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Effect of integrated weed management on weed control and yield components of maize and cassava intercrop in a southern Guinea savanna ecology of Nigeria

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Abstract

The use of pre-emergence herbicides, hoe weeding and live mulch of herbaceous cover plants in a maize/cassava intercrop was investigated at the Teaching and Research Farm of the University of Ilorin, in 2002 and 2004. Experiment consisted of eight main treatments and six sub treatments. The main treatments which is the focus of this article were made up of the application of two pre-emergence herbicides [Primextra and Galex, each at 2.5 kg a.i./ha alone or with one or two supplementary hoe weedings at 6 weeks after planting (WAP) or 6 and 12WAP], a hoe-weeded check (hoeing at 3, 6 and 12WAP) and a weedy control. The experiment was laid out in a randomized complete block design with a criss-cross arrangement, and replicated three times. Data were collected for weed infestation and control, as well as for yield of food crops. When used alone, the pre-emergence herbicides gave satisfactory weed control up to 6WAP, but failed to give season-long weed control. However, better weed control was achieved when the pre-emergence herbicides were supplemented with two hoe-weedings, ($P<0.05$). Consequently, Primextra plus two hoe weedings (Prim+2HW) gave significantly lower weed biomass (42.9 g/m²) and higher yields of the food crops (1135 kg/ha for maize and 10,027 kg/ha for cassava) compared with the hoe-weeded control treatment (63.0 g/m², weed biomass; 849 kg/ha, maize and 8076 kg/ha, cassava), plots treated with Primextra alone (80.4 g/m², weed biomass; 678 kg/ha, maize; 1801 kg/ha, cassava) and the weedy control (116.3 g/m², weed biomass; 358 kg/ha, maize and 1425 kg/ha, cassava).

Keywords: weed; herbicides; savanna; yield; maize; cassava

Introduction

Weed menace has been a major problem in maize and cassava production in southern Guinea savanna. Weed competes with crops for light, soil, moisture and nutrients (Rajcan and Swanton, 2001). Maize has been shown to be sensitive to weed infestation in the first four (4) weeks after planting (Onochie, 1975) and for cassava 8-12 weeks after planting. In Nigeria, yield losses due to weed vary between 40 and 100% depending among other things on type of crops, type of weeds and weed density (Fadayomi, 1991). Herbicide use has been reported to be more profitable than hoe-weeding in the production of various crops in Nigeria (Usoroh, 1983, Singha and Lagoke, 1984, Adigun et al., 1993, Ishaya *et al*., 2008).

Farmers in Nigeria spend more time in controlling weeds than on any other aspects of crop production (Akobundu, 1987). The use of weed management practice that can reduce this labour requirement thereby reducing the cost of food production has been emphasized (Ekeleme et al., 2003). Therefore, the objective of this study was to investigate the effect of two pre emergence herbicides (Primextra and Galex) with or without hand weeding on weed control and yield components of maize and cassava in maize/ cassava intercrop.

Table 1. Effect of integrated weed management on grass weed density (no/m^2) at different periods in 2002 and 2004 at Ilorin, Nigeria.

Weed control Treatments WC	Weed density (no/m^2)					
	2002		2004			
	6WAP	12WAP	6WAP	12WAP	44WAP	48WAP
Primextra	12.3b	20.8b	54.9bc	67.22a	5.56a	8.56a
Prim + 1Hw	16.2b	18.9b	69.9ab	15.50d	4.33a	6.78a
Prim + 2Hw	16.5b	30.0b	73.4ab	14.39d	3.67a	7.22a
Galex	11.5b	16.6b	68.5b	44.78b	5.06a	8.56a
Galex + 1Hw	10.5b	15.7b	87.2a	17.56d	5.11a	9.22a
Galex + 2Hw	10.2b	14.7b	72.2ab	15.89d	5.33a	8.67a
3Hw	2.7c	24.7b	25.2c	17.89d	5.56a	9.67a
Weedy	58.6a	57.2a	72.4ab	30.61c	3.72a	7.67a
SED	6.21	5.12	9.33	3.360	0.997	2.094

Prim = Primextra
Hw = Hoe weeding
WAP = Weeks after planting
Means in the same column bearing the same letter(s) are not significantly different from each other at P = 0.05

Materials and Methods

Plant material and field experiment

The study involving integrated weed management in maize/cassava intercrop was carried out at the Research Farm, Bolorunduro ($8^0$29′N; $4^0$35′E) University of Ilorin, in the southern Guinea savanna ecological zone of Nigeria, between 2002 and 2004. Rainfall distribution pattern of the farm was bimodal; with the first major peak between May and mid-August while the second minor peak is between September and mid-November. The average annual rainfall for Ilorin is 1000-1240mm.

Experimental Layout and treatments

The experiments were designed as randomized complete blocks with eight weed control treatments made up of two pre emergence herbicides application as the main plot treatment and legume cover crops as the sub plot treatment. The main plot treatment is the focus of this paper. Hoe weeding (at 3, 6 and 12WAP) and weedy control plots were included for easy comparison. Each treatment was replicated three times. The main plot size was 36m × 7.8m (280m²) made up of 6 ridges, approximately 1.3m apart. The main treatments consisted of the following: Primextra alone (at 2.5kg a i /ha) (Prim alone) Primextra (at 2.5kg a i /ha) + one hoe weeding (Prim + 1HW at 6WAP) Primextra (at 2.5kg a i /ha) + two hoe weedings (Prim + 2HW at 6 and 12WAP) Galex alone (at 2.5kg a i /ha) Galex (at 2.5kg a i /ha)+ one hoe weeding (Galex + 1HW at 6WAP)Galex (at 2.5kg a i /ha) + two hoe weeding (Galex + 2HW at 6 and 12WAP). Three hoe-weedings (at 3, 6 and 12WAP) Weedy plot (control: no herbicide, no hoe weeding) Each year, the experimental site was ploughed and harrowed, after which ridges which are approximately 1.3m apart were made. This was followed by field layout. Maize (var. DMRY, obtained from Kwara Agricultural Development Project (ADP), Ilorin) was planted on the crest of the ridges at an intra-row spacing of 0.25m immediately after land preparation and field layout. Three seeds were sown per hill which was later thinned to one plant per stand in 2002 and two plants per stand in 2004 both at 2WAP to give a plant population of 20 000 and 40 000 plants per hectare, respectively.

A local variety of cassava stems ("Okoyawo") were obtained from the local farmers in 2002 and from the Teaching and Research Farm of University of Ilorin in 2004. Cassava stems were cut into 25cm setts each and planted at an angle at an intra-row spacing of 0.8m between the crest of the ridge and the furrow on one side of the ridge. This gave a plant population of 12,500 plants per hectare. The cassava planting was done four weeks after the planting of maize in 2002, and along with maize in 2004. Herbicide treatments were applied as pre – emergence sprays at the rate of 2.5kg a.i/ha a day after plating of maize using a CP3 knapsack sprayer, fitted with a green deflector nozzle, which was calibrated to deliver a spray volume of 240l/ha.

Table 2. Effect of integrated weed management on broad leave weed density (no/m^{2}) at different periods in 2002 and 2004 at Ilorin, Nigeria.

Weed control treatments WC	Broadleaved weed density (no/m^2)				
	2002	2004			
	6WAP	6WAP	12WAP	44WAP	48WAP
Primextra	1.33a	2.70a	2.33b	0.444a	0.56a
Prim + 1Hw	1.72a	1.40a	1.00b	0.389a	0.83a
Prim + 2Hw	1.56a	1.10a	0.94b	0.389a	0.72a
Galex	3.89a	9.80a	10.44a	0.444a	0.56a
Galex + 1Hw	3.22a	4.30a	1.17b	0.500a	0.72a
Galex + 2Hw	6.39a	2.70a	1.00b	0.667a	0.33a
3Hw	0.50a	1.40a	1.44b	0.722a	0.67a
Weedy	5.17a	29.40a	10.44a	1.500a	2.11a
SED	1.959	8.50	2.13	0.6050	0.871

Prim = Primextra
HW = Hoe weeding
WAP = Weeks after planting
Means in the same column bearing the same letter(s) are not significantly different from each other at P = 0.05

Weed density and weed biomass were estimated at 6 and 12 weeks after planting (WAP) in 2002 and at 6, 12, 44 and 48WAP in 2004 within (0.5m)² quadrats. Yield component of each food crop was evaluated at harvest in both cropping seasons.

Statistical analysis

All data were subjected to analyses of variance (ANOVA) using GENSTAT statistical package. Significant means were separated by the Duncan Multiple Range Test at 5% probability level.

Results

Effect of pre emergence herbicides on grass weed densities

In 2002, the hoe-weeded control plots had the lowest density of grass weeds while the weedy control plots had the highest density at 6WAP (Table 1). Plots subjected to the other weed control treatments had grass weed densities that were significantly lower than those in the weedy plots but significantly higher than those of the hand weeded control plots. At 12WAP all the weed control treatments recorded significantly lower grass weed densities than weedy control plots. In 2004, the pre emergence herbicide treatments had different effects on grass weed density at 6 and 12WAP. At 6WAP, grass weed density was significantly lower in hoe –weeded plot (25.2 weeds/m^2) than in plots treated with Galex+1HW (87.2 weeds/m^2), Galex + 2HW (72.2 weeds/m^2), Prim+ 2HW), (73.4 weeds/m^2), weedy plots (72.4 weeds/m^2), Galex alone (68.5 weeds/m^2) and Primextra alone with 54.9 weeds/m^2 (Table 1).

At 12WAP, plots treated with Prim+1Hw, Prim+2Hw, Galex+2Hw and Galex+1Hw recorded low grass weed densities which were not significantly different from those in the hoe–weeded plots (Table 1). Plots treated with Primextra and Galex alone had significantly higher grass weed densities than in the weedy plots. Grass weed density was generally low (<10weeds/m²) in all the treatments at 44 and 48WAP and there were no significant differences among the treatments means.

Effect of pre emergence herbicides on broadleaved weed density

In 2002, broadleaved weed density was generally low in all the plots at 6WAP, and there were no significant differences among the treatments means (Table2). No data was collected for this parameter at 12WAP as the whole of the experimental plots were totally dominated by grass weeds. The same trend of result obtained at 6WAP in 2002 was also observed in 2004 at 6WAP. At 12WAP, broadleaved weed density was significantly affected by the pre emergence herbicides. Weed density was significantly lower in plots treated with Primextra alone, Prim+1HW, Prim+2HW, Galex+1Hw, Galex+2Hw and hoe -weeded plot than in plots treated with Galex alone and weedy plots. Broadleaved weed density at 44 and 48WAP followed the same trend of result as in 6WAP.

Table 3. Effect of integrated weed management on grass weed biomass (g/m²) at different periods in 2002 & 2004 in Ilorin, Nigeria.

Weed control Treatments WC	Weed biomass (g/m^2)						
	2002		2004				
	6WAP	12WAP	6WAP	12WAP	20WAP	44WAP	48WAP
Primextra	3.49b	33.4b	15.89a	87.9a	93.0a	35.7a	48.2a
Prim + 1Hw	4.12b	9.7b	17.89a	25.2c	45.4bc	29.5a	48.0a
Prim + 2Hw	4.00b	12.1b	15.44a	17.2c	11.4d	21.4a	38.8a
Galex	3.36b	28.5b	21.08a	66.9a	103.9a	36.4a	52.1a
Galex + 1Hw	4.93b	14.4b	20.03a	23.5c	38.8bc	36.6a	70.5a
Galex + 2Hw	4.34b	11.3b	15.78a	23.5c	18.9cd	18.2a	55.2a
3Hw	0.46c	11.1b	3.72b	24.8c	18.6cd	30.2a	59.6a
Weedy	16.26a	96.7a	21.47a	50.2b	58.2b	25.6a	32.3a
SED	0.872	7.57	2.109	7.07	9.82	8.18	14.60

Prim = Primextra
Hw = Hoe weeding
WAP = Weeks after planting
Means in the same column bearing the same letter(s) are not significantly different from each other at P = 0.05

Effect of pre emergence herbicide treatments on grass weed biomass

In 2002, grass weed biomass was significantly lower under all the weed control treatments compared with the weedy control plots at 6 and 12WAP (Table 3). The hoe-weeded plots recorded the lowest grass weed biomass of 0.46g/m^2 at 6WAP, which was significantly lower than what was obtained under other weed control treatments. At 12WAP, all the plots treated with the pre-emergence herbicides with supplementary hoe-weeding and the hoe-weeded plots recorded significantly lower grass biomass than the weedy control, Primextra alone and Galex alone plots.. In 2004, the pre-emergence herbicide treatments had significant effects on grass weed biomass at 6, 12 and 20WAP but not at 44 and 48WAP. At 6WAP, hoe-weeded control plots had significantly lower grass weed biomass than other weed control treatments which had similar biomass as in the weedy plots (Table 3). At 12WAP, statistically similar grass weed biomass were obtained in plots treated with Prim+2Hw, Galex+2Hw, Galex +IHW, three hoe-weedings and Prim+1Hw (with 17.2, 23.5, 23.5, 24.8 and 25.2g/m^2 respectively) (Table 3). The means obtained from these treatments were significantly lower than those obtained from plots treated with Primextra alone, Galex alone and weedy plots. At 20WAP, grass weed biomass was lowest in plots treated with Prim+2HW (11.4g/m^2) followed by the hoe-weeded plots (18.6g/m^2) and plots treated Galex+2HW (18.9g/m^2). Plots treated with Primextra and Galex alone as well as the weedy control plots had significantly higher grass weed biomass (93.0, 103.9 and 58.2g/m^2 respectively) (Table 3). At 4WAP, the lowest grass weed biomass was obtained under Galex+2Hw (18.2g/m^2) while plots treated with Galex+1HW (36.6g/m^2) had the highest grass weed biomass (Table 3). However, these were not statistically different from each other and this was also observed at 48WAP.

Effect of pre emergence herbicide treatments on broadleaved weed biomass

In 2004, at 6WAP, broadleaved weed biomass was significantly higher in weedy plots and plots treated with Galex alone than in plots subjected to the other weed control treatments (Table 4). A similar trend of result was obtained at 12WAP while at 20, 44 and 48WAP, broadleaved weed biomass was not significantly affected by the weed control treatments.

Effect of pre emergence herbicide treatments on total weed density

At 12WAP in 2002, total weed density was significantly higher in weedy plot than in plots treated with Prim+2Hw (Table 5). Weed density under both treatments were significantly higher than other weed control treatments with the lowest in plots treated with Galex+2HW.

In 2004, total weed density at 12WAP was similar in plots treated with Primextra and Galex alone, both of which were significantly higher than total weed density in the weedy plots (Table 5). However, total

Table 4. Effect of integrated weed management on broadleaved weed biomass (g/m^2) at different periods in 2004 at Ilorin, Nigeria.

Weed control Treatment WC	Broadleaved weed biomass (g/m^2)				
	6WAP	12WAP	20WAP	44WAP	48WAP
Primextra	2.00b	4.7b	14.0a	1.11a	32.3a
Prim + 1Hw	1.03b	1.0b	9.4a	1.22a	0.7a
Prim + 2Hw	0.25b	2.5b	6.7a	4.53a	4.1a
Galex	6.33a	47.1a	34.9a	1.11a	2.1a
Galex + 1Hw	3.61ab	1.3b	17.5a	1.27a	1.1a
Galex + 2Hw	1.72b	0.9b	8.9a	3.14a	0.9a
3Hw	0.42b	1.4b	2.9a	2.19a	3.4a
Weedy	6.67a	14.5b	24.3a	9.2a	84.8a
SED	1.062	5.40	11.45	4.881	45.13

Prim = Primextra
HW = Hoe weeding
WAP = Weeks after planting
Mean bearing the same letter(s) are not significantly different from each other at $p = 0.05$

weed density was significantly lower under the other weed control treatments than weedy control plots. Total weed density was generally low under the various weed control treatments at 48WAP (Table 5).

Effect of pre emergence herbicide treatments on total weed biomass

It had been reported earlier under grass weed biomass that the weed flora of the experimental plots in 2002 was dominated essentially by grass weeds, thus the few broadleaved weed species were weighed together with grass weed species. Consequently, the grass weed biomass in the plots constituted the total weed biomass. In 2004, total weed biomass was significantly affected by the pre emergence herbicide treatments. At 12WAP, total weed biomass was similar and significantly lower in plots treated with Prim +1HW, Prim +2HW, Galex +1HW and Galex +2HW, and hoe-weeded control plots than in plots subjected to the other weed control treatments (Table 5). Total weed biomass was highest in plots treated with Galex alone, followed by those under plots treated with Primextra alone and the weedy plot. At 48WAP, total weed biomass was significantly lower in plots treated with Prim +1HW, Prim +2HW, Galex alone and Galex+2HW than in weedy control plots.

Effect of pre emergence herbicide treatments on grain yield

In 2002, maize grain yield was significantly higher in plots treated with Prim + 2HW (1049 kg/ha) and Galex + 2HW (907 kg/ha) than the hoe – weeded control which had 816 kg/ha (Table 6). Grain yields from Primextra alone, Prim + 1HW and Galex+ 1HW were similar to those from hoe – weeded plots. The weedy plots recorded the lowest maize grain yield of 238 kg/ha. A similar trend of result was obtained in 2004. Maize grain yield was significantly higher in plots treated with Prim + 2HW (1221 kg/ha) than yield obtained in the hoe–weeded plots (883 kg/ha) (Table 6). The average grain yield for both years followed the same trend of result. The lowest grain yield was obtained in plots treated with Galex alone which was similar to yield obtained in the weedy control plots and those treated with Primextra alone and Galex + 1HW.

Effect of pre emergence herbicide treatments on cassava tuber yield

In both years, cassava fresh tuber yield was significantly higher in plots treated with Prim+2HW (8, 237 and 11, 816 kg/ha respectively) compared to plots treated with Primextra alone and Galex alone, each of which had similar effect on cassava fresh tuber yield as the weedy plots (Table 7). The average tuber yield for both years was also obtained with the same treatment (10027 kg/ha).

Discussion

Hoe-weeded plots provided adequate weed control up to 6WAP as significantly lower weed density was observed than in other weed control treatments. This

Table 5. Effect of integrated weed management on total weed density (no/m²) and weed biomass (g/m^2) at different periods in 2002 and 2004 at Ilorin, Nigeria.

Weed control	Total weed density (no/m²)			Total weed biomass g/m^2.	
Treatment	2002	2004		2004	
WC	12WAP	12WAP	48WAP	12WAP	48WAP
Prim extra	24.1bc	69.56a	9.11a	92.1b	80.4ab
Prim + 1HW	19.5c	16.50c	7.61a	26.2d	48.7b
Prim + 2 HW	33.6b	15.33c	7.94a	19.7d	42.9b
Galex	17.3c	55.22a	9.11a	114.1a	54.2b
Galex + 1HW	16.8c	18.67c	9.94a	24.8d	71.6ab
Galex + 2HW	14.6c	16.89c	9.00a	24.4d	56.1b
3 HW	25.6bc	19.33c	10.33a	26.2d	63.0ab
Weedy	64.5a	41.06b	9.78a	64.7c	116.3a
SED	4.37	4.250	0.908	5.71	16.88

Prim = Primextra
HW = Hoe weeding
WAP = Weeks after planting
Means in the same column bearing the same letter(s) are not significantly different from each other at P = 0.05

agrees with Chikoye *et al*., (2005) who reported 33% increase in maize yield in a hoe-weeded plot. Similarly, the other weed control treatments enhanced weed control efficacy especially in those plots subjected to pre-emergence application of Primextra and Galex with **one supplementary hoe- weeding. This also agrees with Chikoye *et al*., (2005) who reported a complete and a good control of weeds by a new formulation of atrazine and metolachlor (Primextra). Weed density at 44 and 48 WAP was very low (< 10 weeds/m²). Plots treated with Primextra alone and Galex alone recorded significantly higher weed density as in weedy control. This implies that these pre-emergence herbicide treatments with no hoe-weeding could not provide season-long weed control because of their short persistence. This confirms the earlier study of Akobundu, (1987) who reported that most pre-emergence herbicide treatments give early weed control of emerging weed seedlings but easily lose their efficacy. This, according to the author allows late emerging and vigorous growing broadleaved weeds like *Vernonia galamensis* to gain ground. This was true of this study as plots treated with Galex alone were totally covered with *V. galamensis.* This suggests that the continuous use of Galex has the potential to cause a change in flora in favuor of *V. galamensis* which may have inherent tolerance to Galex. Earlier report by Radosevich and Holt, (1984) showed that changes in weed flora are most obvious when herbicides are used, also reported was the increase in species richness of weeds as a result of ditch cuttings (Huijser *et al*., (2003). Recent report of Fadayomi and Olofintoye, (2005) had it that pre-emergence application of Galex, Squadron and Pursuit Plus did not effectively control *V. galamensis.*

Weed biomass was affected by the pre emergence treatments such that plots with one hoe-weeding (as at 12WAP; i.e. Prim+1HW, Prim+2HW, Galex+1HW and Galex+2HW) all produced low weed biomass in both years having similar effect with hoe-weeded plot. This agrees with the report of lower weed dry matter by Chikoye *et a*l., (2005). The effect of the pre-emergence herbicides with supplementary hoe-weeding was still visible at 20WAP in plots treated with Prim+2HW, Galex+2HW and hoe-weeded plot. Plots with Prim+2HW produced the lowest weed biomass (11.4g/m²⁾ while plots with Primextra alone without supplementary hoe weeding produced weed biomass similar to weedy control plots which had the highest total weed biomass (grass weed biomass was very low but that of broadleaved weeds was very high). In all other weed control treatments, broad leave weed biomass was very low. Effective weed control was obtained with Prim+2HW as this treatment produced the lowest weed biomass at cassava harvest. Grain yield of maize for both years was generally low in this study. Anuebunwa, (1991) in his earlier study has reported consistent low maize grain yield irrespective of year and weed control

Table 6. Effect of integrated weed management on maize grain yield in 2002 and 2004 at Ilorin, Nigeria.

Weed Control Treatments WC	Maize grain yield (kg/ha)		
	2002	2004	Average
Primextra	799ab	558c	678bc
Prim + 1Hw	812ab	965ab	888b
Prim + 2Hw	1049a	1221a	1135a
Galex	669bc	447c	558c
Galex + 1Hw	850ab	706bc	778b
Galex + 2Hw	907a	942ab	925b
3Hw	816ab	883b	849b
Weedy	238c	478c	358d
SED	88.8	86.9	52.6

Prim = Primextra
HW = Hoe weeding
WAP = Weeks after planting
Means in the same column bearing the same letter(s) are not significantly different from each other at P = 0.05

Table 7. Effect of integrated weed management on cassava fresh tuber yield kg/ha at 11MAP in 2002 and 2004 at Ilorin, Nigeria.

Weed Control Treatments (WC)	Cassava fresh tuber yield kg/ha		
	2002 11WAP	2004 11WAP	Average
Primextra	1857ce	1745b	1801d
Prim + 1Hw	4046bc	7885ab	5965c
Prim + 2Hw	8237a	11816a	10027a
Galex	2080ce	3071b	2575d
Galex + 1Hw	4673b	8410ab	6542bc
Galex + 2Hw	6642ab	9749ab	8195ab
3Hw	6866a	9286ab	8076ab
Weedy	1104de	4080b	1425d
SED	989.9	2412.1	625.9

Prim = Primextra
HW = Hoe weeding
WAP = Weeks after planting
MAP = Months after planting
Means in the same column bearing the same letter(s) are not significantly different from each other at P = 0.05

measurement. However, maize grain yield was significantly better with Prim+2HW in both years than hoe weeded plot. The average grain yield for both years was significantly higher in plots treated with Prim+2HW than other treatments which agrees with the recent report of Chikoye *et al*. (2004). This treatment effectively controlled weeds as reflected in low weed density and weed biomass and this agrees with the report of Mahadi *et al.,* (2007). This treatment seems to show superiority over hoe weeded check. On the contrary, the effect of Primextra alone and Galex alone on grain yield was comparable to weedy plot. As stated earlier, these treatments were inadequate in controlling weeds as indicated by high weed density and weed biomass resulting in low grain yield. Recent report by Adigun and Lagoke (2003) has shown that herbicides have not been consistent in giving season –long weed control and often requires supplementary hand weeding. This is also similar to the observation of Aladesanwa *et al*., (2008) who reported increase in maize grain yield when melon live mulch was supplemented by one hoe- weeding. Cassava fresh tuber yield in both years was significantly higher with Prim+2HW than hoe weeded plot. Other weed control treatments produced lower tuber yield especially in Primextra aloneand Galex alone which had similar effect as weedy plots. Higher tuber yield was observed in 2004 than 2002 and this was probably due to early planting in 2004.

Conclusion

The pre-emergence herbicides used in this study gave satisfactory weed control up to 6WAP, although this resulted in high weed density, weed biomass and weed cover in the intercrop. They failed to give a season-long weed control.

However, better weed control was obtained in plots where these pre-emergence herbicides were supplemented with two hoe-weeding, consequently, Prim+2HW gave the overall best weed control and crop yield in both maize and cassava

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