An Integrated Approach to the Control of *Striga* on Sorghum

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Abstract

Two experiments on intercropping and one on integrated management of *Striga hermonthica* (Del.) Benth were carried out at three sites in northern Ethiopia. In the intercropping experiment soybean, cowpea and haricot bean were tested in different spatial and temporal arrangements with sorghum. The integrated management experiment consisted of various combinations of resistant cultivars, planting methods, fertilizer application, and manual weeding or herbicide (2,4-D) application in comparison with the farmers' practices. Intercropping was generally effective in suppressing *Striga* population. *Striga* shoot counts in intra-row intercropped sorghum with cowpea registered 2 percent of the check but this treatment also reduced sorghum yield significantly. On the other hand, the planting arrangement involving one row of legume intercrop for every two rows of sorghum resulted in significant suppression of *Striga* without significant negative effect on sorghum yield. The full package of *Striga* control practices involving resistant cultivars, row planting, fertilizer (42 kg N ha^{-1}), with supplementary hand pulling at Sirinka and 2,4-D (1 l ha^{-1}) at Adi-Bakel resulted in about 70 and 63 percent reduction of *Striga* shoot counts, respectively, compared with the check plots. The intercropping experiment revealed that its effects were site-specific. Results of our experiments suggest that a full package of recommended management practices be employed for effective suppression of *Striga* and increased yield of sorghum.

Introduction

The parasitic weed *Striga hermonthica* is one of the most important production constraints of cereals in Ethiopia. Ejeta et al. (1993) estimated that it causes 65-70% yield loss in the sorghum producing areas of this country. Heavy losses occur mainly in the highly degraded dryland areas of northern and south-eastern parts of the country. *Striga* has also become a very serious threat to large scale cereal production in the high potential western regions of Ethiopia, discouraging investment in agriculture in those areas. The *Striga* problem is usually complicated by other interacting factors such as aberrant weather conditions and low soil fertility. Devising a simple solution for the problem under such conditions has become a real challenge.

Intercropping has, in many instances, shown promise as a low cost method of controlling *Striga*. Carson (1989) observed that the density of emerged *Striga* plants was reduced when sorghum was intercropped with groundnut in the Gambia. Intercropping sorghum with *Lablab purpureus* suppressed *Striga* emergence and growth, and increased number of heads and straw yield of sorghum in the Sudan (Babiker et al. 1993). Similar results were obtained in northern Cameroon where sorghum and cowpea association produced the best yield of sorghum and greater reduction of *Striga* (Carsky et al. 1994).

The effect of soil nitrogen on *Striga* is still controversial. Some studies have shown that high N levels in the soil enhanced growth of both the host and the parasite (Parker 1984). However, Farina et al. (1985) reported that NPK fertilizer application resulted in 93% reduction in the incidence of *Striga asiatica*. Other workers showed that *Striga asiatica* infestation and sorghum shoot dry matter losses decreased with an increase in soil N (Raju et al. 1990). Urea fertilizer was necessary to bring about effective control of *Striga hermonthica* and increased yield of sorghum with application of herbicides (Babiker et al. 1993).

There are a range of recommended control measures but, available evidence suggests that effective control of *Striga* can only be achieved through the implementation of an integrated approach. This paper describes investigations carried out on intercropping and integrated control methods in an effort to develop sustainable *Striga* management options.

Materials and Methods

Intercropping

The experiment was carried out at three dryland sites at Sirinka, Adibakel and Sheraro in northern Ethiopia. Soybean, cowpea and haricot bean were intercropped in three different spatial arrangements, simultaneous planting with sorghum, at Sirinka. In the following season, treatments were modified to include planting methods less suppressive to sorghum. Legume intercrops were planted in four different spatial and temporal arrangements. One hundred percent seed rate of sorghum and 50% of legumes were maintained across treatments. Sole sorghum with and without fertilizer was included for comparison.

The experiment was laid out in a randomized complete block design (RCBD) in a factorial arrangement with three replicates at Sirinka the first season and two replications at the other sites in the second year. The trial was maintained free of other weeds by repeated hand weeding.

Integrated Control

In 1993, at Sirinka two improved varieties ('Birmash' and 'SRN-39') were compared with a local cultivar under five management practices. In 1994, at Adibakel, the trial was modified to replace poor performing 'Birmash' with two other varieties - 'ICSV-1006', 'ICSV-1007'. The experiment was laid out in RCBD, in a split plot arrangement with three and two replications at Sirinka and Adibakel, respectively, with cultivars as main plots and management practices as sub-plots (size 3.75 m x 5 m). Fertilized plots received 42 kg N ha^{-1}. The herbicide 2,4-D was applied at the rate of 1 l ha^{-1} (directed spray at the flowering stage of *Striga*). Weeds other than *Striga* were removed by repeated hand-weeding.

Results

Intercropping

Striga infestation was considerably less in intercropped plots compared to the check plots (Tables 1 and 2). In particular cowpea/sorghum association was effective in reducing *Striga* population both at Sirinka; *Striga* shoots at the two locations were 2.3 and 42.7% of the control, respectively. At Sheraro, where the environmental conditions are more favorable, there was high response to fertilizer; sole sorghum with fertilizer was the most outstanding treatment both in terms of reduced *Striga* intensity and increased yield of sorghum. Here, fertilizer application in sole sorghum reduced the parasitic weed population by 79% and increased sorghum yield by 85%. The reduced effect of intercrops on *Striga* at Adibakel and Sheraro may be due to insect damage that resulted in poor establishment of the legumes.

These results demonstrated that an optimum planting arrangement of intercrops is required to bring about substantial reduction of *Striga* without significant compromise in sorghum yield. At Sirinka, all three planting arrangements created a highly competitive environment which led to a considerable reduction in sorghum yield, although the loss was partially compensated by the yield of the association crops (Table 1). In the second season, however, the less intimate planting arrangement involving one row of legume for every two rows of sorghum, sown simultaneously, reduced *Striga* intensity by about 54% over the control (Table 2).

Integrated Control

The cultivar 'SRN-39' sustained significantly fewer number of *Striga* shoots than 'Birmash' and the local cultivar at Sirinka (Table 3). At Adibakel, 'ICSV-1006', followed by 'SRN-39' was superior to the local cultivar and 'ICSV-1007' in terms of *Striga* shoot counts (Table 4).

Table 1. Effect of intercropping on *Striga* counts (shoots per plot) and crop yield (kg ha-1) at Sirinka, 1993

Treatment	Striga count	Yields	
		Sorghum	Legume
Intercropping (I)			
Sole sorghum	1391	2984	-
Sorghum/soybean	811	2164	354
Sorghum/cowpea	32	1326	1543
Sorghum/haricot bean	290	1509	1622
Planting arrangements (A)			
Within row	458	1641	1265
Alternating rows	400	2066	1010
Broadcasting	275	1292	1244
LSD (0.05) (I)	458	537	303
LSD (0.05) (A)	NS*	465	NS
LSD (0.05) (I x A)	NS	NS	NS
CV (%)	134	33	27

* *NS=nonsignificant*

Table 2. Effect of intercropping on *Striga* and sorghum yield (kg ha-1), 1994

Intercrop	*Striga* count (Shoots/plot)		Grain yield		Biomass yield	
	AB	SH	AB	SH	AB	SH
Sole sorghum(+)	97	12	321	2476	5066	13000
Sole sorghum(-)	95	57	444	1076	5067	7000
Sorghum/soybean	63	47	360	1020	4867	6167
Sorghum/cowpea	41	62	443	1309	5517	7417
Sorghum/Haricotb.	77	53	466	1296	5783	7083
Lsd 0.05 (I)	29	10	NS	NS	845	1689
Planting arrangement						
BC/30 DAS	72	55	402	1195	5600	7000
BC/Sim.	79	55	474	1116	5889	5889
AR/30 DAS	45	53	383	1276	4800	7222
EOR/Sim.	44	53	435	1246	5267	7444
Lsd 0.05 (A)	34	NS	NS	NS	975	NS
Lsd 0.05 (IxA)	59	20	NS	NS	NS	3291
CV (%)	45	17	24	28	14	22

AB-Adibakel, SH-Sheraro, (+)-with fertilizer, (-)-with out fertilizer, BC-Broadcasting, AR-Alternate row intercropping, EOR-One row of legume every two rows of sorghum, DAS-Days after sowing, Sim.-Simultaneous planting.

These results confirmed that the use of a full package of integrated management methods was beneficial. It can be seen that *Striga* counts were lower in row planted, fertilized, and 2,4-D sprayed sorghum than the rest of the treatments. On the other hand, the highest *Striga* counts were observed in broadcast sown, unfertilized sorghum plots where the weeds were removed by hand pulling (Table 4). A similar trend was observed in the second season although the differences were not significant.

Despite the high level of *Striga* infestation the long season local cultivar ('Degalit') gave the highest yield of 4556 kg ha^{-1} at Sirinka (Table 3). This meant a yield increment of 143% and 196% over the improved varieties, 'Birmash' and 'SRN-39', respectively. At Adibakel, in a relatively poor season, 'ICSV-1006' gave 102% higher yield than the short season local cultivar (Table 4).

Management practices influenced sorghum grain yield significantly. At Sirinka, a 40% yield increase was achieved from the package involving row planting, fertilizer, and 2,4-D application (Table 3). At Adibakel, where the yield was generally low perhaps due to low and erratic rainfall, row planting, fertilizer plus hand pulling gave the highest yield of 564 kg ha^{-1} which was 48% higher than the check (Table 4).

Discussion

Intercropping

Our results confirmed that intercropping, provided it is employed along with an appropriate planting arrangement, can effectively minimize *Striga* incidence and improve yield per unit area in the dry regions. Although the beneficial effect of the legume intercrops was not so obvious at Adibakel and Sheraro because of heavy insect pest damage, it was shown that intercropping can have a useful merit as an alternative low cost measure for combating *Striga* in the subsistence agriculture of northern Ethiopia. In the dry areas of the north where the benefit of inorganic fertilizers is so variable and uncertain, intercropping can be used to optimize yield and maitain soil fertility. Intercropping has the additional advantage of making the system more secure in the event of crop failure.

At Adibakel, application of fertilizer showed a negative trend perhaps because of moisture stress. It resulted in increased crop sensitivity to *Striga* and hence lower yield. On the other hand, there was an impressive high response to fertilizer application, in terms of reduction in *Striga* intensity and improved crop yield, at Sheraro, where the soil fertility and rainfall conditions were relatively better. These findings are in line with that of Doggett (1984, 1988) who stated that addition of N fertilizers reduced *Striga* emergence in fertile soils but increased it in infertile soils.

These results also imply that in moisture stress areas *Striga* management aspects other than chemical fertilizer have to be emphasised whereas fertilizer application should be an integral part of any *Striga* management package in areas with adequate rainfall.

Integrated Control

The varieties 'ICSV-1006' and 'SRN-39' consistently showed high level of resistance to *Striga*. However, the yields from these cultivars were low compared to the dominant, long season farmers' cultivar ('Degalit') at Sirinka. Previous experience shows that these cultivars can have a comparative advantage giving some yield when the local cultivar fails under severe *Striga* infestation and under moisture stress in a poor season. In the drier areas of Tigray region the improved cultivars showed impressive performance. *Striga* resistance and yield performance of the cultivars was enhanced with improved management.

The effect of fertilizer on *Striga* and crop yield is usually variable depending on the season and inherent fertility of the soil. However, results of this particular experiment showed that considerable advantage can be gained from the application of fertilizers when there is adequate rainfall. Row planting enhanced the beneficial effects of fertilizer.

Table 3. Effect of improved management practices on *Striga* and sorghum yield (kg ha-1) at Sirinka, 1993

Variety	*Striga* count (Shoots/plot)	Grain Yield (kg/ha)
Local (Degalit)	1229	4557
Birmash	1499	1810
SRN-39	157	1541
Lsd 0.05 (V)	700	463
Management		
BC-F+HP	1440	2242
BC+F+HP	1407	2793
RP+F+HP	426	2210
RP-F+HP	831	2894
RP+F+2,4-D	702	3142
Lsd 0.05 (M)	NS	463
Lsd 0.05 (VxM)	NS	NS
CV (%)	104	23

Table 4. Effect of improved management practices on *Striga* and sorghum yield (kg ha-1) at Adibakel, 1994

Variety	*Striga* count (Shoots/plot)	Grain yield (Kg/ha)	Biomass yield (Kg/ha)
Local	262	307	4793
LCSV-1006	42	621	2440
ICSV-1007	166	549	2527
SRN-39	80	453	2840
Lsd (V)	105	162	1149
Management			
BC-F+HP	198	381	2767
BC+F+HP	193	532	3042
RP+F+HP	92	564	3483
RP-F+HP	141	393	2642
RP+F+2,4-D	73	541	3817
Lsd 0.05 (M)	117	181	NS
Lsd 0.05 (VxM)	235	362	2569
CV (%)	80	35	39

BC-Broadcasting, RP-Rowplanting, (+)-Fertilizer (42 kg N/ha), (-)-without fertilizer, HP-Hand pulling, 2,4-D herbicide (1 l prod./ha)

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