucuna on such fields with an initial cultivation or by spraying with glyphosate followed by mucuna.

Key words: Glyphosate, *Imperata cylindrica*, land preparation, mucuna, weed flora

Introduction

Imperata cylindrica (L.) Raeuschel (speargrass) is a noxious perennial grass which is widely distributed in tropical Asia, some parts of West Africa and Latin America (Holm *et al*., 1977). *Imperata cylindrica* is propagated by rhizomes and white fluffy spikelets which are dispersed by wind. Holm *et al*. (1977) described *I. cylindrica* as one of the 10 most infamous weeds in the world which affects mainly smallholder farmers who practice slash-and-burn agriculture. Friday *et al*. (1999) contend that fires which are used to clear vegetation in slash-and-burn agriculture perpetuate the weed not only by stimulating the rhizomes to sprout but also prevent the growth of secondary forests that would otherwise shade it. *Imperata cylindrica* is very aggressive and competes with food and plantation crops. In Asia, for example, it has been shown that the weed retards the growth of rubber [*Hevea brasiliensis* (Willd. Ex. Adr. Juss) Muell, Arg] by up to 96% within a period of 5 years (Soedarsan, 1980). In West Africa, Koch *et al*. (1990) and Udensi *et al*. (1999) reported yield losses of 62-80% in maize (*Zea mays* L.) and cassava (*Manihot esculenta* Crantz). Apart from the direct yield

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losses, vast areas of potentially good arable land have been abandoned in some parts of West Africa because smallholder farmers cannot effectively control *I. cylindrica* (Terry *et al*., 1997). Other reasons for abandoning land include poor crop yields, low cash returns, the high labour input needed to cultivate fields infested with this weed, as well as injuries inflicted on the farmer by *I. cylindrica* ramets (Terry *et al*., 1997). The rhizomes of the weed also pierce roots and tubers of yam and cassava thereby creating avenues for secondary infestation by other insect pests and disease pathogens. The weed can be controlled or managed effectively with an adequate supply of labour, machinery and herbicides. Willard *et al*. (1996) observed that two mowings or discings were generally more effective in controlling *I. cylindrica* than single mowing or discing. Bolfrey-Arku *et al*. (2002) also observed that a combination of ploughing and planting mucuna resulted in the best control. Willard *et al*. (1996, 1997) reported that applying either glyphosate at 3.4 kg ha^{-1} or imazapyr at 0.8 kg ha^{-1} alone caused the greatest reduction in shoot and rhizome biomass about 2 years after application. However, the cost of ploughing and herbicides are not always within the reach of many smallholder farmers who depend mainly on machetes and hoes to control weeds. In addition, the problem of soil erosion due to improper ploughing is a serious concern to many farmers. In this regard alternative methods that are less expensive and more friendly to the environment are needed to help farmers manage the weed. The use of velvetbean *(Mucuna pruriens* L.) and other legumes as cover crops to help smother *I. cylindrica* and reclaim abandoned farmlands has been reported (Akobundu, 1992; Versteeg *et al*., 1998; Akobundu *et al*., 2000; Chikoye and Ekeleme, 2001; Bolfrey-Arku *et al*., 2002).

The objectives of this study were to investigate (i) whether an initial cultivation of the soil affects the effectiveness of mucuna to smother speargrass (ii) whether glyphosate alone or glyphosate followed with mucuna is effective in controlling speargrass for more than a season (iii) whether glyphosate or mucuna can control all weed species that exist with speargrass and (iv) the effectiveness of cropping mucuna for one or two seasons in controlling speargrass.

Materials and Methods

Experiments were established in May 2000 at eight sites on farmers' fields in the Ejura-Sekyedumase District (7° 5' N, 1° 3' W) in the Ashanti Region and Wenchi District (7° 7' N, 2° 1' W) in the Brong Ahafo Region of Ghana as:

Experiment One

A randomized complete block design with three treatments and four replications was used. Plot size was 10×5 m. The treatments were:

T_1- mucuna planted for 1 season; T_2 - mucuna planted for 2 seasons; T_3 -fallow

This experiment was established at four sites - Koase (Wenchi District), Kobriti-1, Kobriti-2 and Dromankoma (Ejura-Skyedumase District) and monitored till September 2003.

Mucuna (*Mucuna pruriens* L.) also called velvetbean is a herbaceous legume cover crop that produces a lot of biomass and can therefore smother other weeds.

All the plots were ploughed prior to planting the mucuna in the year 2000 except at Koase to compare the effect of initial cultivation of the soil on the ability of mucuna to smother speargrass. The original speargrass and associated weeds at Koase were slashed, the residue removed and the mucuna planted without any soil cultivation.

Experiment Two

A randomized complete block design with four treatments and three replications was used. Plot size was 10×5 m. The treatments were:

T_1- glyphosate +mucuna; T_2 - glyphosate alone T_3 - hoed plot + mucuna and T_4 - fallow

In T_3 the plots were manually hoed to loosen the soil (simulating what local farmers practice) before planting mucuna.

This experiment was established at four sites-Wenchi (Wenchi District), Kobriti-1, Kobriti-2 and Kyeremfaso (Ejura-Skyedumase District) and monitored till September 2003.

Glyphosate was applied with a knapsack sprayer at 5 L ha^{-1} (1.8 kg a.i. ha^{-1}) with a low volume nozzle with a spray swath of 1.0-1.5 m. The sprayer was calibrated to deliver 150 L ha^{-1}.

Mucuna was planted in 80×20 cm rows at 2 seeds/hill. Data collected include weed density and dry weights (shoot and rhizomes). At each sampling time, a 0.25 m^{-2} quadrat was randomly placed in the plots and the weed species counted as speargrass, other grasses, broad leaves and sedges and then clipped as close to the ground level as possible. The four categories of weeds were dried in the oven at 80°C for 4 days and the dry weight calculated in g m^{-2} for each plot. Soil samples (two 12 cm wide cores per plot) were taken to a depth of 15 cm to determine the presence of the rhizomes of speargrass.

Weed data were transformed to logarithmic values to stabilize the variances. All data were analyzed using analysis of variance (ANOVA) and the means separated with contrasts.

Results

The trends in the results for both experiments were similar hence the results are presented using the sites at Wenchi and Kobriti in most cases to avoid monotony and repetition.

Weed Density

The density of speargrass and associated weeds at 3, 6 and 7 months after applying treatments (MAT) are presented in Table 1 to 7. At 3 MAT, the density of speargrass was similar for the fallow plot and the plots from which speargrass was slashed before planting mucuna. However, the density of speargrass on the plots that were ploughed before mucuna was planted were 16-18, 15-19 and 19-20% that of the fallow plots (Table 1). The densities of other weeds were insignificant on these plots (data not shown) as either the speargrass or mucuna was dominant.

The density of speargrass at Wenchi was 1% (99% reduction) that of the fallow plots when glyphosate was sprayed before planting mucuna (Table 2). When glyphosate alone was sprayed, the density at 3 MAT was 2% (98% reduction) that of the fallow whilst mucuna planted on hoed plots resulted in a density of 54% (46% reduction) of that of the fallow plot (Table 2). The density of broad leaf weeds at 3 MAT was 25% that of fallow plots for glyphosate+mucuna, 209% for glyphosate alone and 87% for mucuna planted on hoed plots at Wenchi. The density of sedges for glyphosate+mucuna was 3% that of the fallow, 22% for glyphosate alone and 30% for mucuna planted on hoed plots (Table 2). At Kobriti, there were no speargrass on plots sprayed with glyphosate and planted to mucuna at 3 MAT (Table 3). The density of speargrass on plots sprayed with glyphosate

Table 1: Density of speargrass at 3 months after applying treatments at four sites in Experiment 1

	Speargrass density (number m^{-2})			
Treatments	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)	Dromankoma (Ploughed)
T_1 - mucuna grown for 1 season	42.0	3.9	8.4	14.6
T_2 - mucuna grown for 2 seasons	39.0	3.5	10.6	14.2
T_3 - fallow (no mucuna)	43.0	21.8	55.5	72.8
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	2.6	2.9	7.8	10.8

SEs are for means in each column; ** - contrasts for means in each column differ at p<0.01; NS - Not Significant

Table 2: Density of speargrass and associated weeds at 3 months after applying treatments in Experiment 2 at Wenchi

	Weed density (number m^{-2})		
Treatments	Speargrass	Broad leaves	Sedges
T_1 - glyphosate +mucuna	0.4	3.5	0.9
T_2 - glyphosate alone	0.9	29.7	6.2
T_3 - hoed plot + mucuna	20.4	12.4	8.4
T_4 - fallow	37.3	14.2	27.5
Contrasts			
T_4 vs T_1	**	NS	**
T_4 vs T_2	**	**	**
T_4 vs T_3	*	NS	**
SE	4.7	3.1	3.1

SEs are for means in each column; *,** - contrasts for means in each column differ at $p<0.05$ and $p<0.01$; NS - Not Significant

Table 3: Density of speargrass and associated weeds at 3 months after applying treatments in Experiment 2 at Kobriti

	Weed density (number m^{-2})		
Treatments	Speargrass	Broad leaves	Sedges
T_1 - glyphosate +mucuna	0.0	4.9	0.0
T_2 - glyphosate alone	0.9	66.6	18.2
T_3 - hoed plot + mucuna	8.8	6.6	1.8
T_4 - fallow	38.6	80.9	51.5
Contrasts			
T_4 vs T_1	**	**	**
T_4 vs T_2	**	NS	*
T_4 vs T_3	**	**	**
SE	5.5	8.9	8.5

SEs are for means in each column; *,** - contrasts for means in each column differ at $p<0.05$ and $p<0.01$; NS - Not Significant

Table 4: Density of speargrass at 6 months after applying treatments at four sites in Experiment 1

	Speargrass density (number m^{-2})			
Treatments	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)	Dromankoma (Ploughed)
T_1 - mucuna grown for 1 season	45.7	0.2	0.1	0.1
T_2 - mucuna grown for 2 seasons	42.6	0.2	0.1	0.2
T_3 -fallow (no mucuna)	48.9	28.1	47.8	53.8
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	4.6	2.1	3.2	4.6

SEs are for means in each column; ** - contrasts for means in each column differ at $p<0.01$; NS - Not Significant

alone was 2% that of the fallow whilst the density for mucuna planted on hoed plots was 22% that of the fallow. The density of broad leaf weeds at 3 MAT was 6% that of fallow plots for glyphosate+mucuna, but 82% for glyphosate alone and 8% for mucuna planted on hoed plots at Kobriti. There were no sedges for glyphosate+mucuna, but the density was 35% for glyphosate alone and 3% for mucuna planted on hoed plots (Table 3).

At 6 MAT, the density of speargrass was not different for the fallow plot and the plots from which speargrass was slashed before planting mucuna (Table 4). However, the density of speargrass on the plots that were ploughed before mucuna was planted were 0.6-0.7, 0.3-0.4 and 0.2% that of the fallow plot (Table 4). As with the results at 3 MAT, the densities of other weeds were insignificant on these plots (data not shown) as either the speargrass or mucuna dominated. The density of speargrass at 6 MAT was 0.35% that of the fallow plots when glyphosate was sprayed before planting mucuna at Wenchi. When glyphosate alone was sprayed, the density at 6 MAT had increased from 2 to 13% that of fallow whilst mucuna planted on hoed plots resulted in a reduced density from 54 to 22% that of the fallow plot (Table 5).

Table 5: Density of speargrass and associated weeds at 6 months after applying treatments in Experiment 2 at Wenchi

	Weed density (number m^{-2})		
Treatments	Speargrass	Broad leaves	Sedges
T_1 - glyphosate +mucuna	0.1	2.8	0.9
T_2 - glyphosate alone	4.9	31.2	8.8
T_3 - hoed plot + mucuna	8.4	10.8	5.4
T_4 - fallow	36.9	16.7	23.6
Contrasts			
T_4 vs T_1	**	**	**
T_4 vs T_2	**	**	**
T_4 vs T_3	**	NS	**
SE	5.7	2.1	3.1

SEs are for means in each column; ** - contrasts for means in each column differ at $p<0.01$; NS - Not Significant

Table 6: Density of speargrass at 7 months after applying treatments at four sites in Experiment 1

	Speargrass density (number m^{-2})			
Treatments	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)	Dromankoma (Ploughed)
T_1 - mucuna grown for 1 season	46.2	0.0	0.0	0.0
T_2 - mucuna grown for 2 seasons	49.1	0.0	0.0	0.0
T_3 - fallow (no mucuna)	57.1	29.8	38.5	40.8
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	2.6	2.9	5.8	4.8

SEs are for means in each column; ** - contrasts for means in each column differ at $p<0.01$; NS - not significant

Table 7: Density of speargrass and associated weeds at 7 months after applying treatments in Experiment 2 at Kobriti

	Weed density (number m^{-2})		
Treatments	Speargrass	Broad leaves	Sedges
T_1 - glyphosate +mucuna	0.0	1.3	0.0
T_2 - glyphosate alone	6.9	56.4	14.2
T_3 - hoed plot + mucuna	3.8	6.6	1.3
T_4 - fallow	37.9	78.3	26.3
Contrasts			
T_4 vs T_1	**	**	*
T_4 vs T_2	**	NS	NS
T_4 vs T_3	**	**	NS
SE	6.7	8.6	6.3

SEs are for means in each column; *,** - contrasts for means in each column differ at $p<0.05$ and $p<0.01$; NS - Not Significant

The density of broad leaf weeds at 6 MAT was 16% that of fallow plots for glyphosate+mucuna, but 186% for glyphosate alone and 64% for mucuna planted on hoed plots at Wenchi. The density of sedges for glyphosate+mucuna was 4% that of the fallow, 37% for glyphosate alone and 23% for mucuna planted on hoed plots (Table 5).

At 7 MAT, mucuna had completely smothered speargrass on the plots that were ploughed before mucuna was planted. However, the density of speargrass was not different for the fallow plot and the plots from which speargrass was slashed before planting mucuna as shown by densities that ranged between 80 and 86% that of the fallow (Table 6). As with the results at 3 and 6 MAT, the densities of other weeds were insignificant on these plots (data not shown) as either the speargrass or mucuna was dominant.

At Kobriti, there were no speargrass on plots sprayed with glyphosate and planted to mucuna at 7 MAT (Table 7). The density of speargrass on plots sprayed with glyphosate alone had increased to 18% that of the fallow whilst the density for mucuna planted on hoed plots had declined to 10% that of fallow. The density of broad leaf weeds at 7 MAT was 1.6% that of fallow plots for

Table 8: Biomass of speargrass at 3 months after applying treatments at four sites in Experiment 1

	Speargrass biomass (g m^{-2})			
Treatments	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)	Dromankoma (Ploughed)
T_1 - mucuna grown for 1 season	206	16	29	24
T_2 - mucuna grown for 2 seasons	209	12	36	20
T_3 - fallow (no mucuna)	262	161	172	198
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	27	13	14	16

SEs are for means in each column; ** - contrasts for means in each column differ at p<0.01; NS - Not Significant

Table 9: Biomass of speargrass and associated weeds at 3 months after applying treatments in Experiment 2 at Wenchi

	Weed biomass (g m^{-2})		
Treatments	Speargrass	Broad leaves	Sedges
T_1 - glyphosate +mucuna	4.1	8.5	7.6
T_2 - glyphosate alone	8.6	63.0	16.0
T_3 - hoed plot + mucuna	54.0	17.0	10.0
T_4 - fallow	137.0	24.0	33.0
Contrasts			
T_4 vs T_1	**	NS	**
T_4 vs T_2	**	*	NS
T_4 vs T_3	**	NS	*
SE	15.7	13.9	9.8

SEs are for means in each column; *,** - contrasts for means in each column differ at p<0.05 and p<0.01; NS - Not Significant

glyphosate+mucuna, but 72% for glyphosate alone and 5% for mucuna planted on hoed plots at Kobriti. There were no sedges on the plots treated with glyphosate+mucuna, but the density of sedges was 53% that of the fallow for glyphosate alone and 4% for mucuna planted on hoed plots (Table 7). The trend in the results at 7 MAT for Wenchi was similar to that of Kobriti (data not shown).

In general, where glyphosate alone was sprayed on the initial speargrass population, the predominant weed species observed from 2 to 4 months were the broad leaves notably *Ageratum conyzoides*, *Phylantus amaras*, *Euphorbia heterophylla*, *Tridax procumbens* and *Spigelia* sp. To a lesser extent, sedges such as *Cyperus* sp. and other grass species such as *Digitaria* and *Brachiaria* were present (data not shown.). On the contrary, plots that were ploughed before mucuna was planted did not show any marked changes in weed flora. The most dominant weed that was not smothered by mucuna or killed by glyphosate were *Commelina* sp.

Weed Dry Weight (Biomass)

The mean dry weight of speargrass at all the locations before applying the treatments in 2000 varied between 375±19.3; 344±17.6; 362±16.7; 248±15.4. and 211±14.6 g m^{-2}. The trends in the results of the weed dry weight were similar to those of the densities. At 3 MAT, the dry weight of speargrass was similar for the plots from which the original vegetation was slashed before being planted to mucuna (Table 8). On the ploughed plots, however, mucuna significantly smothered speargrass resulting in dry weights which varied between 7 and 9%, 16 and 20%, 10 and 12% that of the fallow plots (Table 8).

The dry weight of speargrass at Wenchi was 3% that of the fallow plots when glyphosate was sprayed before planting mucuna (Table 9). When glyphosate alone was sprayed, the dry weight at 3 MAT was 6% that of the fallow whilst mucuna planted on hoed plots resulted in dry weight of 39% of that of the fallow plot (Table 9). The dry weight of broad leaf weeds at 3 MAT was 36% that of fallow plots for glyphosate+mucuna, but 262% for glyphosate alone and 70% for mucuna planted on

Table 10: Biomass of speargrass and associated weeds at 3 months after applying treatments in Experiment 2 at Kobriti

	Weed biomass ($g\ m^{-2}$)		
Treatments	Speargrass	Broad leaves	Sedges
T_1- glyphosate +mucuna	0.0	3.5	0.0
T_2 - glyphosate alone	6.0	32.0	11.0
T_3 - hoed plot + mucuna	34.0	19.0	4.5
T_4 - fallow	142.0	57.0	42.0
Contrasts			
T_4 vs T_1	**	**	*
T_4 vs T_2	**	*	*
T_4 vs T_3	**	*	**
SE 14.5	7.9	10.5	

SEs are for means in each column; *,** - contrasts for means in each column differ at p<0.05 and p<0.01

Table 11: Biomass of speargrass at 7 months after applying treatments at four sites in Experiment 1

	Speargrass biomass ($g\ m^{-2}$)			
Treatments	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)	Dromankoma (Ploughed)
T_1 - mucuna grown for 1 season	134.0	0.0	0.0	0.0
T_2 - mucuna grown for 2 seasons	139.0	0.0	0.0	0.0
T_3 - fallow (no mucuna)	159.0	75.0	101.0	114.0
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	5.8	6.9	12.6	16.8

SEs are for means in each column; ** - contrasts for means in each column differ at p<0.01; NS - Not Significant

hoed plots at Wenchi. The dry weight of sedges for glyphosate+mucuna was 23% that of the fallow, 48% for glyphosate alone and 30% for mucuna planted on hoed plots (Table 9). At Kobriti, there were no speargrass on plots sprayed with glyphosate and planted to mucuna at 3 MAT (Table 10). The dry weight of speargrass on plots treated with glyphosate alone was 4% that of the fallow whilst the dry weight for mucuna planted on hoed plots was 23% that of the fallow. The dry weight of broad leaf weeds at 3 MAT was 6% that of fallow plots for glyphosate+mucuna, but 56% for glyphosate alone and 33% for mucuna planted on hoed plots at Kobriti. There were no sedges for glyphosate+mucuna, but the dry weight of sedges was 26% for glyphosate alone and 10% for mucuna planted on hoed plots (Table 10).

At 7 MAT, mucuna had completely smothered speargrass on the plots that were ploughed before mucuna was planted. However, the dry weight of speargrass was not different for the fallow plot and the plots from which speargrass was slashed before planting mucuna as shown by dry weights that ranged between 84 and 87% that of the fallow (Table 11). Similarly, at Kobriti, there were no speargrass on plots sprayed with glyphosate and planted to mucuna at 7 MAT (Table 12). The dry weight of speargrass on plots treated with glyphosate alone had increased to 33% that of the fallow whilst the dry weight for mucuna planted on hoed plots had declined to 13% that of the fallow. The dry weight of broad leaf weeds at 7 MAT was 12% that of fallow plots for glyphosate + mucuna, but 69% for glyphosate alone and 5% for mucuna planted on hoed plots at Kobriti. There were no sedges on the plots treated with glyphosate + mucuna, but the dry weight of sedges was 27% that of the fallow for glyphosate alone and 13% for mucuna planted on hoed plots (Table 12).

Speargrass Rhizomes

The dry weight of rhizomes was smaller on the treated plots across all locations and followed a similar trend as the weed dry weight. On the fallow plots for example the dry weight of the rhizomes varied from 198 $g\ m^{-2}$ at 3 MAT to 187 $g\ m^{-2}$ at 7 MAT. The dry weight of rhizomes for the

Table 12: Biomass of speargrass and associated weeds at 7 months after applying treatments in Experiment 2 at Kobriti

	Weed biomass (g m^{-2})		
Treatments	Speargrass	Broad leaves	Sedges
T_1 - glyphosate +mucuna	0.0	5.5	0.0
T_2 - glyphosate alone	35.0	30.0	10.0
T_3 - hoed plot + mucuna	14.0	2.5	5.0
T_4 - fallow	104.0	43.0	37.0
Contrasts			
T_4 vs T_1	**	**	*
T_4 vs T_2	*	NS	NS
T_4 vs T_3	**	**	*
SE	17.6	9.8	8.4

SEs are for means in each column; *,** - contrasts for means in each column differ at $p<0.05$ and $p<0.01$; NS - Not Significant

ploughed plots that were planted to mucuna were between 55 g m^{-2} at 3 MAT and 0.3 g m^{-2} at 7 MAT. Where glyphosate was sprayed before mucuna was planted, the dry weight of rhizomes was 15 g m^{-2} at 3 MAP and 0.1 g m^{-2} at 7 MAP.

Discussion

Mucuna effectively smothered speargrass with time and by 7 months after planting mucuna, all the speargrass had been smothered on the ploughed plots. When glyphosate was sprayed on the existing speargrass before planting mucuna, the speargrass were suppressed in 3 months. However, where the initial population of speargrass was only slashed and mucuna planted, the mucuna was not as effective in smothering the speargrass as in the ploughed plots. In addition, mucuna planted on hoed plots consistently reduced the density and dry weight of speargrass from planting to 7 MAT. This observation may be due exposure of the rhizomes to the surface thereby desiccating them compared to the slashed plot where the rhizomes remained intact in the soil and could regenerate new shoots of speargrass at a faster rate. In addition, hoeing or ploughing may have ensured better seed-soil contact that enhanced better emergence and subsequent establishment of mucuna. Willard *et al*. (1996) has reported that two mowings or discings were generally more effective in controlling *I. cylindrica* than single mowing or discing.

The plots that were sprayed with glyphosate alone had speargrass reemerging after 3 months whilst those sprayed with glyphosate followed with mucuna effectively smothered speargrass by 3 months after planting mucuna. The consequence of the re emergence of speargrass after 3 months of spraying glyphosate is an indication that glyphosate alone will not be effective in reclaiming land for producing cassava and yam which take at least 6 months to mature. This finding conflicts with those of Willard *et al*. (1996 and 1997) who reported that applying either glyphosate at 3.4 kg ha^{-1} or imazapyr at 0.8 kg ha^{-1} alone caused the greatest reduction in shoot and rhizome biomass about 2 years after application.

Where glyphosate alone was sprayed on the initial speargrass population, broad leaf weeds notably *Ageratum conyzoides*, *Phylantus amaras*, *Euphorbia heterophylla*, *Tridax procumbens* and *Spigelia* sp. dominated the succeeding weed species. To a lesser extent, sedges such as *Cyperus* sp. and other grass species such as *Digitaria* and *Brachiaria* were present with the sedges dominating, especially at 2 months after establishing mucuna. In contrast, plots that were ploughed before mucuna was planted did not show any marked changes in weed flora because of the heavy shade of the mucuna. Because most weeds require some light to induce their seed to germinate and grow, the presence of shade from mucuna may have reduced the amount of light required to induce weed seed germination, hence the low number of annual weeds. In contrast, good control of speargrass by glyphosate created an opportunity for other weeds to germinate in the open spaces created.

The results of the changes in weed flora are similar to the findings of Udensi *et al*. (1999) who reported that densities of annual broad-leaved weeds increased after *I. cylindrica* density was reduced by herbicides and cover crops. Similarly, Anoka *et al*. (1991) found that reducing the density of *I. cylindrica* by shading it with *Gliricidia sepium* and *Leucaena leucocephala* led to the dominance of other weed species such as *R. cochichinensis* and *C. odorata*.

The most dominant weed that was neither smothered by mucuna nor killed by glyphosate were *Commelina* sp. The *Commelina* sp. appeared yellowish after being sprayed with glyphosate but did not die. Similarly, under the shade of mucuna, it appeared yellowish but was not smothered. It is possible that because of the succulent nature of the *Commelina* sp., the concentration of glyphosate gets diluted within its sap and is thus not effective in blocking the synthesis of amino acids in its roots. We also speculate that there is a physiological mechanism that detoxifies glyphosate within the *Commelina* sp. hence its ability to survive after being sprayed with glyphosate. The ability of the *Commelina* sp. to survive under mucuna also suggests that it is tolerant to shade. These mechanisms may operate individually or in concert. This is a subject that merits further investigation.

Conclusion

The results show that an initial cultivation of the soil improves the effectiveness of mucuna to smother speargrass by seven months. In addition, controlling the initial speargrass population with glyphosate makes mucuna more effective at smothering the regrowth of speargrass and other associated weeds in three months. Glyphosate alone is not effective in giving long term control of speargrass. Neither glyphosate nor mucuna could control *Commelina* sp.

The results suggest that it is possible to reclaim lands that have been abandoned because of speargrass in about seven months with mucuna planted on plots with initial cultivation or by spraying glyphosate followed with mucuna.

The next stage of this work was to compare the effectiveness of cropping mucuna for one or two seasons in controlling speargrass; assess crop growth and yield when cassava and yam are cultivated on plots that have been reclaimed from the menace of speargrass.

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