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USE OF HAND-WEEDING AND HERBICIDES TO CONTROL *STRIGA HERMONTHICA* IN BURKINA FASO

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ABSTRACT

The parasitic weed *Striga hermonthica* (Del.) Benth. causes significant yield loss in sorghum [*Sorghum bicolor* (L.) Moench] in Burkina Faso. Two trials were conducted in the eastern part of the country to evaluate the efficiency of herbicides and mechanical weeding to control the parasite on sorghum. In 1994, 2,4-D, triclopyr, or 2,4-D + triclopyr were applied to striga parasitising the local sorghum landrace Itchoari. Single applications (2 l ha^{-1} at 85 days after sowing, DAS) of both 2,4-D and triclopyr reduced the number of emerged striga from 101 DAS until harvest (123 DAS). All herbicide applications significantly reduced striga flowering (average of 69 %)and seed formation (average of 93 %) at harvest as well as the dry biomass (average of 82 %) of non-parasitic weeds. In 1995, the residual effect of herbicide treatments in the previous year was examined. A residual effect was observed for triclopyr (1 l ha^{-1} at 70 and 85 DAS), with reduced emerged striga throughout the season. In 1996, the 1994 herbicide treatments were compared to manual weeding of striga on two sorghum entries. Both herbicides again reduced striga infestation, but 2,4-D was more effective on local Itchoari whereas triclopyr was more effective on Sariaso 9. Use of herbicides was more cost-effective than mechanical weeding and enhanced striga control contributed to improve sorghum 1000 grain weight.

Key Words: 2,4-D, hand weeding, herbicide,parasitic weed, sorghum, triclopyr

RÉSUMÉ

Le *Striga hermonthica* (Del.) Benth. provoque des baisses importantes de rendement du sorgho au Burkina Faso. Deux essais ont été conduits dans l'est du pays pour évaluer l'effet de trois herbicides et du sarclage mécanique sur le contrôle du parasite du sorgho. En 1994, le 2,4-D, le Triclopyr et le 2,4-D + Triclopyr ont été comparés à un témoin sans herbicide sur une variété locale de sorgho. En 1995, le même sorgho a été semé sur la parcelle d'essai pour étudier l'arrière-effet des trois produits. En 1996, les trois herbicides ont été comparés à un sarclage manuel supplémentaire et à un témoin sans sarclage supplémentaire et sans herbicide, sur deux entrées de sorgho. En 1994, les herbicides ont réduit, significativement par rapport au témoin, le nombre de striga 101 et 116 jours après le semis, le nombre de striga fleuris et le nombre de striga portant des capsules. Par rapport au témoin, les herbicides ont réduit la biomasse sèche de striga et celle des autres adventices. L'arrière-effet des herbicides a réduit, de façon significative par rapport au témoin, le nombre de striga 84 et 115 jours après le semis et la biomasse sèche de striga. En 1996, les herbicides ont entraîné une baisse significative du nombre de *S. hermonthica* par rapport au témoin, 96 et 110 jours après le semis. Le sarclage supplémentaire a provoqué une plus forte émergence du striga par rapport au témoin. Les herbicides n'ont pas entraîné, par rapport au témoin sans herbicide ou au sarclage supplémentaire, un gain significatif du rendement de sorgho. Toutefois, les herbicides et le sarclage supplémentaire ont permis d'obtenir des rendements plus élevés que le témoin en 1994 et 1996. Les herbicides ont été économiquement plus rentables que le sarclage supplémentaire. Les effets positifs d'un traitement chimique se confirment, ouvrant ainsi une perspective de lutte chimique contre le S. hermonthica.

Mots Clés: 2,4-D, sarclage manuel, herbicide, plante parasite, sorgho, triclopyr

INTRODUCTION

Striga hermonthica (Scrophulariaceae) is a root parasite of grasses occurring throughout Burkina Faso (Ouédraogo, 1992). It is an important biotic constraint to sorghum production in the country and is the weed that farmers fear most. However, given their weak financial base, the control methods available are limited to hand pulling (Ramaiah, 1985), the use of tolerant sorghum varieties, and crop rotation (Ramaiah and Parker, 1982). The control of *S. hermonthica* prior to flowering and seed set can contribute to reduction of the soil seed bank and subsequent striga infestation.

Chemical control of striga is not widely practiced due to its high cost and the need for specialised equipment. For chemical control to be accessible to farmers, affordable and environmentally-friendly herbicides are needed. Two such products, 2,4-D and triclopyr, have been evaluated in previous studies. In northern Cameroon, 2,4-D and triclopyr applied at doses of 2,000 g a.i. ha^{-1} and 1,000 g a.i. ha^{-1}, respectively, significantly reduced the number of emerged *S. hermonthica* plants, resulting in significant sorghum grain yield increases (Carsky *et al.*, 1994). 2,4-D at a rate of 2,000 g a.i. ha^{-1} successfully controlled *S. hermonthica* infesting sorghum in Nigeria, improving grain yield (Lagoke *et al.*, 1994). When applied at the same rate to striga infesting maize in the Gambia, 2,4-D proved to be the least expensive and most efficient chemical for controlling the parasite (Carson, 1993). In Nigeria, triclopyr at a dose of 1,850 g a.i. ha^{-1} effectively controlled *S. hermonthica*, resulting in enhanced sorghum yield (Lagoke *et al.*, 1994). Comparable results were obtained in Burkina Faso, where Ouédraogo and Bani (1994) recorded a significant reduction in emerged *S. hermonthica* and an appreciable increase in pearl millet [*Pennisetum glaucum* (L.) R. Br.] yield with triclopyr at doses of 960 g a.i. ha^{-1} and 1,680 g a.i. ha^{-1}.

The experiments described here were conducted on naturally-infested plots in eastern Burkina Faso during three years. The objectives were to test the mode and date of application of three post-emergence herbicides for control of *S. hermonthica* on local sorghum variety "Itchoari"; evaluate the residual effects of the 1994 treatments; and to test the efficiency and economic profitability of three herbicides to control striga on two sorghum entries (local "Itchoari" and improved "Sariaso 9").

MATERIALS AND METHODS

On-station trial. This trial was conducted at the Kouaré Agricultural Research Station, 11 km southwest of Fada N'Gourma. Striga control with herbicides was tested in 1994, with evaluation of residual effects in the following year. The trial was sown in a sandy, tropical ferruginous soil in a plot previously planted to sorghum. The annual rainfall recorded at the Kouaré station was 1,035 mm in 1994, and 911.6 mm in 1995.

The experimental design was a randomised complete block with four repetitions. The main plot measured 6 x 4 m, with a harvested area of 15.4 m^2. A local sorghum landrace, "Itchoari" from the town of Piela, was used in the experiment. Treatments were as follows:

- control without herbicides,
- 2,4-D at 2 $l.ha^{-1}$, 85 days after sowing (DAS),
- triclopyr at 2 $l.ha^{-1}$, 85 DAS,
- 2,4-D + triclopyr at 1 $l.ha^{-1}$, 85 DAS,
- 2,4-D at 1 $l.ha^{-1}$, 70 and 85 DAS,
- triclopyr at 1 $l.ha^{-1}$, 70 and 85 DAS,
- 2,4-D + triclopyr at 0.5 $l.ha^{-1}$, 70 and 85 DAS.

Soil preparation consisted of light tillage. Fertiliser, consisting of NPK complex, was applied to the crop at the rate of 100 kg ha^{-1}, followed by 50 kg ha^{-1} of urea at the booting stage. Sorghum was sown at 0.8 m between rows and 0.4 m between hills, and thinned to two plants per seed hole. In 1994 and 1995, sorghum was planted on 8 and 17 July, respectively. Two weedings were done before *S. hermonthica* began to emerge (at 17 and 36 days after sowing (DAS) in 1994, and at 17 and 43 DAS in 1995. In both years, seeds were treated prior to sowing with Apron Plus 50 DS® (metalaxyl + carboxin + furathiocarb), at the recommended dose of 10 g of commercial product per 750 g of seed. Two treatments of Decis 12 EC (deltametrin), at the recommended dose of 1 l. ha^{-1}, were carried out to control spittle bug (*Poophilus costalis* Walker).

On-farm trial. In 1996, experimentation was carried out in a sandy-clay soil on a farm in the village of Diapangou, 20 km west of Fada-N'Gourma. The farm was selected in the previous year because of its high and uniform infestation of striga (more than 30 plants m^{-2}). The rainfall recorded at Diapangou in 1996 was 863.3 mm.

The experimental design was a randomised complete block with four repetitions. The base plot measured 6 m long and 3.2 m wide and the harvested plot measured 4.8 m long and 2.4 m wide. Three herbicides and a third mechanical weeding were tested on two sorghums, local "Itchoari" from Diapangou, and improved "Sariaso 9". Treatments were as follows:

- untreated control;
- 3rd weeding at sorghum flowering;
- 2.4-D at 1 $l.ha^{-1}$, 68 and 83 DAS
- trichopyr at 1 $l.ha^{-1}$, 68 and 83 DAS;
- 2,4-D + triclopyr at 0.5 $l.ha^{-1}$, 68 and 83 DAS;

Soil preparation consisted of light tillage using donkey-drawn ploughs, the most common practice in the region. Fertilisation, seed treatment, and spacing were the same as in both previous years. Sowing was done on 12 July. Two weedings were carried out at 18 and 34 DAS (prior to the emergence of *S. hermonthica*). The first herbicide application was carried out on 18 September (68 DAS) and the second was on 3 October (83 DAS). Additional weeding of Sariaso 9 was carried out on 25 September (75 DAS) while that of the local variety was done on 3 October (83 DAS).

Herbicides. The recommended dose for 2,4-D is 720 g a.i. l^{-1}, that of triclopyr is 480 g a.i. l^{-1} and the dose for 2,4-D + triclopyr is (128 + 334)g a.i. l^{-1}. In all experiments herbicides were applied with a "Handy" battery-powered centrifugal sprayer that allows very low-volume spraying.

Observations. Beginning two weeks after emergence of the first *S. hermonthica* plant, striga plants were counted every two weeks on the four central rows of each plot. At sorghum harvest, the number of striga with seed capsules was counted, striga was harvested and its dry weight obtained. In addition, sorghum height, grain and straw yield, and the 1,000-seed weight were measured.

A comparative economic analysis of striga control treatments was made in 1996. The costs used in this analysis were the price of herbicides and the labour costs at the Kouaré station. The cost of herbicides was 3,000 CFA l^{-1}. The hourly labour cost at the Kouaré station is 143 CFA. Two days use of the sprayer required 10 batteries, each battery costing 125 CFA.

Statistical analysis. Data were subjected to an analysis of variance (ANOVA). Striga count data were analysed following square root transformation (Gomez and Gomez, 1984).

RESULTS

On-station trial. Although no differences between treatments were observed for emerged striga plants at the first three counts in 1994 (52, 63, and 82 DAS), significant differences ($P<0.05$) were observed during later counts (101, 116, 122 DAS, Table 1). All herbicide treatments killed emerged striga, but the single dose (of either 2,4-D or triclopyr) generally eliminated a greater number. At 116 DAS, single doses of 2,4-D and triclopyr reduced emerged striga by 77 and 75%, respectively (compared to the untreated control); the other herbicide treatments reduced striga number by 39-61% ($P<0.03$). At the end of the season (122 DAS), use of herbicides had reduced the number ($P<0.00$) of flowering and fruiting *S. hermonthica* by 54 - 86% and 79 - 100%,

TABLE 1. Effect of herbicide treatments on *Striga hermonthica* in 1994, Kouaré Station, Burkina Faso

Treatment	Number of striga plants m^{-2}					
	Emerged				Flowering	Fruiting
	82 DAS [a]	101 DAS	116 DAS	122 DAS	122 DAS	122 DAS
Untreated check	3.0 (1.80) [b]	11.0 (3.30)	20.1 (4.45)	25.1 (5.00)	10.6 (3.24)	1.41 (1.34)
2,4-D 2 l ha^{-1} 85 DAS	1.3 (1.30)	1.8 (1.49)	4.6 (2.18)	6.1 (2.45)	1.5 (1.34)	0.00 (0.71)
Triclopyr 2 l ha^{-1} 85 DAS	3.1 (1.85)	5.0 (2.29)	5.0 (2.31)	8.1 (2.87)	1.9 (1.52)	0.05 (0.74)
2,4-D + Triclopyr 1l ha^{-1} 85 DAS	1.7 (1.45)	3.5 (1.99)	12.2 (3.46)	14.0 (3.75)	4.3 (2.15)	0.29 (0.87)
2,4-D 1l ha^{-1} 70 and 85 DAS	2.4 (1.64)	4.8 (2.18)	11.6 (3.31)	18.9 (4.16)	3.3 (1.86)	0.10 (0.77)
Triclopyr 1 l ha^{-1} 70 and 85 DAS	1.7 (1.46)	5.5 (2.40)	9.0 (2.99)	16.1 (3.93)	3.8 (2.00)	0.02 (0.72)
2,4-D+Triclopyr 0.5 l ha^{-1} 70 and 85 DAS	1.6 (1.42)	6.9 (2.65)	7.8 (2.83)	15.4 (3.98)	4.9 (2.28)	0.17 (0.81)
SE (±)	(0.202)	(0.307)	(0.443)	(0.449)	(0.281)	(0.085)
Mean	(1.56)	(2.33)	(3.07)	(3.73)	(2.05)	(0.85)
CV (%)	26.0	26.4	28.8	24.0	27.4	19.9

a DAS = days after sowing
b Values in parentheses are square root transformations of striga counts (x + 0.5)

respectively. Sorghum height and yield components and the biomass of parasitic and non-parasitic weeds did not differ significantly (P<0.05, Table 2).

When herbicide residual effect was evaluated in 1995, there were significant differences between treatments for emerged number of *S. hermonthica* at 84 DAS (P<0.05) and striga dry biomass (P<0.05) (Table 3). Single applications of 2,4-D and 2,4-D + triclopyr at 85 DAS, and the double application of triclopyr at 70 and 85 DAS reduced emerged striga by 79, 65 and 83%, respectively. Herbicide applications reduced end-of-season striga biomass by 47 – 91%, but sorghum yield was not significantly improved by herbicide residual effect.

On-farm trial. Herbicide applications significantly (P<0.01) reduced the number of emerged striga at 96 DAS on both sorghum varieties whereas weeding did not (Table 4). There were highly significant differences (P<0.01) between treatments for the number of *S. hermonthica*, 110 DAS. As of this date, the 2,4-D + Itchoari combination had reduced the number of *S. hermonthica*, as compared to Itchoari without herbicides and without additional weeding by 75%, while the Sariaso 9 + triclopyr combination reduced the number of striga by 84%, in relation to herbicide-free Sariaso 9 without additional weeding.

The analysis revealed a significant difference (P<0.01) between treatments for the number of capsule-bearing striga, 122 DAS, and the Sariaso 9 + triclopyr combination reduced, by 85%, the number of capsule-bearing striga, in relation to the weeded Sariaso 9. The ANOVA revealed a highly significant difference (P<0.01) between treatments for the dry biomass of striga. The Itchoari + 2,4-D combination reduced the dry biomass of *S. hermonthica* by 72%, as compared to the check (Itchoari without herbicides and without additional weeding). Similarly, the Sariaso 9 + triclopyr combination reduced the dry biomass of *S. hermonthica* by 81%, in relation to the untreated control.

Statistical analysis did not reveal any significant difference between treatments with respect to plant height and sorghum grain yield (Table 5). However, striga kill by triclopyr was reflected in enhanced sorghum grain fill, resulting in an increase of 18% in the 1,000-seed weight for Sariaso 9. For the straw weight, ANOVA revealed a significant difference ($P<0.01$) between sorghum cultivars (Sariaso 9 was markedly shorter than Itchoari), but no significant difference due to herbicide treatment.

The average time required for an additional weeding of striga was 78 man hr ha^{-1}, resulting in expenditure of 11,154 francs ha^{-1} (Table 6). Reduction of emerged striga through weeding brought in 9,595 and 17,670 F CFA due to increased grain yield of Itchoari and Sariaso 9, respectively (Table 6). However, on the local variety (Itchoari) this resulted in a net loss (2,794 F CFA) due to elevated labour costs. Striga control with herbicides increased income by 6,516 to 22,840 F CFA on both varieties (Table 6). Herbicide cost amounted to 6420 F CFA (2,4-D or triclopyr) or 3420 F CFA (2,4-D + triclopyr).

DISCUSSION

Striga hermonthica infestation at sorghum harvest in the check plots was lower in 1995 (140,000 plants ha^{-1}) than in 1994 (251,000 plants ha^{-1}), a reflection of year-to-year variability in striga emergence. In 1994, control measures reduced striga infestation by 52% compared to the untreated check. In 1995, this reduction was 44% and attributable to the use of herbicides in the previous year.

In terms of *S. hermonthica* kill, 2,4-D was the most efficient herbicide used in 1994 (single dose of 1,440 g a.i. ha^{-1}), and the second most efficient product in 1996 (double application of 720 g a.i. ha^{-1}). These results concur with those of Carson (1993) in the Gambia, and by Carsky *et al.* (1994) in northern Cameroon. We found triclopyr, at a single dose of 960 g a.i. ha^{-1} to be the second most efficient compound in 1994, and the best on cultivar Sariaso 9 in 1996. Efficiency of *S. hermonthica* control resulting from use of triclopyr supports the results of Ouédraogo and Bani (1994) in central Burkina Faso, and also those of Carsky *et al.* (1994) in northern Cameroon. Herbicide kill of emerged striga led to a large reduction in capsule-bearing striga in both 1994 and 1996.

In 1996, the additional weeding did not reduce emerged striga at 96 and 110 DAS. This is explained by the fact that weeding loosened the soil and was followed by branching and regrowth of weeded striga as well as the development of attached but unemerged striga on the host root system. These striga plants grew, flowered and formed several capsules within 39 days after weeding (122 DAS).

The efficiency of herbicide control of *S. hermonthica* in 1994 was in evidence a year after application through reduced emerged striga

TABLE 2. Herbicide effect on sorghum yield and biomass of *Striga hermonthica* and non-parasitic weeds in 1994, Kouaré Station, Burkina Faso

Treatment	Sorghum				Weed dry weight	
	Grain yield (kg ha^{-1})	1000 grain weight (g)	Straw weight (kg ha^{-1})	Plant height (cm)	Striga dry weight (kg ha^{-1})	Weed dry weight (kg ha^{-1})
Untreated check	333	19.0	3,337	249.3	146.5	28.5
2,4-D 2 l ha^{-1} 85 DAS [a]	421	20.5	4,036	234.3	43.0	36.1
Triclopyr 2 l ha^{-1} 85 DAS	438	20.5	3,662	235.5	63.5	32.9
2,4-D + Triclopyr 1l ha^{-1} 85 DAS	493	20.0	5,225	231.3	88.4	29.3
2,4-D 1l ha^{-1} 70 and 85 DAS	380	20.5	3,158	234.3	87.1	33.2
Triclopyr 1 l ha^{-1} 70 and 85 DAS	479	20.3	4,476	234.5	91.5	31.3
2,4-D+Triclopyr 0.5 l ha^{-1} 70 and 85 DAS	456	20.8	3,239	234.8	109.5	28.3
SE (±)	89.3	0.62	848.0	9.82	23.76	2.615
Mean	429	20.2	3876	236.3	89.9	31.37
CV (%)	41.7	6.2	43.8	8.3	52.9	16.7

[a] DAS = days after sowing

TABLE 3. Residual effect of herbicides on development of *Striga hermonthica* and sorghum in 1995, Kouaré Station, Burkina Faso

Treatment	Number of striga plants m^{-2}								Striga dry weight (kg ha^{-1})	Sorghum		
	Emerged						Flowering					
	61 DAS [a]		84 DAS		115 DAS		115 DAS			Grain yield (kg ha^{-1})	1000 grain weight (g)	Straw weight (kg ha^{-1})
Untreated check	0.12	(0.78)[b]	8.1	(2.7)	14.0	(3.6)	10.8	(3.2)	117.2	1250	20.5	6211
2,4-D 2 l ha^{-1} 85 DAS [a]	0.04	(0.73)	1.7	(1.4)	5.4	(2.2)	4.3	(1.9)	39.1	957	22.5	6016
Triclopyr 2 l ha^{-1} 85 DAS	0.10	(0.77)	4.1	(2.1)	7.4	(2.7)	5.5	(2.3)	50.8	1152	20.5	4902
2,4-D + Triclopyr 1l ha^{-1} 85 DAS	0.06	(0.74)	2.8	(1.8)	7.3	(2.8)	4.9	(2.3)	62.5	1250	20.5	6328
2,4-D 1l ha^{-1} 70 and 85 DAS	0.02	(0.72)	4.1	(2.1)	7.9	(3.0)	5.4	(2.4)	56.6	1133	22.3	5664
Triclopyr 1 l ha^{-1} 70 and 85 DAS	0.02	(0.72)	1.4	(1.3)	3.0	(1.8)	1.7	(1.4)	10.7	1162	20.8	7070
2,4-D+Triclopyr 0.5 l ha^{-1} 70 and 85 DAS	0.04	(0.73)	4.3	(2.2)	5.9	(2.5)	4.1	(2.1)	42.0	1191	22.8	5391
SE (±)	(0.023)		(0.31)		(0.41)		(0.37)		19.52	184.3	1.70	687.6
Mean	(0.74)		(1.9)		(2.6)		(2.2)		54.1	1157	21.4	5940
CV (%)	6.2		31.6		31.4		33.3		72.1	31.9	15.9	23.1

[a] DAS = days after sowing;
[b] Values in parentheses are square root transformations of striga counts (x +1)

TABLE 4. Effect of control components on sorghum yield and *Striga hermonthica* infestation of sorghum , Kouaré Station, Burkina Faso, 1996

Control component	Sorghum		Emerged striga				Fruiting striga		Striga dry weight (kg ha^{-1})
	Panicle no.	1000 seed weight (g)	96 DAS [a]		110 DAS		122 DAS		
Untreated check	39.0	20.62	14.18	(3.76)[b]	15.3	(3.90)	11.5	(3.32)	13.62
3rd weeding	50.7	22.75	14.46	(3.64)	17.3	(4.05)	14.4	(3.68)	8.95
2,4-D	49.7	23.00	2.72	(1.74)	4.4	(2.12)	5.0	(2.16)	4.61
Triclopyr	46.7	23.12	2.82	(1.69)	5.1	(2.21)	5.9	(2.28)	5.05
2,4-D+Triclopyr	44.7	21.75	4.17	(2.13)	6.0	(2.51)	6.7	(2.61)	5.81
SE (±)	2.41	0.610		(0.287)		(0.308)		(0.376)	1.575
Mean	46.2	22.25		(2.59)		(2.96)		(2.81)	7.61
CV (%)	14.8	7.8		31.3		29.4		37.8	58.6

[a] DAS = days after sowing
[b] Values in parentheses are square root transformations of striga counts (x +1)

TABLE 5. Effect of weeding and herbicide control of *Striga hermonthica* on the growth and productivity of sorghum in 1996

Treatments	Plant height (cm)		Panicle number		Grain yield (kg)		1000 grain weight (g)		Straw weight (g)	
	Itchoari	Sariaso 9	Itchoari	Sariaso 9	Itchoari	Sariaso 9	Itchoari	Sariaso 9	Itchoari	Sariaso 9
Check	308	264	43.2	34.7	333	408	20.3	21.0	2,425	1,225
3rd weeding	292	250	51.2	50.2	434	594	22.5	23.0	2,550	1,875
2,4-D	305	255	49.0	50.5	641	624	22.3	23.8	3,275	2,025
Triclopyr	303	258	47.0	46.5	481	599	21.5	24.8	2,700	1,725
2,4-D + Triclopyr	288	251	45.0	44.5	477	559	20.5	23.0	2,775	1,475
Variety mean	299	256	47.1	45.3	473	557	21.4	23.1	2,745	1,665
SE (±)	14.82		3.41		1.11		0.862		397.8	
Grand mean	277		46.2		515		22.3		2,205	
CV (%)	11		15		43		8		36	

number. Thus, herbicides can contribute to integrated control of the parasite without need for application each year.

Neither herbicide use nor weeding significantly improved sorghum grain yield in the two experiments. As previously reported [Ramaiah and Parker (1982); Ramaiah *et al.*(1983), killing emerged *S. hermonthica* plants does not always produce yield increase in the same year. Although not significant, the 48% increase in grain yield obtained with a single dose of 2,4-D + Triclopyr in 1994 is close to the results of Ouédraogo and Bani (1994) when applying 960 g a.i.ha^{-1} of triclopyr to striga parasitising pearl millet. Lagoke *et al.* (1994) reported sorghum grain yield increases of 56% when triclopyr was applied post-emergence at 1.85 g a.i.ha^{-1}. Applications of 2,4-D and triclopyr on *S. hermonthica* led to subsequent increases (40-70%) in yield in 1996, similar to those obtained in northern Cameroon (around 50%) by Carsky *et al.* (1994).

The local variety, Itchoari, has a higher stalk dry biomass than Sariaso 9, of importance in rural areas, where sorghum stalks are an important source of fuel, construction material and fodder. For both varieties, although not statistically significant, weeding and herbicides tended to increase dry biomass of stalks.

The cost of labour for weeding was higher than purchase and application of herbicides. Weeding entailed an additional cost of between 4,734 and 7,734 F CFA. As Carson (1993) pointed out in Gambia, herbicides, especially 2,4-D, are cheaper than weeding.

Though all three herbicides tested showed profitability, the most economical was 2,4-D. Labour costs for a third weeding surpassed the costs of chemical application; it was profitable only on Sariaso 9. With the exception of the Itchoari + 2,4-D combination, it appeared that improved Sariaso 9 was more responsive than Itchoari to striga control techniques.

This study shows that low dose/low cost use of herbicides to control *S. hermonthica* is increasingly becoming a reality in Burkina Faso. The effectiveness and the economic advantages of chemical control of striga could facilitate the transfer of this technology to farmers. It is recommended that farmer-led demonstration tests evaluating single herbicide applications should

TABLE 6. Economic analysis of the cost/benefit of *Striga hermonthica* control on sorghum at Kouaré, Burkina Faso, in 1996[a]

Treatments	Grain yield ($kg\ ha^{-1}$)	Grain value (F CFA)	Gain due to striga control (F CFA)	Cost of striga control (F CFA)	Net gain/loss from control of striga (FCFA)
Itchoari (local landrace)					
Check	333	31,635	0	0	-
3rd weeding	434	41,230	+9,595	11,154	-1,559
2,4-D	641	60,895	+29,260	6,420	+22,840
Triclopyr	481	45,695	+14,060	6,420	+7,640
2,4-D + Triclopyr	477	45,315	+13,680	3,420	+10,260
Sariaso 9 (Improved line)					
Check	408	38,760	-	-	-
3rd weeding	594	56,430	+17,670	11,154	+6,516
2,4-D	624	59,280	+20,520	6,420	+14,100
Triclopyr	599	56,905	+18,145	6,420	+11,725
2,4-D + Triclopyr	559	53,105	+14,345	3,420	+10,925

[a] Calculations based on: sorghum price kg^{-1} at Fada N'Gourma market in November 1996 = 95 FCFA; herbicide cost $litre^{-1}$ = 3000 FCFA; cost of labour hr^{-1} at Kouaré = 143 F CFA

be conducted on-farm. These can be compared to traditional control practices and should include economic analyses.

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