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Effect of application of witch weed control options on performance of two maize varieties in Uganda

F. Ssango and M. Balitenda†
Agribusiness Development Centre/Investment in Developing, Export Agriculture (IDEA Project), P.O. Box 7856 Kampala, Uganda
†Department of Agriculture Extension, Kaliiro sub-county, Kamuli district, Uganda

Abstract

On-farm witch weed (*Striga* sp.) control management options were tested in Kamuli and Iganga districts in *Striga* infested fields. The objective was to test efficacy of striga control options reported elsewhere under Ugandan conditions. A trial was set up with the following treatments: 120 kg N ha^{-1} with and without herbicide (Dicamba, a.i. Dimethylamine) application, use of a trap crop (sunflower) and the control. *Striga* plant population significantly ($P<0.05$) reduced maize yields. However fertilisers and or with herbicide treatments significantly controlled *Striga* infestation resulting in increased yield gains. Under sunflower plots in the first season, no *Striga* plants emerged, however in the following season, sunflower plots were used as the control, *Striga* emergence was very high leading to significant reduction in yields. Combined use of urea and Dicamba was found to be profitable. Through application of fertilisers and Dicamba a farmer reduced his unit cost of production by 25%. An integrated approach comprising of use of mechanical weeding before flowering in combination with other weed control strategies reported in this paper can tremendously reduce on the soil seed bank. This clearly demonstrates that effective management of *Striga* can be achieved through an integrated approach.

Key words: Integrated management, *Striga asiatica, Striga hermonthica, Zea mays*

Introduction

Striga hermonthica and *Striga asiatica* are root parasites that attack most cereal crops in Africa and are considered one of the most important biological constraints to food production in Africa (Sauerborn, 1991; Ransom, 2000). The areas infested as well as the incidence of *Striga* are reported to be increasing in sub-Saharan Africa (Parker, 1991). The precise estimates on the areas infested with *Striga* and level of food production losses are not available for most African countries. However, estimates suggest that cereal production losses are as high as US $ 311million annually (Sauerborn, 1991).

In Uganda, *Striga* is a major biological constraint to maize *(Zea mays)* production and other cereals especially in parts of eastern and northern Uganda. It is considered a leading biological constraint to both sorghum *(Sorghum bicolor)* and maize production. Unlike other weeds, *Striga* is a parasite, that competes with crops for water, nutrients and energy and also exerts a potent phytotoxic effect on its host (Ransom *et al.*, 1995). It is believed to be a major production constraint especially in heavily depleted soils. Under heavy *Striga* infestation coupled with poor soils, yield losses as high as 70% can be recorded. *Striga* and poor soils are closely associated and continued mono cropping of cereals can greatly encourage its occurrence (Ransom *et al.*, 1996).

In situations where the infestation level is beyond economic thresholds, use of chemicals is inevitable. Appropriate use of chemicals against *Striga* is recommended where infestations are high. Ransom (1996) reported that application of the pre-emergent herbicide Dicamba (a.i. Dimethylamine) in maize seedlings to control *Striga* increased maize yields significantly. No similar studies have been reported on management of *Striga* using Dicamba and soil fertilisation in Uganda. Therefore in an effort to develop management options of *Striga* in Uganda, use of fertilisers, herbicide and trap crops were tested on two maize genotypes under heavy *Striga* infestations in Kamuli and Iganga districts of eastern Uganda.

Materials and methods

Ten farmer fields with known history of high *Striga* infestation were selected in Kaliiro and Namutumba in Kamuli and Iganga districts, respectively. Two maize genotypes, Longe 1 (an open pollinated cultivar) and Longe 2H (F_1 hybrid) commonly grown in the country were selected for use in the study. The treatments used in the study were: a) 120 kg N ha^{-1}, b) 120 kg N ha^{-1} application rate plus application of Dicamba at the recommended dosage 6 weeks after crop emergence, c) one plot was planted with sunflower, and d) no treatment was applied (control). Each of the two maize genotypes was subjected to these treatments.

Ten farmers were randomly selected per district and each farmer set up experiments with 3 replications for each treaments. In addition to the maize plots, one sunflower plot was established at each farmer's field. This was used as a trap crop control treatment. Plots of five rows, 10 m in length were used. Six grammes of DAP was applied at planting and plants established at a spacing of 75 cm x 60 cm. Urea was applied 4 weeks after crop emergence by top dressing and subsequent incoporation into the soil. Six weeks after crop emergence, Dicamba was applied using a knapsack sprayer in a 30 cm band on each side of the crop row as recommended by the manufacturer.

Data on *Striga* population per plot was collected fortnightly starting 6 weeks after crop emergence and continued up to the 14th week. Both plant stand per plot and ear/cob bearing plants were recorded. Grain weight per plot was measured at a moisture content of 12 % and yield per hectare computed. Data was subjected to analysis of variance and means compared using Fisher's Protected Least Significant Different test at ($P \leq 0.05$). Correlation analysis of *Striga* counts to maize yield parameters was performed. Statistical analysis was performed using SAS (SAS, 1997).

Economic analysis was computed using one variety Longe 1, by administering a questionnaire to farmers in Kamuli district, who had hosted the trial on their fields and had earlier on recorded high maize yield losses due to *Striga* infestation.

Results and discussion

Average *Striga* population per plot, plant height at reproductive stage, percentage plant count with cobs, cob length, estimated yield per ha and moisture content for 2001B and 2002A seasons are presented in Table 1. Generally higher *Striga* count was observed in plots of Longe 2H compared to those of Longe 1 across the two seasons. This probably suggests that Longe 2H, a hybrid is more prone to *Striga* compared to Longe 1 an open pollinated variety. No *Striga* plant emergence was observed in plots of sunflower. Sunflower is a known striga trap crop, able to stimulate germination of striga but does not allow sustained feeding leading to complete starvation and death of striga seedlings. In this study, sunflower was very effective as a trap crop. Average plant height varied and was highest in plots with fertilisation and herbicide application across the two varieties. Plant height in the plots of Longe 1 under fertilisation and herbicide application increased by 32%, while for Longe 2H by 47% (Table 1). The number of plants bearing a cob of Longe 1 was highest in plots which received both fertiliser and herbicide and significantly differed ($P \leq 0.05$) from the control, however no significant variations were observed between fertilisation and a combination of the two. In Longe 2H, plants with cobs were very few (19.5%)in control plots, fertilisation and herbicide application improved this significantly ($P \leq 0.05$) to over 70%. Yield estimation revealed that application of fertiliser and or herbicide improved maize yields of Longe 1 by over 170%. The yield of Longe 2H significantly increased by over 300% as a result of fertiliser and or herbicide application.

During 2002A season, maize with no additional inputs (control) was planted in plots where sunflower was during the 2001B season. The effect of *Striga* on maize crop in the former sunflower plots was significantly evident (Table 2), despite the fact that no single count had been recorded in 2001B season (Table 1). This probably suggested that one season crop rotation can not adequately reduce *Striga* seed bank in the soil.

The above trend was also observed in hybrid plots. Addition of fertiliser plus a herbicide improved plant height significantly by 62% during 2002A season (Table 2). An additional increase of 30% on plants bearing a cob was recorded as a result of fertiliser and herbicide application (Table 2). Application of inorganic fertiliser and herbicide improved the final yield of Longe 1 by 360% in 2002A season, while the hybrid maintained an impressive 300% yield improvement (Table 2). Comparison of *Striga* counts and percentage plants with cobs for variety Longe 1 are presented in Figure 1. There was a significant *Striga* count reduction in plots that received fertiliser and herbicide applications. Also the number of maize plants with properly filled cobs significantly improved from 48.4% in the control to 85.3% under fertilisation and herbicide application. Estimated yield of Longe1 increased by over 170 % by addition of urea compared to the control (Fig. 2).

An increase of 200% was estimated in the plots of Longe 1 with fertiliser plus herbicide (Fig. 2). This means that, under such a management, a farmer can make significant yield improvements through use of fertilisers and herbicides at the appropriate crop growth stage. A correlation analysis of *Striga* population and yield components of maize revealed that there was a strong negative relationship between *Striga* count and maize yield parameters over the two seasons (Table 3). This shows the significance of *Striga* as a production constraint of maize.

Table 1. Mean values of the different parameters measured in the Striga management trial, 2001B season.

Parameters	Longe 1					Longe 2H				
	Fertiliser	Fertiliser + herbicide	Sunflower	Control	LSD (P<0.05)	Fertiliser	Fertiliser + herbicide	Sunflower	Control	LSD (P<0.05)
Striga count	176.5	120.8	0	427.5	219.9	199.9	213.0	0	640.0	184.0
Average plant height	169.0	190.0	0	144.0	15.5	163.0	172.0	0	117.0	18.6
% plant stand with a cob	76.3	85.3	0	48.4	31.8	81.0	70.7	0	19.5	25.0
Cob length	17.8	18.3	0	14.0	2.95	18.8	17.0	0	11.3	4.5
Yield kg ha^{-1}	3875.0	4290.0	0	1400.0	1233.7	3828.5	3456.0	0	741.8	2136.5
Moisture content	12.9	12.8	0	13.4	n.s*	13.4	13.2	0	14.5	n.s

*ns = not significantly different at $P \leq 0.05$.

Table 2. Mean values of the different parameters measured in the Striga management trial, 2002A season.

Parameters	Longe 1				Longe 2H			
	Fertiliser	Fertiliser + herbicide	Control	LSD (P<0.05)	Fertiliser	Fertiliser + herbicide	Control	LSD (P<0.05)
Striga count	214.7	112.6	428.3	164.3	352.2	182.5	565.2	242.5
Average plant height	157.2	169.0	103.6	22.9	169.4	188.0	115.6	28.7
% plant stand with a cob	65.1	75.7	35.8	15.2	67.7	84.2	32.2	21.1
Cob length (cm)	17.8	19.4	11.2	3.9	19.2	19.8	12.4	4.1
Yield kg ha^{-1}	3060.0	3540.0	760.0	968.2	3540	4180.0	1000.0	1291.2
Moisture content	12.7	13.2	13.4	n.s*	13.2	13.3	13.7	n.s

*ns = not significantly different at $P \leq 0.05$.

During an interview with farmers in Kaliiro, it was revealed that hardly three bags of maize are obtained or harvested in an acre. Cost of production analysis further confirmed this observation. Table 4 indicates costs incurred when growing maize in three different practices. Although, a farmer using the traditional practices incurred less costs compared to the rest, the cost of production per unit kilogram of maize produced was the highest at Ug. Shs. 181 compared to Ug. Shs. 135 for one who used both fertiliser and herbicide (Table 4). This shows that, the tested *Striga* management options are cost effective and if adopted will help to produce the crop cost-effectively.

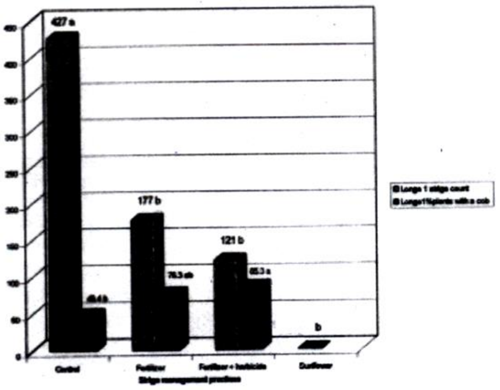

Figure 1. Striga population and percentage of Longe 1 plants with a cob under different Striga management practices, 2001B season.

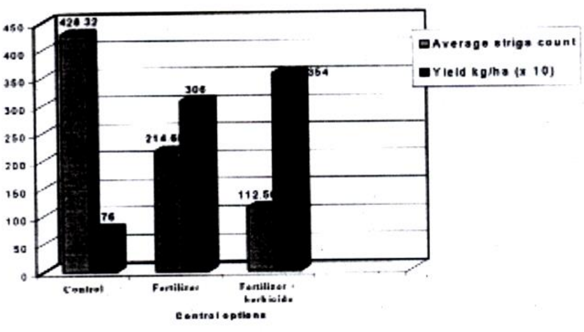

Figure 2. Striga count and yield estimate for cultivar Longe 1, 2002A season.

Conclusion

Control of *Striga* requires an integral approach, no single control option can effectively and economically yield suitable results. Fertilisation in combination with herbicide application was found best option among those tested. However, in a farmer environment, incorporation of other control methods to this strategy like weeding before *Striga* plants have flowered is recommended since this would probably result in reduced quantities of fertiliser and herbicides to be applied. This would help reduced cost of production and hence maximise profits.

Table 3. Pearson correlation coefficients between striga counts and yield parameters of maize.

	Striga count (6 WAP)	Striga count (14 WAP)	Average plant height	% plant stand	Cob length (cm)	Yield	Moisture content
Striga count (6 WAP		0.88***	-0.55***	-0.63*	-0.42*	-0.48 n.s	-0.17 n.s
Striga count (14 WAP)			-0.68***	-0.84***	-0.64***	-0.73***	0.05 n.s
Average Plant height (cm				0.78***	0.80***	0.70***	0.16 n.s
Percentage of plant stand with a cob					0.87***	0.85***	0.04 n.s
Cob length (cm)						0.72***	0.17 n.s
Yield							-0.34 n.s

*, *** The relationship between the two variables is statistically significant at $P \leq 0.05$, 0.001, n.s = not significantly different at $P \leq 0.05$.

Table 4. Cost of production of maize in striga infested land under three different management practices, farmers' experience in Kaliiro sub-county.

Activity / Inputs	Traditional practice (per acre)	Fertiliser (per acre)	Fertiliser + herbicide (per acre)
Inputs			
Seed	12,000	12,000	12,000
Fertiliser (DAP)	0	38,000	38,000
Fertiliser (Urea)	0	70,000	70,000
Herbicide (Dicamba)	0	0	14,000
Sub-total (inputs)	12,000	120,000	134,000
B: Labour			
Land preparation	38,000	40,000	40,000
Planting	10,000	10,000	10,000
Herbicide application	0	0	3,000
Fertiliser application	0	7,500	7,500
Weeding	36,000	24,000	12,000
Harvesting	3,500	16,500	16,500
Post-harvest operations	2,000	8,500	8,500
Sub-total (labour)	89,500	106,500	97,500
Total cost of production	101,500	226,500	231,500
Yield (kg acre^{-1})	560	1,550	1716
Unit cost (Shs kg^{-1})	181	146	135

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