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Integrated Management of *Imperata cylindrica* (Speargrass) in Yam and Cassava: Weed Pressure in Crop, Crop Growth and Yield

G.K.S. Aflakpui and Grace E-K. Bolfrey-Arku
Crops Research Institute, Council for Scientific and Industrial Research (CSIR),
P.O. Box 3785, Kumasi, Ghana

Abstract: The carry-over effects of different methods used to reclaim speargrass infested lands on weed pressure, the growth and yield of cassava and yam were investigated on farmers' fields. The experiments were carried out in the forest-savannah transition zone of Ghana between 2000 and 2003. The dry weight of speargrass rhizomes varied from 182 g at 5 months after planting (MAP) {17 months after treatment (MAT)} to 175 g at 12 MAP (24 MAT) on the fallow plots and plots from which speargrass was slashed before planting mucuna. There were no rhizomes on the ploughed plots that were planted to mucuna and those that were sprayed with glyphosate or hoed before mucuna was planted at 5 MAP. The residue from mucuna suppressed speargrass for about 5 months after senescence resulting in more vigorous and taller cassava plants and cassava root yields of 110-118% greater for the glyphosate+mucuna plot than that of the fallow plot. Hoeing followed with mucuna gave root yields of 53-85% greater than fallow. The tuber yields of yam due to the carry-over effect of glyphosate alone, resulted in 12% increase in yields over fallow plots. Hoeing followed with mucuna resulted in tuber yield 50% greater than fallow whilst using glyphosate+mucuna gave 112% increment in tuber yields. On the ploughed plots, tuber yields of yam were 61% greater than that for fallow plots when mucuna was cropped for one season and 76% greater for mucuna cropped for two seasons. Growing mucuna on ploughed plots for one season was just as effective as cropping for two seasons in smothering speargrass. The results show a significant carry-over effect of an initial cultivation of the soil and mucuna and glyphosate+mucuna to control speargrass for about 5 months in a succeeding cassava and yam crop.

Key words: Cassava, glyphosate, *Imperata cylindrica*, mucuna, yam

Introduction

Imperata cylindrica (L.) Raeuschel (speargrass, cogongrass) is a noxious perennial grass which is a strong competitor with crops. Crop yield losses vary as a function of crop type, cultural practices and environmental conditions. Soedarsan (1980), for example, has shown that *Imperata cylindrica* retards the growth of rubber [*Hevea brasiliensis* (Willd. ex. Adr. Juss) Muell, Arg] by up to 96% within a period of 5 years. Udensi *et al.* (1999) reported that maize grain yield was reduced by about 80% whilst Koch *et al.* (1990) reported 100% yield reduction in maize and >90% reduction in the yield of cassava intercropped with maize. *Imperata cylindrica* interferes with crop growth through direct competition for resources that determine growth and through allelopathic interactions (Akobundu and Ekeleme, 2000). In root and tuber crops such as cassava and yam, additional losses occur in crop quality and quantity because of rotting resulting from fungal infection on wounds created by the ramets

Corresponding Author: Dr. G.K.S. Aflakpui, Crops Research Institute, Council for Scientific and Industrial Research (CSIR), P.O. Box 3785, Kumasi, Ghana Tel: 233-51-60389/60391/60425/60396 Fax: 233-51-60396/60142

and rhizomes of *I. cylindrica* (Terry *et al.*, 1997). Since poor control of speargrass leads to severe crop losses, there is the need to develop effective and sustainable methods for managing the deleterious effect of speargrass on root and tuber crops, especially cassava and yam. 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.

In the first part of this study (Aflakpui and Bolfrey-Arku, 2006) we reported among others that an initial cultivation of the soil improved the effectiveness of mucuna to smother *I. cylindrica.* In addition, when the initial population of speargrass is controlled with glyphosate mucuna is more effective at smothering the regrowth of speargrass and other associated weeds in seven months. Glyphosate alone was not effective in giving long term control of *I. cylindrica* and neither glyphosate nor mucuna could control *Commelina* sp. It is therefore possible to reclaim lands that have been abandoned due to speargrass in about seven months with mucuna planted on plots with initial cultivation or with application of glyphosate followed with mucuna.

The purpose of the present research is to (i) assess the effect of these different methods of reclaiming speargrass infested lands on weed pressure in yam and cassava, (ii) assess the growth and yield of these crops on lands that have been reclaimed from the menace of speargrass and (iii) compare the effectiveness of cropping mucuna for one or two seasons in controlling speargrass

Materials and Methods

The field experiments were started in May 2000 as indicated in the companion paper.

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:

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, T_4-fallow:

Experiment 1 was established at four sites-Koase (Wenchi District), Kobriti-1, Kobriti-2 and Dromankoma (Ejura-Sekyedumase District); Experiment 2 at Wenchi (Wenchi District), Kobriti-1, Kobriti-2 and Kyeremfaso (Ejura-Sekyedumase District) and monitored till September 2003.

All fallow plots from the previous season and all other plots with weeds on them were slashed and the vegetation left on the plots. This was done to measure the residual effect of the treatments applied in the previous year. The previous year's plots were maintained to help in evaluating the carry-over effects of the treatments applied in the previous year. The improved cassava variety Tek bankye was planted at three sites whilst the farmers' preferred local variety was planted at one site. Cassava was planted on the flat at 1×1 m spacing. Yam setts of the cultivar dente were planted on mounds spaced at 1×1 m at four locations. All the planting materials were treated with Dursban against insects especially termites before planting. Mucuna was planted in 80×20 cm rows at 2 seeds per hill.

Weed data collected include weed density and dry weights. At each sampling time, a 0.25 m^2 quadrate was randomly placed in the central rows of each plot 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 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.

Crop Data

Cassava plant height was measured at 5, 7 and 10 MAP. The height of 10 plants selected at random in the central rows of each plot were measured from the ground level to the jorquette (point of branching) at 10 months whilst at earlier dates, the height was measured from ground level to the apex of each plant. Cassava plants were harvested at 3, 5, 7 and 10 months after planting to determine the shoot dry matter. At harvest, fresh weight and dry weights of the cassava were also determined. To determine the root dry weight, 1 kg sample each was taken from each plot and dried in the oven at 80°C to a constant weight. The fresh and dry weights of yam were recorded only at harvest.

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

Results

Weed Pressure in Crop

At the time of planting the crops, there were no speargrass on the plots that were ploughed and planted to mucuna. Mucuna was not effective in smothering speargrass on the plots that were slashed (Table 1). When glyphosate alone was sprayed, the density of speargrass at the time of planting was 50% that of fallow plots at Kobriti (Table 2). There were no speargrass on the plots that were hoed and planted to mucuna as well as those that were sprayed with glyphosate before planting mucuna. The density of other grasses at the time of planting was not significantly different for all the comparisons between the fallow and other treatments except for the greater density ($p<0.05$) of grasses on the plots treated with glyphosate alone at Kobriti (Table 2). The density of broad leaf weeds at the time of planting was greater ($p<0.01$) for all the treatments compared with the fallow treatment. The densities ranged between 195% for the plots that were hoed and planted to mucuna and 329% for glyphosate alone compared with that of the fallow. The density of sedges at Kobriti was greater ($p<0.01$) only on plots treated with glyphosate+mucuna compared with the fallow (Table 2). The results obtained at Wenchi at the time of planting were similar to those of Kobriti (Table 3).

At 5 MAP (17 MAT) the trend in the density of speargrass was similar to that described for the time of planting on the ploughed plots (Table 4). However, the density of broad leaf weeds on the plots that were ploughed before planting mucuna was significantly increased compared to that of the fallow (Table 5). The increment in the density of broad leaf weeds on the plots planted to mucuna ranged between 747 and 933% that of the fallow. At Kobriti, the trend in the density of speargrass at 5 MAP was similar to that at the time of planting (Table 6). The broad leaf weeds dominated the population of weeds in the other treatments followed by the sedges and to a lesser extent, other grasses. The results obtained at Wenchi were similar to those for Kobriti (data not shown).

At 12 MAP (24 MAT), some shoots of speargrass were recorded on some of the plots that were ploughed and planted to mucuna, resulting in densities of between 1 and 6% of that of the fallow (Table 7). The density of broad leaf weeds on the plots planted to mucuna decreased to about 29-30% of the values recorded at 5 MAP (Table 8). At Kobriti, the density of speargrass was greater ($p<0.01$) in the fallow plots compared to the other treatments at 12 MAP (Table 9). There were no speargrass on the plots sprayed with glyphosate and planted to mucuna. The density of speargrass on the plots that were hoed and planted to mucuna was 4% that of the fallow whilst the density on plots sprayed with glyphosate alone was 43% that of the fallow (Table 9). On the results on the ploughed plots, the density of broad leaf weeds was reduced to between 9 and 21% of the values obtained at 5 MAP. The results obtained at Wenchi were similar to those for Kobriti (data not shown).

Speargrass Rhizomes

The dry weight of rhizomes varied from 182 g at 5 MAP (17 MAT) to 175 g m^{-2} at 12 MAP (24 MAT) on the fallow plots and plots from which speargrass was slashed before planting mucuna. There were no rhizomes on plots ploughed and planted to mucuna, sprayed with glyphosate

Table 1: Density of speargrass at the time of planting cassava and yam (12 months after applying treatments) at 4 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	38.1	0	0	0
T_2-mucuna grown for 2 seasons	35.1	0	0	0
T_3-fallow (no mucuna)	43.1	28.8	16.2	32.1
Contrasts				
T_3 vs T_1	NS	**	*	**
T_3 vs T_2	NS	**	*	**
SE	1.6	4.7	3.6	6.9

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 2: Density of speargrass and associated weeds at the time of planting cassava and yam (12 months after applying treatments) at Kobriti

	Weed density (number m^{-2})			
Treatments	Speargrass	Other grasses	Broad leaves	Sedges
T_1-glyphosate+mucuna	0	9.7	58.7	32.4
T_2-glyphosate alone	39.1	1.8	76.5	10.7
T_3-hoed plot+mucuna	0	5.3	45.3	8.4
T_4-fallow	77.3	6.7	23.2	7.9
Contrasts				
T_4 vs T_1	**	NS	*	**
T_4 vs T_2	**	NS	**	NS
T_4 vs T_3	**	NS	NS	NS
SE	6.9	1.8	8.4	4.6

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 the time of planting cassava and yam (12 months after applying treatments) at Wenchi

	Weed density (number m^{-2})			
Treatments	Speargrass	Other grasses	Broad leaves	Sedges
T_1-glyphosate+mucuna	0	7.8	52.9	29.2
T_2-glyphosate alone	31.3	1.4	68.4	9.6
T_3-hoed plot+mucuna	0	4.3	48.8	7.6
T_4-fallow	61.8	6.1	13.1	7.2
Contrasts				
T_4 vs T_1	**	NS	**	**
T_4 vs T_2	**	NS	**	NS
T_4 vs T_3	**	NS	**	NS
SE	5.9	1.4	6.8	4.2

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

Table 4: Density of speargrass at 5 months after planting cassava and yam (17 months after applying treatments) at 4 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	34.3	0	0	0
T_2-mucuna grown for 2 seasons	31.6	0	0	0
T_3-fallow (no mucuna)	38.4	25.9	15.6	27.1
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	1.5	2.2	2.1	3.2

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

Table 5: Density of broad leaf weeds at 5 months after planting cassava and yam (17 months after applying treatments) at 4 sites in Experiment 1

	Broad leaf density (number m^{-2})			
Treatments	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)	Dromankoma (Ploughed)
T_1-mucuna grown for 1 season	8.6	70.5	68.8	63.2
T_2-mucuna grown for 2 seasons	3.5	79.2	76.3	66.3
T_3-fallow (no mucuna)	5.4	8.7	9.2	7.1
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	1.5	7.7	9.6	8.9

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 and associated weeds at 5 months after planting cassava and yam (17 months after applying treatments) at Kobriti

	Weed density (number m^{-2})			
Treatments	Speargrass	Other grasses	Broad leaves	Sedges
T_1-glyphosate+mucuna	0	10.7	64.5	23.4
T_2-glyphosate alone	34.4	1.98	84.1	11.1
T_3-hoed plot+mucuna	0	5.83	49.8	7.1
T_4-fallow	67.9	7.26	20.2	6.9
Contrasts				
T_4 vs T_1	**	NS	**	*
T_4 vs T_2	*	*	**	NS
T_4 vs T_3	**	NS	*	NS
SE	11.9	1.8	8.4	4.6

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 7: Density of speargrass at 12 months after planting cassava and yam (24 months after applying treatments) at 4 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	33.9	1.3	2.2	0
T_2-mucuna grown for 2 seasons	32.6	0.4	1.3	0
T_3-fallow (no mucuna)	42.5	24.8	19.2	22.1
Contrasts				
T_3 vs T_1	NS	**	*	**
T_3 vs T_2	NS	**	*	**
SE	1.7	3.8	4.6	4.0

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

Table 8: Density of broad leaf weeds at 12 months after planting cassava and yam (24 months after applying treatments) at 4 sites in Experiment 1

	Broad leaf density (number m^{-2})			
Treatments	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)	Dromankoma (Ploughed)
T_1-mucuna grown for 1 season	2.6	21.3	20.6	18.6
T_2-mucuna grown for 2 seasons	1.5	23.8	22.4	19.3
T_3-fallow (no mucuna)	1.6	2.7	3.2	2.1
Contrasts				
T_3 vs T_1	NS	**	**	**
T_3 vs T_2	NS	**	**	**
SE	0.5	2.5	2.9	2.7

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

Table 9: Density of speargrass and associated weeds at 12 months after planting cassava and yam (24 months after applying treatments) at Kobriti

	Weed density (number m^{-2})			
Treatments	Speargrass	Other grasses	Broad leaves	Sedges
T_1-glyphosate+mucuna	0	1.6	6.3	3.7
T_2-glyphosate alone	29.7	1.3	13.4	2.8
T_3-hoed plot+mucuna	3.1	1.1	10.5	1.6
T_4-fallow	68.5	3.2	1.4	2.1
Contrasts				
T_4 vs T_1	**	NS	*	NS
T_4 vs T_2	**	NS	*	NS
T_4 vs T_3	**	NS	*	NS
SE	4.8	0.8	1.8	1.3

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

Table 10: Plant height of cassava at 5 months after planting (17 months after applying treatments) at Kobriti [K(1,2) = sites 1 and 2] and Wenchi for Experiment 2

	Cassava plant height (cm)		
Treatments	Kobriti(1)	Kobriti(2)	Wenchi
T_1-glyphosate+mucuna	138	146	119
T_2-glyphosate alone	99	95	89
T_3-hoed plot+mucuna	103	121	112
T_4-fallow	59	63	61
Contrasts			
T_4 vs T_1	**	**	**
T_4 vs T_2	**	**	*
T_4 vs T_3	**	**	**
SE	6.7	5.6	7.3

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

Table 11: Plant height of cassava as affected by treatments at 10 months after planting (22 months after applying treatments) at Kobriti [K(1,2) = sites 1 and 2] and Wenchi for Experiment 2

	Cassava plant height (cm)		
Treatments	Kobriti(1)	Kobriti(2)	Wenchi
T_1-glyphosate+mucuna	201	204	198
T_2-glyphosate alone	180	177	176
T_3-hoed plot+mucuna	192	186	189
T_4-fallow	91	97	100
Contrasts			
T_4 vs T_1	**	**	**
T_4 vs T_2	**	**	**
T_4 vs T_3	**	**	**
SE	5.9	4.6	5.7

SEs are for means in each column; ** contrasts for means in each column differ at $p<0.01$

or hoed before mucuna was planted at 5 MAP. However, at 12 MAP the dry weight of rhizomes varied between 1.5 and 2.1 g. Where glyphosate alone was sprayed before mucuna was planted, the dry weight of rhizomes varied between 56 g at 5 MAP (17 MAT) and 43 g at 12 MAP (24 MAT).

Cassava Plant Height

Cassava grown on plots sprayed with glyphosate and planted to mucuna was most vigorous and tallest at 5 MAP (Table 10). The height of cassava planted on the fallow plots at 5 MAP was 42 to 51% that of glyphosate+mucuna treated plots, 59 to 68% that of glyphosate alone and 52 to 57% that of plots that were hoed and planted to mucuna (Table 10). At 12 MAP, the height of cassava planted on the fallow plots was 47 to 53% that of glyphosate+mucuna treated plots, 50 to 56% that of glyphosate alone and 45 to 50% that of plots that were hoed and planted to mucuna (Table 11).

Table 12: Shoot dry matter of cassava after applying treatments at Kobriti

	Dry matter (g)			
Treatments	3 MAP	5 MAP	7 MAP	10MAP
T_1-glyphosate+mucuna	84	128	194	296
T_2-glyphosate alone	48	86	121	198
T_3-hoed plot+mucuna	58	98	149	226
T_4-fallow	18	32	49	94
Contrasts				
T_4 vs T_1	**	**	**	**
T_4 vs T_2	**	**	**	**
T_4 vs T_3	**	**	**	**
SE	5.8	4.7	7.7	8.5

SEs are for means in each column; ** contrasts for means in each column differ at $p<0.01$

Table 13: Shoot dry matter of cassava after applying treatments at Wenchi

	Dry matter (g)			
Treatments	3 MAP	5 MAP	7 MAP	10 MAP
T_1-glyphosate+mucuna	47	99	178	234
T_2-glyphosate alone	25	66	97	115
T_3-hoed plot+mucuna	30	84	148	132
T_4-fallow	11	27	44	71
Contrasts				
T_4 vs T_1	**	**	**	**
T_4 vs T_2	NS	**	**	**
T_4 vs T_3	NS	**	**	**
SE	5.9	6.4	5.8	7.8

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

Shoot Dry Matter of Cassava

At Kobriti, the shoot dry matter of cassava planted on the fallow plots was 21% at 3 MAP, 25% at 5 and 7 MAP and 31% at 10 MAP that of glyphosate+mucuna treated plots. Where glyphosate alone was sprayed, the shoot dry matter of cassava varied between 37% at 3 MAP and 47% at 10 MAP. The corresponding values for plots that were hoed and planted to mucuna were between 31% at 3 MAP and 41% at 10 MAP (Table 12). At Wenchi, the shoot dry matter of cassava planted on the fallow plots was 23% at 3 MAP, 27% at 5 MAP and 24% at 7 MAP and 30% at 10 MAP that of glyphosate+mucuna treated plots. Where glyphosate alone was sprayed, the shoot dry matter of cassava varied between 40% at 3 MAP and 61% at 10 MAP. The corresponding values for plots that were hoed and planted to mucuna were between 36% at 3 MAP and 53% at 10 MAP (Table 13).

Yield of Cassava

The root yields of cassava (either fresh or dry) grown on plots sprayed with glyphosate and planted to mucuna were the largest ($p<0.01$) at 15 MAP (Table 14). The fresh root yields of cassava planted on the fallow plots at 15 MAP was 45 to 46% that of plots treated with glyphosate+mucuna at Kobriti. Where glyphosate alone was sprayed, the yield varied between 71 and 76%, whilst the corresponding value for plots that were hoed and planted to mucuna was between 47 and 57%. (Table 14). At Wenchi, the fallow plots yielded 47% as much as glyphosate+mucuna plots, 63% as much as glyphosate alone and 54% as much when plots were hoed and planted to mucuna (Table 14). The dry weight of the cassava roots followed the same trend since the average dry matter varied between 32 and 38% (Table 14).

Yield of Yam

The fresh tuber yield of yam on the slashed plots on which mucuna was grown was similar to that of the fallow plots (Table 15). The fresh tuber yields of yam planted on the fallow plots at 10 MAP

Table 14: Root yield of cassava as affected by treatments 15 months after planting (27 months after applying treatments) for Experiment 2 at Kobriti [K(1, 2) = sites 1 and 2] and Wenchi

	Fresh weight ($t\ ha^{-1}$)			Dry weight ($t\ ha^{-1}$)		
Treatments	K (1)	K (2)	Wenchi	K (1)	K (2)	Wenchi
T_1-glyphosate+mucuna	84.2	77.4	55.1	31.9	29.4	19.3
T_2-glyphosate alone	50.2	50.4	41.4	19.1	19.2	14.5
T_3-hoed plot+mucuna	66.5	55.0	48.5	25.3	25.3	16.9
T_4-fallow	38.5	35.8	26.2	12.3	11.4	8.4
Contrasts						
T_4 vs T_1	**	**	**	**	**	**
T_4 vs T_2	**	**	**	**	**	**
T_4 vs T_3	**	**	**	**	**	**
SE	1.7	1.6	1.8	1.1	1.2	1.2

SEs are for means in each column; ** contrasts for means in each column differ at $p<0.01$

Table 15: Effect of treatments on the yield of yam 10 months after planting (22 months after applying treatments) at 3 sites for Experiment 1

	Koase (Slashed)	Kobriti-1 (Ploughed)	Kobriti-2 (Ploughed)
Treatments	($kg\ ha^{-1}$)	($kg\ ha^{-1}$)	($kg\ ha^{-1}$)
T_1-mucuna grown for 1 season	7,950	11,800	12,950
T_2-mucuna grown for 2 seasons	7,690	12,900	13,225
T_3-fallow (no mucuna)	6,580	7,330	6,830
Contrasts			
T_3 vs T_1	NS	**	**
T_3 vs T_2	NS	**	**
SE	521	436	441

SEs are for means in each column; ** contrasts for means in each column differ at $p<0.01$

Table 16: Effect of treatments on the yield of yam 10 months after planting yam (22 months after applying treatments) at 1 site for Experiment 2

	No. of tubers	Fresh weight	Dry weight
Treatments	($kg\ ha^{-1}$)	($kg\ ha^{-1}$)	($kg\ ha^{-1}$)
T_1-glyphosate+mucuna	1.9	15,900	3,975
T_2-glyphosate alone	1.7	8,430	2,107
T_3-hoed plot+mucuna	1.7	11,267	2,816
T_4-fallow	1.6	7,500	1,875
Contrasts			
T_4 vs T_1	NS	**	**
T_4 vs T_2	NS	NS	NS
T_4 vs T_3	NS	**	**
SE	0.2	650	170

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

ranged between 56 and 61% that of the plots planted to mucuna. The fresh tuber yield of the fallow plots at 10 MAP was 47% that of glyphosate+mucuna treated plots, 89% that of the glyphosate alone and 66% that of plots hoed and planted to mucuna (Table 16).

As with cassava, the dry weight of the yam tubers followed the same trend as the fresh weight. The average dry matter varied between 24 and 25% (Table 16).

Discussion

Weed Pressure in Crop

The density of speargrass continued to be smaller on plots which were ploughed or hoed and planted to mucuna such that at the time of planting the crops, there were no speargrass on these plots; this trend continued till 5 MAP (17 MAT). The density of speargrass was similar on plots irrespective of whether mucuna was cropped for one or two seasons. Similarly, there were no speargrass on the plots that were sprayed with glyphosate before planting mucuna. This shows that the carry-over effect of mucuna either on cultivated soil or land previously sprayed with glyphosate in controlling speargrass is significant, for at least 5 months, in the succeeding season in a yam or cassava crop. 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 or hoed plots or where glyphosate was sprayed before planting mucuna. The smaller density of speargrass observed on ploughed or hoed plots may be attributed to exposure of the rhizomes to the surface thereby desiccating them, compared to the slashed plot where the rhizomes remained intact in the soil. The observation in this study that initial cultivation influences the ability of mucuna to smother speargrass is consonant to the findings of Willard *et al*. (1996) that mowing probably affected rhizomes by depleting carbohydrate reserves as shoot regrowth occurred. However, this effect of an initial cultivation helping to control speargrass conflicts with the result of Akobundu *et al*. (2000) who did not report of any effect of slashing speargrass on the ability of mucuna to control speargrass. This difference may be attributed to the effect of hand weeding of the plots at short intervals by Akobundu *et al*. (2000) to allow the mucuna to establish. In this study, the plots were not weeded after establishing the experiments in 2000. The plots were only slashed at the time of planting the crops (as described in the materials and methods) and once a month after planting yam and cassava, especially, after 7 MAP except the fallow plots which were weeded once every month after planting the crops. When glyphosate alone was sprayed, the density of speargrass at the time of planting was about 50% that of the fallow plots. Thus, the results from this study show that the use of glyphosate alone can only control the existing speargrass for short duration crops such as maize and cowpea but not for long duration crops such as cassava or yam contrary to the findings of Willard *et al*. (1996). The result of Udensi *et al*. (1996) that glyphosate can suppress speargrass for at least 16 weeks is partially similar to the results of this study. At 12 MAP (24 MAT), a few shoots of speargrass were recorded on some of the plots that were ploughed and planted to mucuna, resulting in densities of between 1 and 6% of that of the fallow. Since speargrass is also dispersed through white fluffy spikelets by wind, it is possible that the incidence of speargrass on some of the plots at 24 MAT may be due to dispersal of weed seeds by wind from adjacent plots. The density of broad leaf weeds was increased once speargrass population was reduced by the various treatments. By 24 months after applying treatments, *Commelina* sp. dominated the weed species at Kobriti, whilst *Chromolaena odorata* dominated at the rest of the sites where mucuna was grown for 2 seasons. The mechanisms by which cover crops suppress speargrass were not investigated in this study, but other researchers have reported that shading and allelopathy are the main ways by which cover crops smother weeds (Fujii *et al*., 1991; Macdicken *et al*., 1997). In addition, Nancy *et al*. (1996) also indicated that the possible mechanism by which cover crops modify weed seed germination is through altering the seed environment and other interference methods such as allelopathy.

Crop Growth and Yield

The carry-over effects of the treatments were positively reflected in the vigour and growth of cassava. As a result, cassava grown on plots which were sprayed with glyphosate alone, were 45-67% (28 to 40 cm) taller than that of the fallow plots at 5 MAP and 76-97% (76 to 89 cm) at 10 MAP. Hoeing followed with mucuna led to plants that were 74-92% (44 to 58 cm) taller at 5 MAP and 89-101% (89 to 110 cm) at 10 MAP. The corresponding effect of using glyphosate+mucuna was a 95-133% (58 to 83 cm) increment in height at 5 MAP and 98-120% (98 to 110 cm) at 10 MAP.

The residual effect of glyphosate alone, applied to control speargrass, resulted in an increased the shoot dry matter of cassava that was 127-166% greater than that of the fallow plots at 3 MAP and 61-110% at 10 MAP. Hoeing followed with mucuna resulted in shoot dry matter of about 64-69%

greater at 3 MAP and 85-140% at 10 MAP. The corresponding effect of using glyphosate+mucuna was a 172-222% increment in the shoot dry matter at 3 MAP and 85-110% at 10 MAP. The early stages of growth recorded greater percentage increments than the latter stages in the above comparisons. Clearly, the accumulation of the shoot dry matter of cassava was more enhanced on the reclaimed plots than the fallow plots because of the absence of weeds. Akobundu (1987), reported that in the humid and sub-humid tropics, 12 weeks of weed -free period is required for cassava and 16 weeks for white yam, to prevent crop yield reduction.

Similar to the shoot dry matter, the carry-over effect of glyphosate alone resulted in fresh root yields of cassava that was 30-58% greater than that of the fallow plots at 15 MAP. Hoeing followed with mucuna yielded fresh root yields of about 53-85% greater than the fallow at 15 MAP whilst using glyphosate+mucuna led to a 110-118% increment in fresh root yields at 15 MAP. In yam, the carry-over effect of glyphosate alone, resulted in fresh tuber yields that were 12% greater than that of the fallow plots at 10 MAP. Hoeing followed with mucuna resulted in fresh tuber yields of about 50% greater than the fallow at 10 MAP whilst using glyphosate+mucuna led to a 112% increment in fresh tuber yields at 10 MAP. On the ploughed plots, tuber yields of yam were 61 and 76% greater than that for the fallow plot when mucuna was planted for one season and two seasons, respectively.

Increases in the yield of crops due to the suppression of speargrass have been reported mainly in maize and to a lesser extent, cassava but not in yam. In maize, Udensi *et al*. (1999) reported that maize grain yield was greatest where speargrass was controlled in the preceding year with herbicides compared to mucuna. The observation of Udensi *et al*. (1999) contrasts with the findings in this study where the plots treated with glyphosate alone resulted in smaller yield of cassava and yam than those of these crops planted with mucuna after hoeing or on plots treated with glyphosate+mucuna. In this study, we observed that speargrass emerged at about 3 months after treatment when glyphosate alone was used, an indication that this treatment is inappropriate for long duration crops such as cassava and yam. This assertion is corroborated by Chikoye *et al*. (2001), that competition from speargrass affected the yield of cassava more than maize in a maize+cassava intercrop. However, the results in this study are consonant with the findings of Akobundu *et al*. (2000), that maize grain yield was greater in plots previously seeded to mucuna than in plots without mucuna. Chikoye *et al*. (2001), also reported that maize grain yield from plots planted to cover crops and weeded controls were either similar to or 27 to 52% greater than the weedy control. Almost all cover crop treatments recorded greater cassava root yields than the weedy control. Chikoye *et al*. (2002) attributed the smaller yields they observed in cassava and maize to low crop density at harvest, competition from speargrass and annual weeds and or competition from cover crops. In this study the main reason for the smaller yield of cassava may be attributed to competition from speargrass and annual weeds but not to plant density.

Conclusion

The results from this study have shown a significant carry-over effect of an initial cultivation of the soil and mucuna and glyphosate+mucuna to control speargrass. The residue from mucuna, after senescence, adequately suppressed speargrass for about 5 months. This resulted in more vigorous and taller cassava plants and cassava root yields of between 110-118% greater than that of the fallow plots when glyphosate+mucuna was used. Hoeing followed with mucuna yielded fresh root yields of about 53-85% greater than the fallow. In yam, the fresh tuber yields due to the carry-over effect of glyphosate alone, resulted in tuber yields that were 12% greater than that of the fallow plots. Hoeing followed with mucuna resulted in fresh tuber yields of about 50% greater than the fallow whilst using glyphosate+mucuna led to a 112% increment in fresh tuber yields at 10 MAP. On the ploughed plots, tuber yields of yam were 61 and 76% greater than that for the fallow plot when mucuna was planted for one season and two seasons, respectively.

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