INFLUENCE OF CHLORSULFURON AND 2, 4-D ON MANAGEMENT OF STRIGA HERMONTHICA ON SORGHUM

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ABSTRACT

Purpose: This study was conducted to determine the herbicidal efficacy of chlorsulfuron, 2, 4-D and their tank mixtures on Striga incidence and sorghum growth and yield.

Design/Methodology/Approach: The experimental area was disc ploughed, harrowed, levelled, ridged and divided into 4 x 8m sub-plots, with four rows in each. The crop was sown in the first week of July. Sorghum seedlings were thinned to two per hole, 15 days after emergence. Treatments were laid out in a Randomised Complete Block Design (RCBD) with four replicates.

Findings: Striga emergence in the untreated control was 1, 6 and 25 plants/m-2 at 45, 60 and 90 days after

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sowing (DAS). Chlorsulfuron at 2.38-3.75g a.i. ha-1 reduced Striga emergence by 84-88%. 2, 4-D at 0.38-0.76kg a.e. ha-1 reduced Striga emergence by 20-64%. The tank mixtures of chlorsulfuron and 2, 4-D reduced Striga emergence by 64-76%.

Originality/value: The results indicate an antagonistic interaction between chlorsulfuron and 2, 4-D.

Keywords: Striga; Chlorsulfuron; 2, 4-D; management; sorghum; yield

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INTRODUCTION

Striga hermonhica (Del.) Benth., an Orobanchaceae, is a difficult to control weed: the plant is a copious seed producer. The seeds produced are endowed with prolonged viability and special germination requirements (Parker and Riches, 1993; Joel et al., 2007). Striga seeds only germinate on perception of a host-derived signal. Subsequent to germination, the radicle elongates and an haustorium is formed. The haustorium attaches to the host roots, penetrates and establishes connection with the host xylem. The Striga seedlings develop and remain subterranean for 6-8 weeks. During the subterranean phase, the parasite is most damaging and is not amenable to conventional control measures (Babiker, 2007). Due to the irrevocable damage inflicted during the subterranean phase, farmers are reluctant to adopt post-emergence control measures. Several control methods, cultural, chemical and biological, have been researched with positive, but often inconsistent, results across seasons and sites (Parker and Riches, 1993; Joel et al., 2007). Among these methods, herbicides are considered to have the most potential; however, they have to be effective, selective and affordable (Hess and Lenne, 1999).

Aly (2007) reported that Dicamba and 2, 4-D are the most widely used herbicides against Striga. Dicamba is a systemic herbicide applied to the crop foliage about 35 days after crop emergence. However, it often showed erratic performance and may damage the crop (Babiker, A.G.T., personal communication). As a post-emergence treatment, 2, 4-D often gives good control, but does not evade the early damage inflicted by the parasite during the early stages of the parasite development.

The present study was therefore undertaken to explore the possibility of developing a Striga management strategy based on herbicides as a possible means of manipulation of early developmental stages of the parasite. The herbicides chlorsulfuron, 2, 4-D, and their tank mixtures were evaluated for efficacy on Striga and selectivity to sorghum.

MATERIALS AND METHODS

The experiment was conducted at the Arab Sudanese Company Farm in Sennar State, 296km south of Khartoum in the 2010/11 season. The site lies in the semi-arid tropical zone at Latitude 13°23’N and Longitude 13°56’E. In addition, Sennar state is characterised by a short rainy season starting in July, with a peak in August.

The average annual rainfall is between 400-600mm (Sennar Metrological station – personal contact).

The experimental area was disc ploughed, harrowed, levelled, ridged and divided into 4 x 8m sub-plots, with four rows in each. Sorghum (cv. Wad Ahmed) seeds, supplied by the Arab Seed Production Company, were treated with the fungicide Thiram. The seeds were sown in holes 4cm deep on ridges 80cm apart, at a within row spacing of 20cm. All sub-plots were artificially infested with S. hermonthica seeds. The Striga seeds used in this study were collected from under sorghum at Abunaama, Sudan in 2009. Inoculums were prepared by a thorough mixing of 1g of Striga seeds with 1kg of soil, previously sieved through 2mm mesh. Inoculums were applied to the soil at the time of sowing. The crop was sown in the first week of July in each season. Sorghum seedlings were thinned to two per hole, 15 days after emergence. Treatments were laid out in a Randomised Complete Block Design (RCBD) with four replicates.

The herbicides 2, 4-D (as Decbore), chlorsulfuron (as Glean), and their tank mixtures, were applied as aqueous spray, 30 days after sowing (DAS) by a knapsack sprayer at a volume rate of 238L ha-1. Weeds other than Striga were removed by hand at biweekly intervals for the first six weeks. Supplementary irrigation was applied, when necessary, throughout the duration of the trials.

EFFECTS OF CHLORSULFURON, 2, 4-D, AND THEIR TANK MIXTURES, ON STRIGA INCIDENCE AND SORGHUM GROWTH AND YIELD

Chlorsulfuron alone at 2.38, 2.98 and 3.57g a.i ha-1, 2, 4-D at 0.38, 0.57 and 0.76kg a.e. ha-1, and chlorsulfuron at 2.38g a.i ha-1 tank mixed with 2, 4-D at 0.38, 0.57 and 0.76 kg a.e. ha-1 were applied. An untreated Striga infested control was included for comparison.

Treatment effects were assessed by determining i) number of emerged Striga plants per metre square 45, 60 and 90 DAS, ii) Striga dry weight from an area of 1m2 at harvest, iii) sorghum height 30, 45 and 90 DAS, iv) head length in cm, v) head weight in g, vi) and grain yield in kg ha-1. All measurements were taken from the two middle rows.

STATISTICAL ANALYSIS

Data were subjected to statistical analysis using GenStat (PC/Windows 7), VSN International Ltd., UK statistical package (Rothamsted Experimental Station). Means were transformed using square root and separated for significance using a Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effects on Striga emergence

Striga displayed delayed emergence up to 60 DAS (Table 1). At 45 DAS, Striga emergence was inconsistent and maximum emergence was 1 plant m-2. At 60 DAS, the parasite displayed maximum emergence (6 plants m-2) in the untreated control sub-plots, followed by sub-plots treated with 2, 4-D at 0.57kg a.e. ha-1. Despite the encountered low emergence of the parasite, chlorsulfuron at 2.38 and 2.98g a.i. ha-1 effected excellent suppression of the parasite (83.3%). The tank mixture of 2, 4-D and chlorsulfuron tended to be less suppressive to the parasite than chlorsulfuron alone (Table 1).

At 90 DAS, although Striga emergence was maximal in the untreated control (25 plants m-2), chlorsulfuron at all rates maintained its excellent suppressive effects (88-92%). In contrast to a report by Last (1960), 2, 4-D showed inconsistent performance. The herbicide at 0.57 and 0.76kg a.e. ha-1 effected 20% and 44% reductions in Striga emergence.

Despite the lack of statistical significance between the suppressive effects of chlorsulfuron alone and its tank mixtures with 2, 4-D, the general trend was a decrease in efficacy relative to chlorsulfuron alone. This decrease in efficacy may be as noted in a similar situation due to the restriction of chlorsulfuron movement by 2, 4-D in the plant. Previous reports showed that foliar applied 2, 4-D and chlorsulfuron tank mixtures were less effective than expected (Adam, 2007). By virtue of its negative effects on root development in sorghum (Last, 1960), 2, 4-D may affect the uptake of chlorsulfuron by the sorghum roots, and consequently lessen its efficacy during the early stages of parasitism, where Striga is most vulnerable to the herbicide. The decrease in efficacy of 2, 4-D with time compared to that of chlorsulfuron may be attributed to their differential persistence in soil. Chlorsulfuron is renowned for prolonged persistence while 2, 4-D is known to have a relatively shorter persistence in soil (Boivin et al., 2005). However, the two herbicides have different modes of actions. 2, 4-D is an auxin like herbicide, which kills plant through the enhancement of uncoordinated cell division. Chlorsulfuron, on the other hand, is an acetolactate synthase (ALS) inhibitor (Dastgheib and Field, 1998). The herbicide inhibits synthesis of the branched amino acids L-leucine, L-isoleucine and L-valine, and thus may interfere with protein synthesis, cell division and haustorium functionality (Ray, 1984).

Table 1: Effects of chlorsulfuron, 2, 4-D and their tank mixtures on S. hermonthica emergence

Treatment	*Herbicide rate ha^{-1}*	*Striga emergence (plants/m^2) (DAS)*		
		45	60	90
Untreated control	-	1(1)±0.5	6(2)±0.9	25(4)±14.1^{a}
Chlor.[i]	2.38	0(1)±0.2	1(1)±0.3	3(2)±1.3^{c}
Chlor.	2.98	0(1)±0.2	1(1)±0.3	2(1)±0.7^{c}
Chlor.	3.57	0(1)±0.3	1(2)±0.3	4(2)±1.2^{c}
2, 4-D [ii]	0.38	1(1)±0.3	3(2)±0.7	9(3)±2.4^{bc}
2, 4-D	0.57	1(1)±0.2	5(2)±0.4	20(4)±3.3^{ab}
2, 4-D	0.76	1(1)±0.3	2(2)±0.4	14(4)±2.1^{abc}
Chlor. + 2, 4-D	2.38 +0.38	1(1)±0.4	2(2)±0.4	6(2)±3.4^{c}
Chlor. + 2, 4-D	2.38 +0.57	0(1)±0.1	3(2)±1.6	7(3)±2.1^{bc}
Chlor. +2, 4-D	2.38 +0.76	1(1)±0.3	1(1)±1.0	9(3)±2.8^{bc}
$p \leq 0.05$		NS	NS	2.6*
CV %		*15.3*	*30.0*	*36.9*

± Standard errors of means. Means within a column having the same superscript letter(s) are not significantly different according to LSD test. Data in parentheses are square root transformed. * = $P \leq 0.05$. i = rate in g a.i., ii = rate in kg a.e.

Source: Devised by authors

Effects on Sorghum height

At 15 days after herbicide treatments (45 DAS), differential growth in sorghum was observed (Table 2). Chlorsulfuron alone and in mixtures with 2, 4-D, irrespective of rate, reduced sorghum height significantly in comparison to the untreated Striga infested control (Table 2). 2, 4-D alone did not reduce sorghum height significantly. However, the observed reductions in sorghum height were insignificant at 90 DAS, thus showing considerable recovery of the treated crop with time.

Table 2: Effects of chlorsulfuron, 2, 4-D and their tank mixtures on sorghum height

Treatment	*Herbicide rate ha^{-1}*	*Sorghum height (cm) (DAS)*		
		30	45	90
Untreated control	-	39.4±4.2	72.4±9.7^{a}	143.0±4.9
Chlor.[i]	2.38	32.1±6.0	56.2±6.0^{cde}	145.3±3.5
Chlor.	2.98	34.5±2.8	53.5±6.0^{e}	142.2±6.1
Chlor.	3.57	34.2±2.1	55.3±2.5^{de}	135.9±6.0
2, 4-D[ii]	0.38	34.2±4.3	70.2±11.2^{ab}	138.0±6.0
2, 4-D	0.57	34.2±2.7	69.4±7.7^{abc}	129.2±7.8
2, 4-D	0.76	29.8±1.5	59.4±2.0^{abcde}	134.9±3.8
Chlor. + 2, 4-D	2.38 + 0.38	30.0±4.4	56.4±4.4^{bcde}	139.6±4.4
Chlor. + 2 ,4-D	2.38 +0.57	36.1±3.9	67.9±3.9^{abcd}	139.2±3.9
Chlor. +2, 4-D	2.38+ 0.76	30.7±1.0	52.9±1.0^{e}	136.0±1.0
$p \leq 0.05$		NS	2.6*	NS
CV %		*18.9*	*15.7*	*8.0*

± Standard errors of means. Means within a column having the same superscript letter(s) are not significantly different according to LSD test. * = $P \leq 0.05$. i = rate in g a.i./, ii= rate in kg a.e.

Source: Devised by authors

Grain yield

Chlorsulfuron alone, irrespective of rate, yielded the highest grain yield and realised a 23.2-31.8% increase in grain yield over the respective untreated striga infested control. It was noted that 2, 4-D displayed inconsistent performance where the herbicide at the middle rate showed the lowest grain yield. Of interest is the trend in increase in yield obtained from the tank mixtures of 2, 4-D and chlorsulfuron in comparison to 2, 4-D alone (Table 3). The consistent increase in grain yield with an increasing proportion of 2, 4-D in mixtures with a constant rate of chlorsulfuron may indicate an antagonistic action between the two herbicides and warrant further investigation.

CONCLUSIONS

- Striga is a difficult weed to control and its management requires integrated practices comprising different components.
- Chlorsulfuron, alone, was more suppressive to Striga than 2, 4-D.

Table 3: Effects of chlorsulfuron, 2, 4-D and their tank mixtures on grain yield

Treatment	Herbicide rate ha^{-1}	Yield kg ha^{-1}
Untreated control	-	2193.8±321.5
Chlor.[i]	2.38	2790.6±332.3
Chlor.	2.98	2890.6±356.7
Chlor.	3.57	2703.1±154.1
2, 4-D[ii]	0.38	2037.5±592.8
2, 4-D	0.57	1750.0±230.9
2, 4-D	0.76	2184.4±200.4
Chlor. + 2, 4-D	2.38+0.38	2271.9±366.5
Chlor. + 2, 4-D	2.38+0.57	2496.9±432.9
Chlor. + 2, 4-D	2.38 +0.76	2521.9±239.5
$p \leq 0.05$		NS
CV%		*27.2*

± Standard errors of means.i = rate in g a.i., ii = rate in kg a.e.

Source: Devised by authors

- 2, 4-D and chlorsulfuron tended to be antagonistic. Tank mixtures of the former with a constant rate of the latter tended to be less suppressive to Striga and less toxic to sorghum.

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Dr. Babiker Mohammed Mahgoub Is a weed scientist, an Associate Professor, Pests and Plant Health Department, College of Agriculture, University of Bahri, Sudan. He has published 15 scientific papers in national and international journals on the subject of weed biology and control. He is a reviewer for several national and international journals and two weed control books. Dr Babiker is an external examiner for PhD and MSc students, and an internal examiner for PhD students. He is a member of several NGOS, and an agriculture expert for the Sudanese Wildlife Society. He has attended several workshops, and has 22 years' experience in university teaching.

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