# Integrated management of *Imperata cylindrica* (speargrass) in yam and cassava: Weed pressure in crop, crop growth and yield

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## ABSTRACT

The carry-over effects of different methods used to reclaim speargrass-infested lands on weed pressure, growth and yield of cassava and yam were investigated on farmers' fields in the forest-savanna transition zone of Ghana between 2000 and 2003. The dry weight of speargrass rhizomes varied from 182 g $m^{-2}$ at 5 months after planting (MAP)(17 months after treatment [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. No rhizomes were observed 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 to 118 per cent greater for the glyphosate + mucuna plot than that for the fallow plot. Hoeing followed with mucuna had root yields of 53 to 85 per cent greater than fallow. The tuber yields of yam due to the carry-over effect of glyphosate alone resulted in 12 per cent increase in yields over fallow plots. Hoeing followed with mucuna resulted in tuber yield 50 per cent greater than that for fallow, whilst using glyphosate + mucuna recorded 112 per cent increment in tuber yields. On the ploughed plots, tuber yields of yam were 61 per cent greater than that for fallow plots when mucuna was cropped for one season and 76 per cent 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.


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## RÉSUMÉ

AFLAKPUI, G. K.S. & BOLFREY-ARKU, G. E.-K.: *La lutte intégrée contre* Imperata cylindrica *(le chiendent) d'igname et de manioc: La contrainte de mauvaise herbe dans la culture, la croissance et le rendement de culture.* Le transfert d'effects de différentes méthodes employées pour défricher les champs infestés de chiendent, sur la contrainte de mauvaise herbe, la croissance et le rendement de manioc et d'igname étaient enquêtés sur les champs d'agriculteurs. Les expériences étaient menées dans la zone transitionnelle de la forêt-savane du Ghana entre les années 2000 et 2003. Le poids de rhizomes secs de chiendent variaite de 182 g $m^{-2}$ à 5 mois après la plantation (MAP) {17 mois après le traitement (MAT)} à 175 g $m^{-2}$ à 12 MAP (24 MAT) sur les lots en jachère et les lots sur lesquels le chiendent était entaillé avant la plantation de mucuna. Il n'yavait pas de rhizomes sur les lots labourés qui étaient plantés de mucuna et ceux qui étaient pulvérisés de glyphosate ou sarclés avec la house avant que mucuna était planté à 5 MAP. Le résidu de mucuna inhibait le chiendent pour environ 5 mois après la sénescence aboutissat à des plante de manioc plus grandes et plus vigoureuses et à des rendements de racine du manioc de 110-118% plus élevés pour le lot de glyphosate + mucuna que pour le lot en jachère. Le sarclage suivi de mucuna donnait des rendements de racine de 53-85% plus élevés que la jachère. Les rendements de tubercule d'igname dû au transfert d'effet de glyphosate seule, aboutssait à 12% d'augmentation de rendements au-dessus de lots en jachère. Le sarclage suivi de mucuna donnait un rendement de tuberckule de 50% plus élevé que la jachère alors que l'utilisation de glyphosate + mucuna donnait 112% d'augmentation de rendements en tubercule. Sur les lots labourés, les rendements de tubercule d'igname étaient 61% plus élevés que ce de lots en jachère lorsque le mucuna était cultivé pour une salson et 76% plus élevés pour mucuna cultivé pour deux saisons. La culture de mucuna sur les lots laboures pour une saison était aussi efficace que la culture pour deux saisons pour couvrir le chiendent. Les résultants montrent un transfert d'effet considérable d'une culture initiale du sol et mucuna et glyphosate + mucuna pour maîtriser le chiendent pour à peu près 5 mois dans les cultures de manoic et d'igname qui ont suivi.

## Introduction

*Imperata cylindrica* (L.) Raeuschel (speargrass, congograss) is a noxious perennial grass and 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 *I. cylindrica* retards the growth of rubber (*Hevea brasiliensis* [Willd. Ex. Adr. Juss] Muell, Arg) by up to 96 per cent within 5 years. Udensi *et al*. (1999) reported that maize grain yield was reduced by about 80 per cent whilst Koch *et al*. (1990) reported 100 per cent yield reduction in maize and over 90 per cent reduction in yield of cassava intercropped with maize.

*Imperata cylindrica* interferes with crop growth through competing directly for resources that determine growth and through allelopathic interactions (Akobundu & 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 and rhizomes of *I. cylindrica* (Terry *et al*., 1997). Because poor control of speargrass leads to severe crop losses, the need is 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.

The first part of this study reports that an initial cultivation of the soil improves the effectiveness of mucuna to smother *I . cylindrica*. Also, 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 7 months. Glyphosate alone was ineffective in giving long-term control of *I. cylindrica*, and neither glyphosate nor mucuna could control *Commelina* spp. It is, therefore, possible to reclaim lands that have been abandoned because of speargrass in about 7 months with mucuna planted on plots with initial cultivation or by applying glyphosate followed with mucuna.

The purpose of this study was to (i) assess the effects 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 to (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.

*Experiment 1*

A randomised complete block design with three treatments and four replications was used. Plot size was 10 m × 5 m. The treatments were $T_1$- mucuna planted for one season; $T_2$ - mucuna planted for two seasons; and $T_3$ - fallow.

*Experiment 2*

A randomised complete block design with four treatments and three replications was used. Plot size was 10 m × 5 m. The treatments were $T_1$- glyphosate + mucuna; $T_2$ - glyphosate alone; $T_3$ - hoed plot + mucuna; and $T_4$ - fallow.

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

All fallow plots from the previous season and 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 m × 1 m spacing. Yam setts of the cultivar "dente" were planted on mounds spaced at 1 m × 1 m at four locations. All the planting materials were treated with Dursban against insects, especially termites, before planting. Mucuna was planted in 80 cm × 20 cm rows at two seeds per hill.

Weed data collected included weed density and dry weights. At each sampling time, a 0.25-$m^2$ quadrat was randomly placed in the central rows of each plot. The weed species were counted as speargrass, other grasses, broadleaves, 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 $^0$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 rhizomes of speargrass that were present.

*Crop data*

Cassava plant height was measured at 5, 7 and 10 MAP. The heights 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. 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 MAP to determine the shoot dry matter. At harvest, fresh 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 $^0$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 stabilise the variances. All data were analysed using ANOVA and means separated by contrasts.

## Results

*Weed pressure in crop*

Tables 1 to 8 present the densities of speargrass and associated weeds at the time of planting cassava and yam, 5 and 12 months after planting (MAP), which correspond to 12, 17 and 24 months after applying treatments (MAT). At the time of planting the crops, no speargrass were found on the plots ploughed and planted to mucuna. Mucuna was ineffective 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 per cent that of fallow plots at Kobriti (Table 2). There were no speargrass on the plots that were hoed

TABLE 1

*Density of Speargrass at the Time of Planting Cassava and Yam (12 Months After Applying Treatments) at Four Sites in Experiment 1*

| *Treatment* | *Speargrass density (number $m^{-2}$)* | | | |
|---|---|---|---|---|
| | *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 and planted to mucuna as well as on those 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 broadleaved 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 per cent for the plots that were hoed and planted to mucuna and 329 per cent 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 for Wenchi at the time of planting were similar to those for Kobriti (Table 3).

At 5 MAP (17 MAT), the trend in the density of speargrass was similar to that for the time of planting on the ploughed plots (Table 4). However, the density of broadleaved weeds on the plots that were ploughed before planting mucuna

TABLE 2

*Density of Speargrass and Associated Weeds at the Time of Planting Cassava and Yam (12 Months After Applying Treatments) at Kobriti*

| *Treatment* | *Weed density (number m$^{-2}$)* | | | |
|---|---|---|---|---|
| | *Speargrass* | *Other grasses* | *Broadleaves* | *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*

| *Treatment* | *Weed density (number m$^{-2}$)* | | | |
|---|---|---|---|---|
| | *Speargrass* | *Other grasses* | *Broadleaves* | *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 increased significantly compared to that of the fallow (Table 5). The increase in the density of broadleaved weeds on the plots planted to mucuna ranged between 747 and 933 per cent 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 broadleaved weeds dominated the population of weeds in the other treatments followed by the sedges and, to a lesser extent, other grasses. The results for Wenchi were similar to those for Kobriti.

At 12 MAP (24 MAT), some shoots of speargrass were recorded on some plots that were ploughed and planted to mucuna, resulting in densities of between 1 and 6 per cent of that of the fallow (Table 7). The density of broadleaved weeds on the plots planted to mucuna decreased to about 29-30 per cent 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 4

*Density of Speargrass at 5 Months After Planting Cassava and Yam (17 Months After Applying Treatments) at Four Sites in Experiment 1*

| *Treatment* | *Speargrass density (number m⁻²)* | | | |
|---|---|---|---|---|
| | *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 Broadleaf Weeds at 5 Months After Planting Cassava and Yam (17 Months After Applying Treatments) at Four Sites in Experiment 1*

| *Treatment* | *Broadleaf density (number m⁻²)* | | | |
|---|---|---|---|---|
| | *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*

| *Treatment* | *Weed density (number m$^{-2}$)* | | | |
|---|---|---|---|---|
| | *Speargrass* | *Other grasses* | *Broadleaves* | *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 Four Sites in Experiment 1*

| *Treatment* | *Speargrass density (number m$^{-2}$)* | | | |
|---|---|---|---|---|
| | *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 9). No speargrass were observed 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 per cent that of the fallow, whilst the density on plots sprayed with glyphosate alone was 43 per cent that of the fallow (Table 9). On the results on the ploughed plots, the density of broadleaved weeds was reduced to between 9 and 21 per cent of the values recorded at 5 MAP. The results for Wenchi were similar to those for Kobriti.

*Speargrass rhizomes*

The dry weight of rhizomes varied from 182 g m$^{-2}$ 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, 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 m$^{-2}$. Where glyphosate alone was sprayed before mucuna

TABLE 8

*Density of Broadleaf Weeds at 12 Months After Planting Cassava and Yam (24 Months After Applying Treatments) at Four Sites in Experiment 1*

| *Treatment* | *Broadleaf density (number $m^{-2}$)* | | | |
|---|---|---|---|---|
| | *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*

| *Treatment* | *Weed density (number $m^{-2}$)* | | | |
|---|---|---|---|---|
| | *Speargrass* | *Other grasses* | *Broadleaves* | *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

was planted, the dry weight of rhizomes varied between 56 g $m^{-2}$ at 5 MAP (17 MAT) and 43 g $m^{-2}$ 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 per cent that of glyphosate + mucuna-treated plots, 59 to 68 per cent that of glyphosate alone, and 52 to 57 per cent 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 per cent that of glyphosate + mucuna-treated plots, 50 to 56 per cent that of glyphosate alone, and 45 to 50 per cent that of plots that were hoed and planted to mucuna (Table 11).

*Shoot dry matter of cassava*

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

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*

| *Treatment* | *Cassava plant height (cm)* | | |
|---|---|---|---|
| | *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*

| *Treatment* | *Cassava plant height (cm)* | | |
|---|---|---|---|
| | *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 $P<0.01$

*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 were 45 to 46 per cent that of plots treated with glyphosate + mucuna at Kobriti. When glyphosate alone was sprayed, the yield varied between 71 and 76 per cent, whilst the corresponding value for plots that were hoed and planted to mucuna was between 47 and 57 per cent (Table 14). At Wenchi, the fallow plots yielded 47 per cent as much as glyphosate + mucuna plots, 63 per cent as much as glyphosate alone, and 54 per cent as much when plots were hoed and planted to mucuna (Table 14). The dry weight of the cassava roots followed the same trend because the average dry

TABLE 12

*Shoot Dry Matter of Cassava After Applying Treatments at Kobriti*

| *Treatment* | *Dry matter (g m⁻²)* | | | |
|---|---|---|---|---|
| | *3 MAP* | *5 MAP* | *7 MAP* | *10 MAP* |
| $T_1$- 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*

| *Treatment* | *Dry matter (g m⁻²)* | | | |
|---|---|---|---|---|
| | *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

matter varied between 32 and 38 per cent (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 ranged between 56 and 61 per cent that of the plots planted to mucuna. The fresh tuber yield of the fallow plots at 10 MAP was 47 per cent that of glyphosate + mucuna-treated plots, 89 per cent that of the glyphosate alone, and 66 per cent 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 per cent (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, no speargrass were observed 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

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*

| *Treatment* | *Fresh weight (t ha⁻¹)* | | | *Dry weight (t ha⁻¹)* | | |
|---|---|---|---|---|---|---|
| | *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 Yield of Yam 10 Months After Planting (22 Months After Applying Treatments) at Three Sites for Experiment 1*

| *Treatment* | *Koase (slashed)* | *Kobriti-1 (ploughed)* | *Kobriti-2 (ploughed)* |
|---|---|---|---|
| | | *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 $P<0.01$

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 in which the rhizomes remained intact in the soil.

The observation in this study that initial cultivation influences the ability of mucuna to smother speargrass agrees with the findings of Richards & Caldwell (1985) cited by Willard *et al*. (1996) that mowing probably affected rhizomes by depleting carbohydrate reserves during shoot regrowth. However, the effect of an initial cultivation helping to control speargrass conflicts with the result of Akobundu, Udensi & Chikoye (2000) who did not report any effect of slashing speargrass on the ability of mucuna to control speargrass. The difference may be attributed to the effect of handweeding of the plots at short intervals (Akobundu *et al*., 2000) to allow the mucuna to establish. In this study, the plots were not weeded after setting up the experiments in 2000. The plots were only slashed at the time of planting the crops 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

TABLE 16

*Effect of Treatments on Yield of Yam 10 Months After Planting Yam (22 Months After Applying Treatments) at One Site for Experiment 2*

| *Treatment* | *No. of tubers* | *Fresh weight (kg ha$^{-1}$)* | *Dry weight (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

speargrass at the time of planting was about 50 per cent that of the fallow plots.

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 plots that were ploughed and planted to mucuna, resulting in densities of between 1 and 6 per cent of that of the fallow. Because speargrass is also dispersed through white fluffy spikelets by wind, the incidence of speargrass on some plots at 24 MAT may possibly be due to dispersal of weed seeds by wind from adjacent plots.

The density of broadleaved weeds was increased once speargrass population was reduced by the various treatments. Twenty-four months after applying treatments, *Commelina* spp. dominated the weed species at Kobriti, whilst *Chromolaena odorata* dominated at the remaining sites where mucuna was grown for two seasons. This study did not investigate the mechanisms by which cover crops suppress speargrass, but other researchers have reported that shading and allelopathy are the main ways by which cover crops smother weeds (Fujii, Shibuya & Usami, 1991; Macdicken *et al.*, 1997). Nancy *et al.* (1996) also indicated that cover crops modify weed seed germination possibly 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 per cent (28-40 cm) taller than plants on the fallow plots at 5 MAP and 76-97 per cent (76-89 cm) at 10 MAP. Hoeing followed with mucuna led to plants that were 74-92 per cent (44-58 cm) taller at 5 MAP and 89-101 per cent (89-110 cm) at 10 MAP. The corresponding effect of using glyphosate + mucuna was a 95-133 per cent (58-83 cm) increase in height at 5 MAP and 98-120 per cent (98-110 cm) at 10 MAP.

The residual effect of glyphosate alone, applied to control speargrass, resulted in an increased shoot dry matter of cassava that was 127-166 per cent greater than that of the fallow plots at 3 MAP and 61-110 per cent at 10 MAP. Hoeing followed with mucuna resulted in shoot dry matter of 64-69 per cent greater at 3 MAP and 85-140 per cent at 10 MAP. The corresponding effect of using glyphosate + mucuna was a 172-222 per cent increase in the shoot dry matter at 3 MAP and 85-110 per cent at 10 MAP. The early stages of growth recorded greater percentage increases 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 on the fallow plots because weeds were absent. Akobundu (1987) reported that in the humid and sub-humid tropics, 12 weeks of weed-free period are required for cassava and 16 weeks for white yam to prevent reduced crop yield.

Similar to the shoot dry matter, the carry-over effect of glyphosate alone resulted in fresh root yields of cassava that were 30-58 per cent greater than those of the fallow plots at 15 MAP. Hoeing followed with mucuna recorded fresh root yields that were 53-85 per cent greater than those of the fallow at 15 MAP, whilst using glyphosate + mucuna led to a 110-118 per cent increase in fresh root yields at 15 MAP. In yam, the carry-over effect of glyphosate alone resulted in fresh tuber yields that were 12 per cent greater than those of the fallow plots at 10 MAP. Hoeing followed with mucuna resulted in fresh tuber yields 50 per cent greater than the fallow at 10 MAP, whilst using glyphosate + mucuna led to a 112 per cent increase in fresh tuber yields at 10 MAP. On the ploughed plots, tuber yields of yam were 61 and 76 per cent greater than those for the fallow plots 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 when 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 in which the plots treated with glyphosate alone resulted in smaller yields of cassava and yam compared to those of these crops planted with mucuna after hoeing, or on plots treated with glyphosate + mucuna. In this study, it was observed that speargrass emerged at about 3 months after treatment when glyphosate alone was used, indicating 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 that of maize in a maize + cassava intercrop. However, the results of this study agree 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 per cent 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 or competition from cover crops or both. 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 and 118 per cent greater than those of the fallow plots when glyphosate + mucuna was used. Hoeing followed with mucuna recorded fresh root yields of 53-85 per cent greater than those of the fallow. In yam, the fresh tuber yields due to the carry-over effect of glyphosate alone resulted in tuber yields that were 12 per cent greater than those of the fallow plots. Hoeing followed with mucuna resulted in fresh tuber yields of 50 per cent greater than the fallow, whilst using glyphosate + mucuna led to a 112 per cent increase in fresh tuber yields at 10 MAP. On the ploughed plots, tuber yields of yam were 61 and 76 per cent greater than those for the fallow plots when mucuna was planted for one and two seasons, respectively.

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REFERENCES

**Akobundu, I. O.** (1987) *Weed science in the tropics: Principles and practices*. John Wiley and Sons.

**Akobundu, I. O.** & **Ekeleme, F.** (2000) Effect of methods of *Imperata cylindrica* management on maize grain yield in the derived savanna of southwestern Nigeria. *Weed Res.* **40**, 335-341.

**Akobundu, I. O., Udensi, U. E.** & **Chikoye, D.** (2000) Velvetbean (*Mucuna* spp.) suppresses speargrass (*Imperata cylindrica* (L.) Raeuschel) and increases maize yield. *Int. J. Pest Mgmt* **46**(2), 103-108.

**Chikoye, D., Ekeleme, F.** & **Udensi, E. U.** (2001) Congo grass suppression by intercropping cover crops in corn/cassava systems. *Weed Sci.* **49**, 658-667.

**Chikoye, D., Mayong, V. M., Carsky, R. J., Ekeleme, F., Gbehounou, G.** & **Ahanchede, A.** (2002) Response of speargrass (*Imperata cylindrica*) to cover crops integrated with handweeding and chemical control in maize and cassava. *Crop Prot.* **21**, 145-155.

**Fujii, Y., Shibuya, T.** & **Usami, Y.** (1991) Allelopathic effect of *Mucuna pruriens* on the appearance of weeds. *Weed Res., Tokyo* **36**, 43-49.

**Koch, W., Grobmann, F., Weber, A., Lutzeyer, H. J.** & **Akobundu, I. O.** (1990) *Weeds as components of maize-cassava cropping systems*. Standortgemaesse Landwirtschaft. Universitaet Hohenheim, Stuttgart, Germany.

**Macdicken, K. G., Hairiah, K. L., Otsamo, A., Duguma, B.** & **Majid, N. M.** (1997) Shade based control of *Imperata cylindrica*: Tree fallows and cover crops. *Agroforestry Systems* **36**, 131-149.

**Nancy, G. C., Bennett, M. A., Stinner, B. R., Cardina, J.** & **Regnier, E. E.** (1996) Mechanism of weed suppression in cover crop-based production systems. *Hort. Sci.* **31**, 410-413.

**Soedarsan, A.** (1980) The effect of alang-alang [*Imperata cylindrica* (L.) Raeuschel] and control techniques on plantation crops. *Biotrop Special Publication* **5**, 71-77.

**Terry, P. J., Adjers, G., Akobundu, I. O., Anoka, A. U., Drilling, M. E., Tjitrosemito** & **Utomo, M.** (1997) Herbicides and mechanical control of *Imperata cylindrica* as a first step in grassland rehabilitation. *Agroforestry Systems* **36**,151-179.

**Udensi, E. U., Akobundu, I. O., Ayeni, A. O.** & **Chikoye, D.** (1999) Management of congograss (*Imperata cylindrica*) with velvetbean (*Mucuna pruriens*) and herbicides. *Weed Technol.* **13**, 201-208.

**Willard, T. R., Shilling, D. G., Gaffney, J. F.** & **Currey, W. l.** (1996) Mechanical and chemical control of congograss (*Imperata cylindrica*). *Weed Technol.* **10**, 722-726.