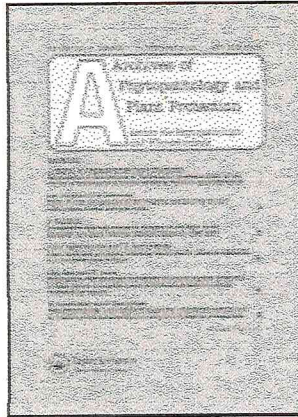


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Archives Of Phytopathology And Plant Protection

Publication details, including instructions for authors and
 subscription information:

<http://www.tandfonline.com/loi/gapp20>

Effect of cultural methods on *Striga* (*Striga hermonthica* (Del.)) Benth management and yield of cereals in the Savanna Zone of Nigeria: a review

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Available online: 24 Aug 2011

To cite this article: E. O. Imoloame & S. D. Joshua (2011): Effect of cultural methods on *Striga*
 (*Striga hermonthica* (Del.)) Benth management and yield of cereals in the Savanna Zone of Nigeria:
 a review, Archives Of Phytopathology And Plant Protection, 44:17, 1655-1665

To link to this article: <http://dx.doi.org/10.1080/03235400903458720>

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Effect of cultural methods on *Striga* (*Striga hermonthica* (Del.)) Benth management and yield of cereals in the Savanna Zone of Nigeria: a review

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(Received 1 October 2009; final version received 2 December 2009)

Data were obtained from the research done in the Guinea Savanna (Zaria 11°11'N; 070 38'E) and Sudan Savanna (Maiduguri – 11°51'N; 13°15'E) regions of Nigeria, respectively on different cultural methods of *Striga* control and management. In the Guinea Savanna, trials on the effects of nitrogen on the response of resistant and susceptible upland rice varieties to *Striga hermonthica* infestation and the effect of resistant and susceptible varieties of maize and crop rotation on *Striga* infestation was carried out, while the effect of inter-cropping trap crop (Bambaranut) with resistant sorghum varieties on *S. hermonthica* was studied in the Sudan Savanna Zone of Nigeria. In the Guinea Savanna, it was observed that a combination of upland rice variety, Faro 40 and an application of 90 kg N/ha in the wet season and WAB 56-50 upland rice variety and 120 kg N/ha in the dry season, respectively reduced *Striga* infestation and produced maximum grain yield. Also, the growing of resistant variety of maize (Across 97ITZ comp. I-W) after 1 or 2 years' rotation with cowpea or soybean was observed not only to be effective in *Striga* control, but resulted in higher grain yield of maize. In the Sudan Savanna, the use of resistant varieties of sorghum, ICSV1002 and ICSV1007 intercropped with bambaranut significantly reduced *Striga* infestation, but the grain yield of the resistant varieties was low. From these studies, Faro 40 with 90 kg N/ha application rate and WAB56–50 with 120 kg N/ha were suitable for the management of *Striga* and for higher grain yield of upland rice in both wet and dry seasons, respectively, while Across 97ITZ comp. I-W, resistant maize variety and 1 or 2 years rotation with cowpea or soybean were also the best for the management of *S. hermonthica* and for higher maize yield in the Guinea Savanna zone. Further research needs to be carried out in the Sudan Savanna to select a high yielding resistant variety of sorghum which when intercropped with bambaranut will not only control *Striga* infestation but will also give high grain yield.

Keywords: cultural methods; *Striga* management; cereal crops; Nigeria Savanna

Introduction

The genus *Striga* (Witch weed) is considered native to Africa. It is also encountered in Asia, while it was accidentally introduced to US and Australia (Raynal-Roques 1996). At least 35 different species of *Striga* are found in Africa, representing 38% of

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the total number of *Striga* species in the world (Raynal-Roques 1991). Five species of *Striga* that cause significant damage to crops are *Striga hermonthica* (Del.) Benth, *Striga asiatica* (L) O. Kuntze, *Striga forbesii* Benth, *Striga aspera* and *Striga gesnerioides* (Willd.). The first four species attack cereal crops (Sorghum, Millet, Maize and rice) with *S. hermonthica* being the most serious in Sub-Saharan Africa (Parkinson 1985; Gworgwor 1993). *S. gesnerioides* attacks mostly legumes, especially cowpea (Gworgwor 1993).

As a root parasite, *Striga* takes up assimilates and water from their host through haustorial connections (Pieterse and Pesch 1983; Okonkwo 1990). Keeping their stomata permanently opened, *Striga* withdraws so much water from the host that they induce drought symptoms (Shah et al. 1987; Stewart and Press 1990). Host development may be further impaired by the production of toxins or a disturbance of the hormone balance (Frost et al. 1997).

Crop loss due to *Striga* infestation in the Savanna of Africa cannot be overemphasised. Yield reduction in sorghum even under good management has been estimated at 20–90% (Lagoke 1991). Yield losses of maize due to *Striga* infestation in Nigeria alone was estimated at 70%, while losses in Africa was about 40% representing an annual revenue loss of about \$7 billion (M'boob 1986). Grain yield losses due to *Striga* infestation in upland rice and other host crops have been estimated to be between 10 and 100% (Johnson et al. 1997).

In view of its economic importance and the fact that it can cause hunger and poverty among the farmers and the populace in Nigeria, effective *Striga* control and management has become imperative in order not only to maximise cereal yield per hectare, but also to improve the socio-economic well-being of the farmers.

Past researchers have identified several effective cultural technologies (Parker and Riches 1993). Examples include resistant host crop cultivars, crop rotation, intercropping, better sanitation and maintaining soil fertility (Parker and Riches 1993). The objective of this article is to review the effects of cultural methods of *Striga* control (nitrogen rates, variety, crop rotation and intercropping) on *S. hermonthica* and recommend suitable cultural practices to the farmers in the savanna zone of Nigeria.

The data for this article were obtained from research done in Guinea Savanna (Zaria – 11°11'N; 07°38'E) and Sudan Savanna (Maiduguri – 11°51'N; 13°15'E) by Adagba et al. (2003), Kureh et al. (2006) and Gworgwor et al. (1993), on different methods of *Striga* management.

Results

Table 1 shows that Faro 45 supported earliest emergence of *Striga* compared with all the other varieties in the two seasons except Faro 40 and WAB 56–60 (resistant Varieties), which supported no *Striga* emergence. Similarly, Faro 48 supported significantly fewest *Striga* shoots compared with all the other varieties during the dry season except Faro 40 and WAB 56–50 which supported no *Striga* shoot at 9 and 12 WAS and at harvest (Table 1). However, during the wet season, Faro 45 supported fewest *Striga* shoot compared with other varieties at 9, 12 WAS and at harvest, except Faro 40 and WAB 56–50 which supported no *Striga* shoots during the two seasons, at 9 and 12 WAS and at harvest (Table 1).

The application of 30–120 kg N/ha in the wet and dry seasons, though not significant, consistently delayed and reduced the emergence of *Striga* in rice at 9

Table 1. Effect of crop variety and nitrogen levels on the number of days to *Striga* emergence, *Striga* count and grain yield in upland rice at Samaru, Zaria in 1998 dry and wet seasons.

Treatment (varieties)	Number of days to <i>Striga</i> emergence		<i>Striga</i> shoot count at				Grain yield			
			9WAS ^a		12WAS		Harvest (kg/ha)			
	1 ^b	1 ^c	1	11	1	11	1	11	1	11
FARO 46	45.7ab	45.4ab	7.6ab	10.8a	13.1a	22.8a	15.1ab	26.8a	2299c	1166a
FARO 11	47.3ab	50.8a	10.9ab	4.6c	13.5a	12.0c	11.7ab	15.6c	2646bc	858a
FARO 45	40.8b	39.9c	12.0ab	2.8cd	16.0a	7.5c	16.7a	9.7c	2257c	1735a
FARO 48	50.3a	48.5ab	4.6bc	3.7c	6.1b	13.0bc	8.8b	16.66c	2813abc	114.4a
FARO 38	41.9ab	43.1bc	12.2a	6.7b	14.6a	17.1ab	12.5ab	24.3ab	2781abc	1552a
FARO 40 (resistant)	ne	ne	0.0c	0.0d	0.0b	0.0d	0.0c	0.0c	3316ab	1790
WAB 56-50 (resistant)	ne	ne	0.0c	0.0d	0.0b	0.0d	0.0c	0.0c	3711a	1255
SE ($\pm$)	3.99	2.99	4.61	1.02	5.88	5.93	5.78	7.78	400	374
Nitrogen (kg/ha)										
0	42.3a	44.9a	8.9a	5.9a	12.0a	16.3a	12.6	17.9	1573d	515c
30	43.1a	45.1a	7.8a	3.5a	10.0a	10.2b	10.0	13.7	2173c	1175b
60	47.0a	45.5a	6.3a	3.7a	8.8ab	9.1b	10.0	11.0	2440c	1487ab
90	47.5a	46.7a	3.6a	3.7a	5.6b	9.4b	6.5	11.9	3491b	1827a
120	46.1a	46.5a	7.2a	3.7a	8.9ab	6.6b	6.9	11.9	4162a	1722a
SE ($\pm$)	2.85	3.40	2.64	1.19	2.84	2.75	2.85	3.61	301	248
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Source: Adagba et al. (2003). Means followed by the same letter(s) in the same column are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT). NS, not significant; ne = no emergence.

^aWeeks after sowing.^bDry season experiment.^cWet season experiment.

WAS and at harvest in both seasons compared with no nitrogen application. It was only at 12 WAS that the above rates of nitrogen significantly reduced *Striga* infestation than no nitrogen application.

WAB 56-50 produced maximum grain yield of rice in the dry season, while Faro 40, Faro 48 and Faro 38 produced grain yield comparable to the maximum. However, Faro 45 and Faro 46 produced significantly the lowest grain yield (Table 1). In the wet season, Faro 40 produced the maximum yield but not significantly different from Faro 45, Faro 38, Faro 48, WAB 56-50, Faro 46 and Faro 11 which produced the lowest yield. In the dry season, 30–120 kg N/ha produced significantly higher yield compared with no nitrogen application. However, 120 kg N/ha produced significantly the highest yield compared with the other treatments in the dry season (Table 1). In the wet season, although 90 kg N/ha produced the highest grain yield, it was not significantly different from that produced from 60 and 120 kg N/ha. However, 30–120 kg N/ha produced significantly higher grain yield compared with no nitrogen application (Table 1).

It was observed that maize grown after 1 year rotation with trap crops, namely, soybean, cowpea and groundnut had significantly greater vigour than continuous sole maize and maize after 1 year of fallow (Table 2). Continuous sole maize had significantly the lowest vigour compared with the rest of the treatments. It was also observed that significantly lower *Striga* seed bank was recorded for maize grown after 1 year of fallow compared to the other treatments. Significantly lower *Striga* shoots were supported in maize after 1 year rotation with trap crops and fallow compared to continuous sole maize, with maize after 1 year of rotation with groundnut supporting significantly fewest *Striga* shoots. Crop damage severity was significantly higher in continuous sole maize compared with maize after 1 year of legume trap crops and fallow, with significantly least damage occurring in maize after 1 year of legume trap crops (Table 2). The grain yield of maize after 1 year of legume trap crops was significantly higher than that from continuous sole maize and maize after 1 year of fallow. Maize after 1 year rotation with cowpea produced the highest grain yield which is comparable with the yield of maize after 1 year rotation with the other trap crops (Table 2).

Table 2. Effect of 1-year rotation with legume trap-crops on *Striga hermonthica* seed bank, incidence, crop vigour score, damage severity and grain yield of maize at Samaru, Nigeria, 2002 wet season.

Type of rotation	<i>S. hermonthica</i> , seed bank, no./100 g soil	Crop vigour score, ^a 11 WAP	<i>S. hermonthica</i> count, (no./m ²), 11 WAP	Count damage severity, 11 WAP ^b	Grain yield (kg/ha)
Continuous sole maize	8.7	7.5	1.5	4.1	3402
Maize after fallow	13.2	8.2	1.1	3.6	3480
Maize after soybean	6.2	8.5	0.7	3.1	4273
Maize after cowpea	6.2	8.7	0.7	3.0	4359
Maize after groundnut	8.7	8.4	0.5	3.0	4087
SE (±)	0.30	0.11	0.17	0.08	139.95

Source: Kureh et al. (2006). Data obtained weeks after planting. Means followed by the same letter(s) in the same column are not significantly different at 5% level of probability, according to Duncan's Multiple Range Test (DMRT).

^aCrop vigour score using a scale of 1–10, where 1 = complete damaged plants and 10 = healthy plants.

^bCrop damage severity using a scale of 1–9, where 1 = healthy plants and 9 = completely damaged plants.

Table 3. Effect of 2-year rotation with legume trap-crops on *S. hermonthica* seed bank, incidence, crop vigour score, damage severity and grain yield of maize at Samaru, Nigeria, 2003 wet season.

Type of rotation	Crop vigour score ^a , 11WAP	<i>S. hermonthica</i> count, (no./m ²), 11 WAP	Count damage severity ^b , 11 WAP	Grain yield (kg/ha)
Continuous maize	7.6	0.4	4.0	2047
Maize after 2 years of fallow	8.8	0.4	3.0	3195
Maize after 2 years of soybean	9.8	0.3	2.1	4082
Maize after 2 years of cowpea	8.6	0.7	2.5	3776
Maize after 2 years of groundnut	9.2	0.2	2.5	3247
SE ($\pm$)	1.85	0.13	0.23	364.35

Source: Kureh et al. (2006). Data obtained weeks after planting. Means followed by the same letter(s) in the same column are not significantly different at 5% level of probability, according to Duncan's Multiple Range Test (DMRT).

^aCrop vigour score using a scale of 1–10, where 1 = completely damaged plants and 10 = healthy plants

^bCrop damage severity using a scale of 1–9, where 1 = healthy plants and 9 = completely damaged plants.

Similarly, maize grown after 2 years of legume trap crops and fallow grew more vigorously than continuous sole maize though the difference in crop vigour was not significant. Although maize after 2 years of legume trap crops of soybean and groundnut supported the least *Striga* shoots, it was not significantly different from that of continuous sole maize and maize after 2 years of fallows (Table 3). The damage severity by *S. hermonthica* in continuous sole maize was significantly higher than in maize after 2 years rotation with legume trap crops and 2 years of fallow. The damage severity by *S. hermonthica* in maize after 2 year rotation with trap crop was significantly the least compared with the other treatments. Maize after 2 years of rotation with soybean produced significantly the highest grain yield compared with continuous sole maize, but comparable with maize after 2 year rotation with other trap crops and 2 years of fallows (Table 3).

Table 4 shows that the maize cultivar (Across 97 ITZ comp. 1-W) tolerant to *S. hermonthica* exhibited more vigorous growth, which was significantly greater in 2002 and 2003 than the susceptible variety of maize. Similarly, the resistant variety of maize supported less *Striga* shoot which was significant in 2001 and 2002 than the susceptible variety; it had a lower level of crop damage severity though not significantly different and produced significantly higher grain yield in the three years compared with the susceptible variety (Table 4). ICSV 1007 planted alternative stand same row as bambaranut delayed *Striga* emergence more than the other treatment in both years, 1995 and 1996 (Table 5). The delay was significantly higher compared with sole Ware-warenbashi in the two years. The same variety had delayed *Striga* emergence in the alternative stand arrangement than the sole stand in 1995. Sole planting of ICSV 1007 and ICSV 1002 significantly supported delayed emergence of *Striga* which was similar to sole planting of Ware-warenbashi in both years (Table 5). *Striga* count/m² at 9 and 12 WAS in ICSV 1007, ICSV 1002 and Ware-warenbashi sorghum varieties planted with bambaranut in the same row, alternative stand or alternative row was lesser compared with sorghum varieties planted sole in both years. However, the *Striga* infestation was significantly more in sole Ware-warenbashi and ICSV 1002 compared with the plots having the intercrop of these varieties with bambaranut in both years except at 12 WAS in 1995.

Table 4. Effect of maize cultivar on crop vigour score, *Striga hermonthica* infestation, damage severity and grain yield at Samaru, Nigeria 2001–2003.

Cultivars	Crop vigour ^a			<i>S. hermonthica</i> count, (no./m ²), 11 WAP			Count damage severity, ^b 11 WAP			Grain yield (kg/ha)		
	2001	2002	2003	2001	2002	2003	2001	2002	2003	2001	2002	2003
Across 97 Comp 1-W (resistant)	7.0	8.5	9.2	0.3	0.5	0.2	5.0	3.1	2.4	3363	4236	3657
TZB-SR (susceptible)	6.0	7.8	8.4	0.7	1.0	0.3	6.7	3.7	3.2	2660	3745	2891
SE ($\pm$)	1.05	0.04	0.21	0.11	0.04	0.08	0.60	0.03	0.03	66.56	59.50	167.19

Source: Kurch et al. (2006). Data obtained weeks after planting.

^aCrop vigour score using a scale of 1–10, where 1 = completely damaged plants and 10 = healthy plants.^bCrop damage severity using a scale of 1–9, where 1 = healthy plants and 9 = completely damaged plants.

Table 5. Effects of intercropping trap crop (Bam baranut) with three sorghum varieties on *Striga* days to emergence, *Striga* count and grain yield of sorghum.

Treatments	<i>Striga</i> days to emergence		<i>Striga</i> count/plant				Grain yield (kg/ha)	
			9WAS		12WAS			
	1995	1996	1995	1996	1995	1996	1995	1996
Sole – ICSV 1002	54.8ab	57.0ab	26.0ab	22.0b	29.3ab	21.5b	741.0c	611.11c
Sole – ICSV 1007	57.5ab	73.0a	5.5b	2.7c	14.3abc	10.0b	556.9c	499.1c
Sole ware-warenbashi	47.3b	43.5b	36.2a	36.2a	36.5a	44.5a	1271.5b	722.2bc
ICSV 1002 planted with alternate stand row of bambamra-nut (1:1row)	51.5ab	48.0b	14.0b	10.8c	17.0abc	10.8b	984.1b	907.4ab
ICSV 1007 planted with alternate stand row of bambamra-nut (1:1row)	67.8ab	50.8b	0.5bc	0.0c	1.0c	0.0c	794.6bc	574.1c
Ware-warenbashi planted with alternate stand row of bambamra-nut (1:1row)	54.8ab	46.8b	8.3b	9.5c	9.8bc	13.0b	1681.0a	1018.5a
ICSV 1002 planted with alternate stand same row of bambaranut (1:1row)	53.8ab	53.5b	10.8b	6.8c	11.8abc	10.3b	1175.0b	814.8bc
ICSV 1007 planted With alternate stand same row of bambamra-nut (1:1row)	69.3a	75.0a	1.8bc	0.0c	1.5c	0.5c	892.6b	666c
Ware-warenbashi planted With alternative stand same row of bambamra-nut (1:1row)	62.8a	54.0a	7.8b	9.3c	11.5abc	11.0b	1625a	999.9ab
SE ($\pm$)	5.60	6.0	9.10	6.0	11.10	8.0	7.50	75.20
LSD ($P < 0.05$)	18.10	21.0	21.0	11.0	25.70	19.0	201.80	192.3

Source: Hudu et al. (1999). Means followed by the same letter(s) in the same column are not significantly different at 5% level of probability, according to Duncan's Multiple Range Test (DMRT).

The susceptible local sorghum variety, Ware-warenbashi planted sole supported significantly higher *Striga* plants compared with sole planting of ICSV 1002 and ICSV 1007 varieties, especially at 12 WAS in 1996 (Table 5). Statistically, there was no significant difference in *Striga* count 9 and 12 WAS ($P > 0.05$) in ICSV 1007 planted alternative rows with bambaranut and ICSV1007 planted alternative stand on the same row with bambaranut in 1995 and 1996. Ware-warenbashi planted with alternative row of bambaranut produced significantly the highest grain yield compared with all the other treatment in both years, which is comparable only to the grain yield produced from Ware-warenbashi planted alternative stand, same row of bambaranut. All the sorghum varieties planted with bambaranut irrespective of the arrangement produced higher grain yield than sole planted varieties (Table 5). The lowest grain yield was produced from the resistant varieties ICSV1007 and ICSV1002 that were planted sole.

Discussion

Faro 40 and WAB 56-50 consistently exhibited resistance to *S. hermonthica* as it supported no *Striga* emergence or infestation. This could be due to mechanical barrier by the host's root and or the initiation of anti-haustoria factors and low production of stimulant (Parker and Riches 1993).

The application of 30 to 120 kg N/ha in the wet and dry seasons though not significant, consistently delayed and reduced the emergence of *Striga* in the rice crop compared with no nitrogen application. Earlier reports on the effect of fertiliser have also indicated that adequate nitrogen reduces *Striga* infestation and increase host yield (Ogborn 1979; Mansfield 1982). Also, the high levels of nitrogen needed to suppress *Striga* have been associated with reduced exudation of *Striga* germination stimulants by hosts' roots (Pieterse 1996) and consequently reduced infestation (Bebawi 1987). High nitrogen level has also been associated with the reduction of radicle elongation of the few germinated *Striga* seeds providing an escape mechanism effect on the attachment of *Striga* seedlings to the host (Pesch and Pieterse 1982).

WAB 56-50 and FARO 40 produced maximum grain yield in the dry and wet seasons respectively compared with the other varieties probably because they exhibited resistance to *S. hermonthica* by not supporting germination of any *Striga* plants throughout the life of the crop, unlike the other varieties which supported varying degrees of infestation of *Striga*. This could have prevented competition between the resistant varieties and the *Striga* for growth resources like water, light and nutrients which could have supported higher yield. Ransom et al. (1996) had also indicated that the superior grain yield of the resistant varieties of maize compared with the susceptible varieties was related to the delayed and even lack of parasitism of the resistant varieties.

In both dry and wet seasons, 30–120 kg/ha of nitrogen application produced significantly higher grain yield compared with no nitrogen application. However, 120 kg N/ha and 90 kg N/ha produced the highest grain yield in both dry and wet seasons, respectively.

This could be due to the ability of high levels of nitrogen that delayed and reduced *Striga* emergence and infestation around the crop, which resulted in the crop utilising the nitrogen more efficiently which supported higher yields.

Maize grown after one year or two years of soybean, cowpea, groundnut and fallow had greater vigour than continuous sole maize. This could have resulted from the improvement in the soil fertility by the trap crops and fallow through their ability to fix atmospheric nitrogen and organic matter addition, respectively.

The significantly lower *Striga hermonthica* seed bank observed for maize after 1 year rotation with legume trap crops of soybean and cowpea compared with the rest of the treatment and the lower *Striga* shoot count in maize grown after 1 or 2 years rotation with legume trap crops compared with continuous sole maize, could be due to suicidal germination of *Striga* seeds by the trap crops. This led to the abortion of *Striga* development, reduced seed bank and *Striga* infestation. This agrees with Kim et al. (1997) who found that rotation with legume trap crops reduced *Striga hermonthica* infestation through depleting the seed population in the soil and improving the soil's nitrogen status. The damage in maize planted after one or two years rotation with trap crops was significantly less than that in continuous sole maize due to lower *Striga* infestation and higher crop vigour in maize grown after rotation with trap crops compared with continuous sole maize.

The grain yields of maize grown after 1 or 2 years rotation with trap crops though comparable to each other were significantly higher than that of continuous sole maize. Maize grown after 1 year rotation with cowpea produced the highest grain yield, while maize grown after 2 years rotation with soybean produced the highest grain yield. The significantly higher grain yield of maize after one or two years of rotation with legume trap crops compared to continuous sole maize, was done to higher crop vigor, lower *Striga* seed bank and infestation and less *Striga* damage in maize after 1 or 2 years of legume trap crops compared to continuous sole maize.

The higher performance of the tolerant/resistant variety of maize could be done to a product of agro-ecomic potential, a level of tolerance to *S. hermonthica* and the environment as reported by Ejeta and Butler (1993).

Sorghum variety, ICSV1007 intercropped with bambaranut in the same row alternative stands significantly delayed *Striga* emergence more than sole planting of local susceptible Ware-warenbashi in the two years, probably due to the low stimulant produced by the resistant varieties (Gworgwor 1993); the suicidal germination of *Striga* seeds buried within few centimetres of the soil profile by the trap crops, and variable response of deeply buried *Striga* seeds to germinating stimulants produced by the trap crops and sorghum varieties (Babiker et al. 1987).

The plots in which each of the sorghum varieties ICSV1007, ICSV1002 and Ware-warenbashi was intercropped with bambaranut, irrespective of the arrangement, had less *Striga* population than the sole planting of each of the sorghum varieties. This could be as a result of the lower germinating stimulants produced by the resistant varieties and the ability of the bambaranut to cause suicidal germination to *S. hermonthica* seeds which helped in reducing the *S. hermonthica* population. The low grain yield in sole planted local susceptible Ware-warenbashi variety compared with the same variety intercropped with bambaranut can be attributed to mainly high *Striga* infestation. The low grain yield obtained in ICSV 1007 despite the low *Striga* infestation under field condition might be due to varietal difference in response to environment apart from where it was initially developed (Babiker et al. 1987).

Summary

A combination of Faro 40 and an application of 90 kg N/ha in the wet season and WAB 56-50 and an application of 120 kg N/ha in the dry season are recommended to the farmers in the Guinea Savanna Zone of Nigeria for the effective management of *S. hermonthica* and for higher yields of upland rice. Similarly, the growing of resistant variety of maize (Across 97 ITZ comp. 1-W) after 1 or 2 years rotation with cowpea or soybean is found not only effective in *Striga* control, but results in higher yield in the Guinea savanna. Although intercropping of resistant sorghum varieties with legume trap crop of bambaranut reduced *S. hermonthica* significantly, it did not increase yield of the resistant varieties of Sorghum, ICSV1007 and ICSV1002 in the Sudan Zone of Nigeria. Therefore, further research is suggested to select a resistant sorghum variety that is not only effective in suppressing *Striga* but has the potential for higher yield in the Sudan Savanna Zone of Nigeria.

References

- Adagba MA, Lagoke STO, Ndahi WB. 2003. Effect of nitrogen fertilizer on the response of resistant and susceptible upland rice varieties to *Striga hermonthica* infestation. Nig J Weed Sci. 16:47-54.

- Babiker AGT, Hamdoun AM, Mansi MG. 1987. Influence of some soil and environmental factors on response of *Striga hermonthica* (Del.) Benth. seeds to selected germination stimulants. In: Weber HC, Forstreuter W, editors. Parasitic flowering plants. Marburg: FRG. p. 805–817.
- Bebawi FF. 1987. Response of Sorghum cultivars and *Striga* population to nitrogen fertilization. Plant Soil. 59:161–267.
- Ejeta G, Butler LG. 1993. Host parasite interactions through the *Striga* life cycle and their contributions to *Striga* resistance. Africa Crop Sci J. 1:75–80.
- Frost DC, Gnerney MC, Press MC, Scholar JD. 1997. *Striga hermonthica* reduces photosynthesis in Sorghum – the importance of stomatal limitation and potential role for ABA. Plant Cell Environ. 20:483–838.
- Gworgwor NA. 1993. Studies on the biology and control of *Striga* species (Scrophulariaceae). Ph.D. Dissertation, Philips University, Fachbereich Biologie, Marburg, Germany. 184pp.
- Hudu AL, Gworgwor NA. 1999. Effect of intercropping trap crop (*Bambara groundnut*, *Vigna subterranean* (L) Verdcourt) with resistant sorghum varieties on the control of *Striga hermonthica* (Del.) Benth. in sorghum in the semi-arid region of Nigeria. Ph.D. Thesis, Department of Crop Science, University of Maiduguri, Nigeria.
- Johnson DE, Riches CR, Diallo R, Jones MP. 1997. *Striga* on rice in West Africa. Crop host range and potential of host resistance. Crop Prot. 16:153–157.
- Kim SK, Adetimirin VO, Akintunde AY. 1997. Nitrogen effects on *Striga hermonthica* infestation, grain yield and agronomic traits of tolerant and susceptible maize hybrids. Crop Sci. 37:711–716.
- Kureh I, Hussaini AM, Odunze AC, Chikoye D, Emechebe AM, Tarawali G, Franke, AC, Ellis-Jones J. 2006. Agronomic performance of integrated *Striga hermonthica* management strategies. Nig J Weed Sci. 19:41–48.
- Lagoke STO, Parkinson V, Agunbiade RM. 1991. Parasitic weed control methods in Africa. In: Kim SK, editor. Combating *Striga* in Africa. Proceedings of International Workshop Organised by IITA, ICRISAT and IDRC, Ibadan, Nigeria. 22–24 August IITA, Ibadan. p. 13–14.
- Lagoke STO. 1991. Parasitic weeds and crop production in Africa. Presented at the 19th Annual Conference of Weed Science Society of Nigeria, held at ABU Zaira on 1–5 December 1991.
- Mansfield RA. 1982. *Striga* research at the Institute for Agricultural Research, Agronomy Department, 1979–1982. Mimeograph. Report of IDRC. Funded Project.
- M'boob SS. 1986. A regional programme for West and Central Africa. In: Proceedings of FAO/OAU. All-African Government Consultation on *Striga* control, 20–24 October 1986, Maroua, Cameroon. p. 190–194.
- Ogborn JEA. 1979. The potential use of germinators for *Striga* control by Africa peasant farmers. In: Musselman LJ, et al. editors. Second International Symposium on Parasitic Weeds, Raleigh, N. Carolina. Supplement. p. 29–36.
- Okonkwo SNC. 1990. The elusive witch-weed (*Striga* spp.) problem. Strategies for effective management in Africa peasant agriculture. In: Trabonsi R, Lagoke STO, Hoevers R, M'boob SS, editors. Proceedings of the First General Workshop of the Pan African *Striga* Control Network (PA SCON) Ibadan, Nigeria. p. 25–34.
- Parkinson, V. 1985. *Striga* (Serious threat to maize production in Africa and research being conducted by IITA). Proceedings of OAU/FAO Workshop on *Striga*, Younde, Cameroon, 1985. p. 47–55.
- Parker WC, Riches CR. 1993. Parasitic weeds of the world: biology and control. Wallingford, UK: CABI. p. 332.
- Pesch CJ, Pieterse AH. 1982. Inhibition of germination in *Striga* by means of Urea. Experientia 38:559–560.
- Pieterse AH, Pesch CJ. 1983. The witch weeds (*Striga* spp.). A review. Abstr Trop Agric 9:9–37.
- Pieterse AH. 1996. The effect of nitrogen on Oronche and *Striga*. State of the art. In: Moreno MT, Cubero JE, Berner, D, Joel D, Musselman LJ, Parker C, editors. Advances in parasitic plant research. Proceedings of the 6th International Symposium on the Parasitic Weed. Cordoba, Spain, 16–18 April 1996. p. 273–282.
- Ransom JK, Odhainabo GD, Eplee RE, Diallo AO. 1996. Estimates from field studies of the phytotoxicity effects of *Striga* spp. on maize. In: Moreno MT, Parker C, editors. Advances in parasitic plant research. Proceedings of the 6th International Symposium on the Parasitic Weed. Cordoba, Spain, 16–18 April 1996. p. 327–333.

- Raynal-Roques A. 1991. A hypothetic history of *Striga*. A preliminary draft. In: Moreno MT, Cubero JJ, Berner D, Berner D, Joel D, Musselman LJ, Parker C, editors. Advances in parasitic plant research. Proceedings of the Sixth International Symposium of Parasitic Weeds Cordoba, Spain. p. 97-104.
- Raynal-Roques A. 1996. Diversification in the genus *Striga*. In: Ramsom JK, Musselman LJ, Worsham AD, Parker C, editors. Proceedings of the 5th International Symposium of Parasitic Weeds. CMMYT, Nairobi, Kenya. p. 251-261.
- Shah N, Smirnoff N, Stewart GR. 1987. Photosynthesis and stomatal characteristics of *Striga hermonthica* in relation to the parasitic habit. *Physiol Plantarum* 69:699-703.
- Stewart GR, Press MC. 1990. The physiology and biochemistry of parasitic angiosperms. *Annu Rev Plant Mol Biol* 41:127-151.