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Development of Suitable Strategies for the Economical Control of *Avena fatua* and *Phalaris minor* in Wheat

MUHAMMAD JAMIL[1], ZAHID ATA† AND ABDUL KHALIQ†
National Agricultural Research Center, Islamabad–Pakistan
†*Department of Agronomy, University of Agriculture, Faisalabad–38040, Pakistan*
[1]Corresponding author's e-mail: jamil_narc@yahoo.com

ABSTRACT

A field experiment was conducted by using sorgaab along with lower rates of organic herbicides to find out some suitable ways for the control of *Avena fatua* and *Phalaris minor* in wheat under Faisalabad. Concentrated sorgaab (*Sorghum bicolor* water extracts) was combined with reduced doses of organic herbicides i.e. 2, 4-D, benzoic acid and sulfosulfuron. For comparison the recommended doses of these chemicals were used and a weedy check was maintained. Sorgaab @ 6 or 12 L ha^{-1} in combination with lower rate of sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS significantly reduced *Avena fatua* density (78-92%) and dry weight (72-98%) and was statistically on par with full dose of sulfosulfuron @ 35 g ha^{-1} at 30 DAS (T_{11}) which reduced *Avena fatua* density by 89-96% and dry weight by 99%. One spray of conc. sorgaab @ 12 L ha^{-1} combined with lower rate of sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS (T_8) suppressed *Phalaris minor* density by 82-91% and dry weight by 86-87%. One spray of standard dose of sulfosulfuron @ 35 g a. i. ha^{-1} at 30 DAS (T_{11}) reduced *Phalaris minor* density by 91-95% and dry weight by 97-100%. Although maximum increase in grain yield was obtained in plots which were applied standard dose of sulfosulfuron @ 35 g a. i. ha^{-1} but statistically similar yield was also resulted by one spray of conc. sorgaab @ 12 L ha^{-1} with sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS.

Key Words: *Avena fatua*; *Phalaris minor*; Wheat; Sorghum water extract; herbicide

INTRODUCTION

Weed losses are encountered nearly everywhere in agriculture. The introduction of high yielding wheat varieties having high inputs requirements has resulted in tremendous increase in weed population in wheat fields. The extent of losses in wheat caused by weeds is alarming. The weed spectrum of wheat in Pakistan consists of a number of weeds among which *Phalaris minor* L. (Canary grass) and *Avena fatua* L. (Wild oat) are most serious weeds. *Phalaris minor* in rice-wheat areas of Punjab is a serious problem resulting in significantly yield losses (Byerlee *et al.*, 1986). *Avena fatua* and *Phalaris minor* had a major share of the total nutrient uptake by weeds. Cheema and Nazir (1995) pointed out that different wild oat densities showed highly negative correlation between grain yield and yield components such as fertile tillers, number of grains per spike and 1000-grain weight. Wheat yield reduction by wild oat was more pronounced in unfertilized plots, whereas the magnitude of yield losses reduced with successive increase in nitrogen rates. Menan *et al.* (2003) reported that economic threshold for wild oat was between 11.77 and 14.70 plants/m^2 and for black grass between 15.70 and 32.56 plants/m^2. Donovan (1998) pointed out that as wild oat density increased, competition from the weed, and consequently crop losses, increased. The timely control of these weeds is very essential for better wheat production.

The organic chemical compounds having herbicidal properties which are relatively less toxic and cheaper, may be combined with allelopathic water extracts at lower rates. This on one side may improve the efficiency of allelopathic extracts and on other side may provide the opportunities of reducing the herbicidal rates and hence the cost of weed control could be lowered with relatively a more environmentally safe approach. Inhibition of *Avena fatua* by mixture application is in line with findings of Rice *et al.* (1981) and Einhelling *et al.* (1982) who concluded that combinations of chemicals have synergistic effects. The allelochemicals present in conc. sorgaab may work synergistically with lower rates of these organic compounds to decrease *Avena fatua* and *Phalaris minor* density and dry weight. The present study was therefore, designed to develop a suitable strategy to control these weeds in wheat.

MATERIALS AND METHODS

A field experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad for two years. The experiments were laid out in a randomized complete block design with three replications in 7m x 2m plot size. Wheat cultivar (Punjab-96) was sown in the first week of November, in the respective year, using the standard procedure. A basal dose of 110 kg N, 55 kg P and 60 kg K ha^{-1} was applied. The whole of phosphorous and potassium and half of nitrogen was applied at the time of sowing. The remaining half nitrogen was applied with second irrigation. Concentrated sorgaab (*Sorghum bicolor* L. water extract) was used as natural weed inhibitor and various herbicides such as 2, 4-D benzoic acid sulfosulfuron in combination with sorgaab was used in this field experiment. For preparation of sorgaab, sorghum (*Sorghum bicolor L.*) was harvested at maturity dried for a few days, chopped with electric fodder cutter into 2-cm pieces and stored under shade. This chopped material was soaked in distilled water for 24 h at room temperature (21^{o}C) in a ratio of 1:10 (W/V) and were filtered with the help of sieve (10 & 60 mesh) according to procedure devised by Cheema *et al*. (1998). The extract was boiled at 100^{o}C to concentrate up to 20 times for easy handling and application. The concentrated sorghum water extract along with lower doses of organic compounds were used as a post emergence spray in the respective plots. The field trials comprised of eleven treatments viz. two sprays at 30 + 40 days after sowing (DAS) of conc. sorgaab @ 12 L ha^{-1}. In other treatments conc. sorgaab @ 6 and 12 L ha^{-1} each was combined with about 1/3rd dose of organic compounds i. e. 2, 4-D @ 350 g a. i. ha^{-1}, benzoic acid @ 2 kg ha^{-1} and sulfosulfuron @ 15 g a. i. ha^{-1}. Standard dose of 2, 4- @ 1050 g a. i. ha^{-1}, benzoic acid @ 5 kg ha^{-1} and sulfosulfuron @ 35 g a. i. ha^{-1} and a weedy check were also included for comparison. Volume of spray (320 L ha^{-1}) was determined by calibration. Spray was done with knapsack hand sprayer fitted with flat fan nozzle. All other agronomic operations except those under study were kept normal and uniform for all the treatments. Standard procedures were adopted for recording the data on various growth and yield parameters. Data collected was statistically analysed by using the Fisher's Analysis of Variance technique and Duncan`s New Multiple Range (DNMR) test at 0.05P was applied to compare the differences among treatments (Steel & Torrie, 1984).

RESULTS

The data shown in Table I revealed that sorgaab @ 6 or 12 L ha^{-1} in combination with lower rate of sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS significantly reduced *Avena fatua* density (78-92%) and was statistically on par with full dose of sulfosulfuron @ 35 g ha^{-1} at 30 DAS (T_{11}) which reduced *Avena fatua* density by 89-96% at 60 DAS during both years of study. Among other treatments benzoic acid @ 2 kg ha^{-1} with sorgaab @ 12 L ha^{-1} reduced *Avena fatua* density only during 1st year while during 2nd year no effect was noted. The combination of conc. sorgaab @ 6 or 12 L ha^{-1} with lower dose of 2, 4-D @ 350 g a. i. ha^{-1} had minimum effect on *Avena fatua* density reducing 8-33% during both years of experimentation. It means that 2, 4-D and conc. sorgaab had better suppression of broad leaved weeds as compared to grasses. Two sprays of sorgaab @ 12 L ha^{-1} cause only 5-25% reduction of *Avena fatua* but when it was combined with lower dose of sulfosulfuron @ 15 g a. i. its efficiency was increased up to 92%. Dry weight of *Avena fatua* was reduced significantly (72-98%) by the application of sorgaab @ 6 or 12 L ha^{-1} along with lower rate of sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS recorded at 60 DAS during both years of study and it was statistically on par with full dose of sulfosulfuron @ 35 g a. i. ha^{-1} at 30 DAS (T_{11}) reducing *Avena fatua* dry weight by 90-99%. It can be suggested that the mixture of conc. sorgaab along with lower doses of sulfosulfuron @ 15 g a. i. ha^{-1} can be used for controlling *Avena fatua* under field conditions. Combination of sorgaab @ 6 or 12 L ha^{-1} with lower rate of benzoic acid @ 2 kg ha^{-1} and lower rate of 2, 4-D @ 350 g a. i. ha^{-1} reduced dry of *Avena fatua* by 24-64% and 5-33% recorded at 60 DAS during both years of experimentation.

Among sorgaab and organic compounds combinations, one spray of conc. sorgaab @ 12 L ha^{-1} combined with lower rate of sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS (T_8) suppressed *Phalaris minor* density by 82-91% recorded at 60 DAS during two years of experimentation and application of sorgaab @ 6 L ha^{-1} along with sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS (T_7) was statistically on par with it (Tables II). One spray of standard dose of sulfosulfuron @ 35 g a. i. ha^{-1} at 30 DAS (T_{11}) reduced *Phalaris minor* density by 91-95% during both years. One spray of sorgaab @ 12 L ha^{-1} with lower dose of benzoic acid @ 2 kg ha^{-1} reduced density of *Phalaris minor* by 55% during 1st year and during 2nd year no effect was noted at 60 DAS. It is difficult to narrate the reason for this differential response. The results indicated that sulfosulfuron at lower rate along with conc. sorgaab @ 12 L ha^{-1} can effectively be used for controlling *Phalaris minor*. The lower doses of sulfosulfuron along with conc. sorgaab might had combined action and reduced maximum number of *Phalaris minor*. Various workers have shown that additive activities are responsible for the observed effects in natural systems (Netzyl *et al.*, 1988; Ben *et al.*, 1995). *Phalaris minor* can be reduced up to 91% and dose of sulfosulfuron can be reduced up to 57% by combining it with sorgaab.

Maximum depression of *Phalaris minor* dry weight (74-87%) was recorded at 60 DAS during both years of experimentation by the application of conc. sorgaab @ 6 or 12 L ha^{-1} along with lower rate of sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS (T_7 & T_8) and it was statistically on par with standard dose of sulfosulfuron @ 35 g a. i. ha^{-1} at 30 DAS (T_{11}) reducing 97-100% dry weight of *Phalaris minor* (Tables II). The application of sorgaab @ 12 L ha^{-1} along with lower dose of benzoic acid and 2, 4-D reduced dry weight of *Phalaris minor* by 67-68 and 45-51%, respectively at 60 DAS while their sole applications showed less reduction. Sorgaab and lower dose of sulfosulfuron can be used to overcome *Phalaris minor* and mixture of sorgaab @ 12 L ha^{-1} along with lower dose of sulfosulfuron @ 15 g a. i. ha^{-1} was as effective as standard dose of sulfosulfuron @ 35 g a. i. ha^{-1}. More over two sprays of standard dose of conc. sorgaab @ 12 L ha^{-1} at 30 + 40 DAS reduced *Phalaris minor* dry weight by only 37-41% but when it was combined with lower doses of organic

Table I. Influence of concentrated sorgaab with some organic herbicides on *Avena fatua* density (m^{-2}) and dry weight ($g\ m^{-2}$)

Treatments		Avena fatua density (m^{-2})					Avena fatua dry weight ($g\ m^{-2}$)				
		1st year		2nd year		Mean	1st year		2nd year		Mean
T_1	Control (weedy check)	32.00a[1]	(-)[2]	24.00a[1]	(-)[2]	28.00	12.49a[1]	(-)[2]	9.46a[1]	(-)[2]	10.98
T_2	Conc. sorgaab @ 12 L ha^{-1} (30 + 40 DAS)	24.00b	(25.00)	23.33a	(2.78)	23.67	9.21b	(26.22)	7.14abc	(24.54)	8.18
T_3	Conc. sorgaab @ 6 L ha^{-1} + 2, 4-D @ 350 g a. i. ha^{-1} (30 DAS)	22.67bc	(29.17)	24.67a	(-2.70)	23.67	9.22b	(26.14)	9.00ab	(4.90)	9.11
T_4	Conc. sorgaab @ 12 L ha^{-1} + 2, 4-D @ 350 g a. i. ha^{-1} (30 DAS)	21.33bcd	(33.33)	22.00a	(8.33)	21.67	8.39b	(32.85)	8.23ab	(13.01)	8.31
T_5	Conc. sorgaab @ 6 L ha^{-1} + benzoic acid @ 2 kg ha^{-1} (30 DAS)	14.67de	(54.17)	20.67a	(13.89)	17.67	4.99cd	(60.05)	7.22abc	(23.71)	6.10
T_6	Conc. sorgaab @ 12 L ha^{-1} +benzoic acid @ 2 kg ha^{-1} (30 DAS)	10.67ef	(66.67)	17.33a	(27.78)	14.00	4.53d	(63.76)	6.07bc	(35.90)	5.30
T_7	Conc. sorgaab @ 6 L ha^{-1} + Sulfosulfuron @ 15 g a. i. ha^{-1} (30 DAS)	5.33fg	(83.33)	5.33b	(77.78)	5.33	2.34e	(81.29)	2.67de	(71.79)	2.50
T_8	Conc. sorgaab @ 12 L ha^{-1} + Sulfosulfuron @ 15 g a. i. ha^{-1} (30 DAS)	2.67g	(91.67)	2.67b	(88.89)	2.67	0.91ef	(92.71)	0.22e	(97.71)	0.56
T_9	2, 4-D @ 1050 g a. i. ha^{-1} (30 DAS)	17.33bcde	(45.83)	18.67a	(22.22)	18.00	5.86cd	(53.04)	5.17cd	(45.33)	5.52
T_{10}	Benzoic acid @ 5 kg ha^{-1} (30 DAS)	16.00cde	(50.00)	20.00a	(16.67)	18.00	6.46c	(48.26)	7.79abc	(17.65)	7.13
T_{11}	Sulfosulfuron @ 35 g a. i. ha^{-1} (30 DAS)	1.33g	(95.83)	2.67b	(88.89)	2.00	0.10f	(99.21)	0.09e	(99.01)	0.10
	LSD	6.375		7.956			1.713		2.671		

1. Means not sharing a letter in common differ significantly at 0.05 p
2. Figures in parenthesis show percent decrease over control

Table II. Influence of concentrated sorgaab with some organic herbicides on *Phalaris minor* density (m^{-2}) and dry weight ($g\ m^{-2}$)

Treatments		Phalaris minor density (m^{-2})					Phalaris minor dry weight ($g\ m^{-2}$)				
		1st year		2nd year		Mean	1st year		2nd year		Mean
T_1	Control (weedy check)	29.33a[1]	(-)[2]	14.67a[1]	(-)[2]	22.00	7.79a[1]	(-)[2]	2.45a[1]	(-)[2]	5.12
T_2	Conc. sorgaab @ 12 L ha^{-1} (30 + 40 DAS)	20.00b	(31.18)	14.00a	(4.57)	17.00	4.58b	(41.24)	1.55abc	(36.79)	3.06
T_3	Conc. sorgaab @ 6 L ha^{-1} + 2, 4-D @ 350 g a. i. ha^{-1} (30 DAS)	17.33bc	(40.90)	10.67ab	(27.29)	14.00	3.22bcd	(58.62)	1.31abc	(46.55)	2.27
T_4	Conc. sorgaab @ 12 L ha^{-1} + 2, 4-D @ 350 g a. i. ha^{-1} (30 DAS)	14.67bc	(49.99)	10.67ab	(27.29)	12.67	3.82bc	(50.96)	1.34abc	(45.35)	2.58
T_5	Conc. sorgaab @ 6 L ha^{-1} + benzoic acid @ 2 kg ha^{-1} (30 DAS)	14.67bc	(49.99)	12.00ab	(18.20)	13.33	4.12bc	(47.13)	0.84bcd	(65.57)	2.48
T_6	Conc. sorgaab @ 12 L ha^{-1} +benzoic acid @ 2 kg ha^{-1} (30 DAS)	13.33c	(54.54)	13.33a	(9.11)	13.33	2.58cde	(66.91)	0.77bcd	(68.43)	1.68
T_7	Conc. sorgaab @ 6 L ha^{-1} + Sulfosulfuron @ 15 g a. i. ha^{-1} (30 DAS)	4.00d	(86.36)	5.33bc	(63.64)	4.67	1.85def	(76.25)	0.63bcd	(74.19)	1.24
T_8	Conc. sorgaab @ 12 L ha^{-1} + Sulfosulfuron @ 15 g a. i. ha^{-1} (30 DAS)	2.67d	(90.91)	2.67c	(81.82)	2.67	1.07ef	(86.26)	0.33cd	(86.58)	0.70
T_9	2, 4-D @ 1050 g a. i. ha^{-1} (30 DAS)	14.67bc	(49.99)	5.33bc	(63.64)	10.00	4.63b	(40.52)	1.67ab	(31.86)	3.15
T_{10}	Benzoic acid @ 5 kg ha^{-1} (30 DAS)	16.00bc	(45.45)	5.33bc	(63.64)	10.67	3.70bcd	(52.53)	1.12bcd	(54.21)	2.41
T_{11}	Sulfosulfuron @ 35 g a. i. ha^{-1} (30 DAS)	1.33d	(95.45)	1.33c	(90.91)	1.33	0.23f	(97.11)	0.00d	(100.0)	0.11
	LSD	5.409		6.303			1.750		1.116		

1. Means not sharing a letter in common differ significantly at 0.05 p
2. Figures in parenthesis show percent decrease over control

Table III. Influence of concentrated sorgaab with some organic herbicides on yield (t ha^{-1}) of wheat

Treatments		1st Year		2nd Year		Mean
T_1	Control (weedy check)	2.58d[1]	(+)[2]	2.21e[1]	(+)[2]	2.39
T_2	Conc. sorgaab @ 12 L ha^{-1} (30 + 40 DAS)	3.46bc	(33.98)	3.27bcd	(48.27)	3.37
T_3	Conc. sorgaab @ 6 L ha^{-1} + 2, 4-D @ 350 g a. i. ha^{-1} (30 DAS)	4.12ab	(59.69)	3.42abcd	(54.72)	3.77
T_4	Conc. sorgaab @ 12 L ha^{-1} + 2, 4-D @ 350 g a. i. ha^{-1} (30 DAS)	4.42a	(71.32)	3.21bcd	(45.14)	3.81
T_5	Conc. sorgaab @ 6 L ha^{-1} + benzoic acid @ 2 kg ha^{-1} (30 DAS)	4.64a	(79.97)	2.85cd	(29.09)	3.75
T_6	Conc. sorgaab @ 12 L ha^{-1} + benzoic acid @ 2 kg ha^{-1} (30 DAS)	4.88a	(89.02)	2.91cd	(31.71)	3.89
T_7	Conc. sorgaab @ 6 L ha^{-1} + Sulfosulfuron @ 15 g a. i. ha^{-1} (30 DAS)	4.76a	(84.63)	3.45abc	(56.22)	4.11
T_8	Conc. sorgaab @ 12 L ha^{-1} + Sulfosulfuron @ 15 g a. i. ha^{-1} (30 DAS)	4.98a	(92.89)	4.01a	(81.71)	4.49
T_9	2, 4-D @ 1050 g a. i. ha^{-1} (30 DAS)	4.14ab	(60.59)	3.18bcd	(44.08)	3.66
T_{10}	Benzoic acid @ 5 kg ha^{-1} (30 DAS)	2.92cd	(13.05)	2.76de	(25.04)	2.84
T_{11}	Sulfosulfuron @ 35 g a. i. ha^{-1} (30 DAS)	4.15ab	(60.98)	3.85ab	(74.13)	4.00
	LSD	0.777		0.602		

1. Means not sharing a letter in common differ significantly at 0.05 p
2. Figures in parenthesis show percent increase over control

Fig. 1. Relationship between grain yield (t ha^{-1}) and *Avena fatua* density m^{-2} during 1st year (a), and 2nd year (b)

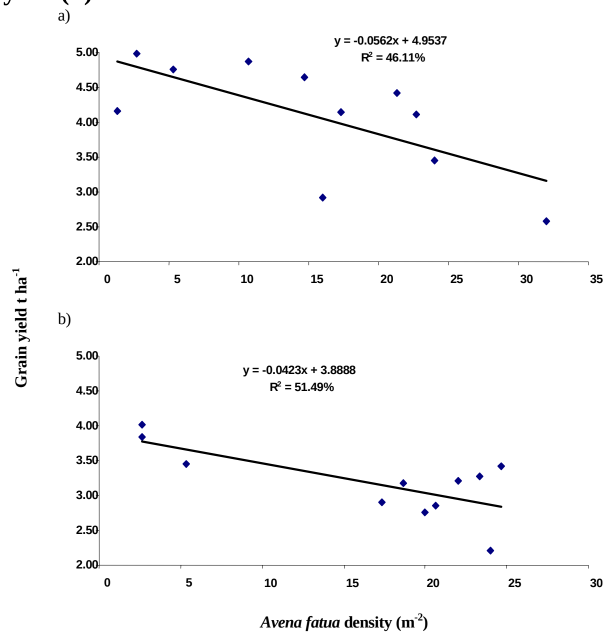
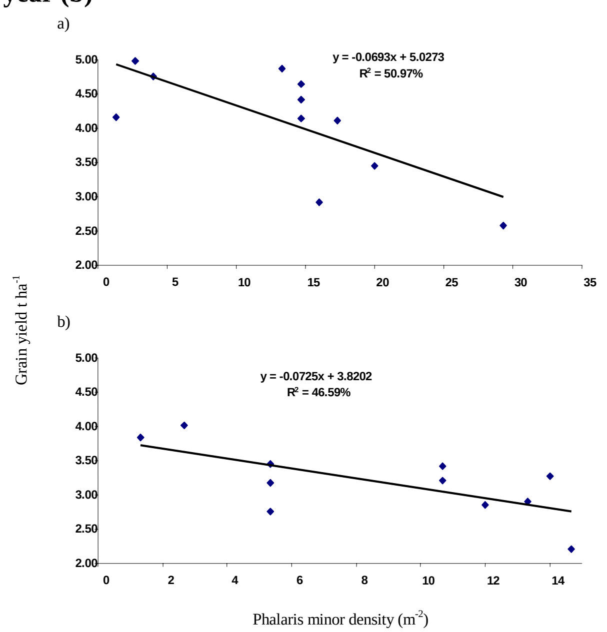


Fig. 2. Relationship between grain yield (t ha^{-1}) and *Phalaris minor* density m^{-2} during 1st year (a) and 2nd year (b)



compounds especially sulfosulfuron, its effectiveness was improved and the mixture reduced *Phalaris minor* dry weight up to 86-98% by saving 57% of sulfosulfuron.

Grain yield of wheat was significantly improved by different treatments as compared to control (weedy check) during both the years of study (Table III). Among mixture of sorgaab with organic compounds, application of one spray of sorgaab @ 12 L ha^{-1} combined with lower dose of sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS significantly enhanced grain yield by 82-93% over control during both years of study and it was statistically on par with one spray of conc. sorgaab @ 6 L ha^{-1} at 30 DAS with sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS (T_7) increasing 56-85% wheat yield during both years. One foliar spray of sorgaab @ 6 or 12 L ha^{-1} with lower dose of 2, 4-D increased wheat yield by 45-71% during both years of study while application of lower dose of benzoic acid @ 2 kg ha^{-1} with sorgaab @ 6 or 12 L ha^{-1} enhanced grain yield by 29-89%. Two sprays of sorgaab @ 12 L ha^{-1} improved grain yield by 33-48% while 93% yield increase was obtained by mixing it with lower dose of sulfosulfuron. Full dose of sulfosulfuron @ 35 g a. i. ha^{-1} increased grain yield by 61-74% and it was statistically on par with one spray of conc. sorgaab @ 12 L ha^{-1} with sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS (T_8) during both years. Sorgaab along with lower doses of organic compounds exhibited combined effects and improved growth and ultimately enhanced wheat yield.

DISCUSSION

The results of this field study show that sorgaab combined with lower doses of organic herbicides can significantly suppress *Avena fatua* and *Phalaris minor* populations and their growth. Application of sorgaab @ 12 L ha^{-1} along with lower doses of sulfosulfuron @ 15 g a. i. ha^{-1} proved to most suitable treatment combination which reduced *Avena fatua* and *Phalaris minor* density by 89-92%, 82-91% and weed dry weight by 93-98%, 86-87%, respectively recorded at 60 DAS during both years of study. One spray of sorgaab @ 12 L ha^{-1} along with lower doses of 2, 4-D @ 350 g a. i. ha^{-1} was next best treatment having suppression of *Avena fatua* and *Phalaris minor* density by 8-33%, 27-50% and their dry weight by 13-32%, 45-51%, respectively. The mixture of benzoic acid with sorgaab also reduced *Avena fatua* and *Phalaris minor* density by 28-65%, 9-55% and their dry weight by 36-64%, 67-68%, respectively. The concentration of sorgaab @ 12 L ha^{-1} with lower rates of organic herbicides was more effective and reduced more weed density and biomass as compared to its application @ 6 L ha^{-1} along with lower rates of organic herbicides. It is suggested that its concentration up to 15 L ha^{-1} or 18 L ha^{-1} may be increased and tested along with lower doses of organic compound to control weed effectively.

Mixture of sorgaab @ 12 L ha^{-1} along with lower dose of sulfosulfuron @ 15 g a. i. ha^{-1} appeared best combination for controlling *Avena fatua* and *Phalaris minor* and it can be suggested that this mixture can be developed to control these narrow leaved weeds in wheat crop. The combined action (Netzyl *et al.*, 1988; Ben *et al.*, 1995) caused by mixing sorgaab with lower dose of sulfosulfuron might be the main reason which reduced *Phalaris minor* dry weight equal to standard dose of sulfosulfuron. The allelochemicals present in sorghum water extract acted collectively with lower doses of organic compounds. The combination of

Fig. 3. Relationship between grain yield (t ha^{-1}) and *Avena fatua* dry weight (g m^{-2}) during 1st year (a) and 2nd year (b)

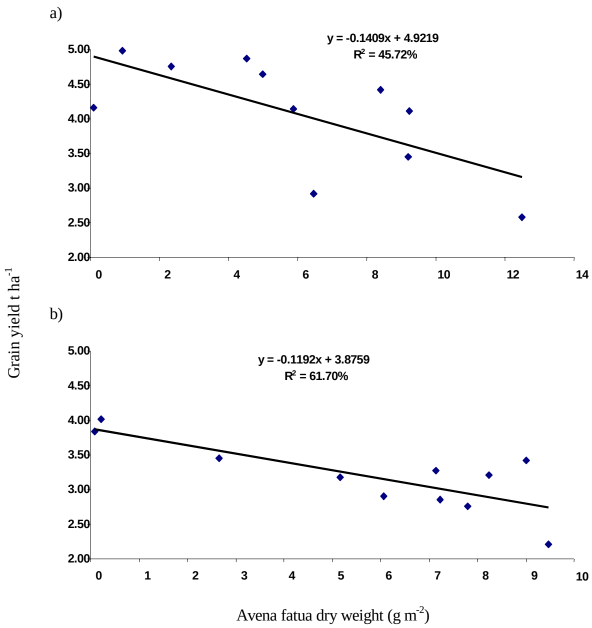
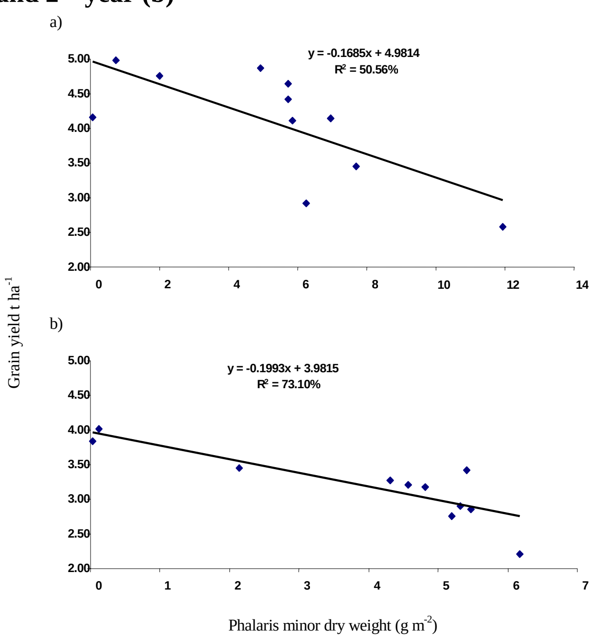


Fig. 4. Relationship between grain yield (t ha^{-1}) and *Phalaris minor* dry weight (g m^{-2}) during 1st year (a) and 2nd year (b)



more than two compounds could enhance the phytotoxic effects (Rasmussen & Einhelling, 1979). The suppression of total weed dry-mass with conc. sorgaab and lower doses of organic compounds suggests the enhanced allelopathic inhibitory effects of sorghum allelochemicals along with herbicidal activities of organic herbicides on these weeds. When sorgaab and lower doses of organic herbicides are mixed, combined effect of the mixture resulted into maximum reduction of weed dry weight. So the efficiency of sorgaab to reduce total dry weight of weeds can be increased by mixing, it with lower doses of organic herbicides and use of herbicides can be lowered up to 57-67%.

Maximum increase in grain yield was obtained in plots where one spray of sorgaab @ 12 L ha^{-1} with sulfosulfuron @ 15 g a. i. ha^{-1} (T_8) was used. Sorgaab combined with lower doses of organic herbicides exhibited synergistic effects and improved growth and ultimately enhanced wheat yield while application of benzoic acid may inhibit wheat growth along with weeds during 2nd year and resulted in low yield. Grain yield was negatively correlated with *Avena fatua* and *Phalaris minor* density and biomass (Fig 1, 2, 3 & 4).

CONCLUSION

It is suggested that sorgaab can be used in combination with lower rates of the organic herbicides as sulfosulfuron and mixing sorgaab @ 12 L ha^{-1} with almost 1/3rd dose of this herbicide performed better in reducing the *Avena fatua* and *Phalaris minor* density and biomass and in enhancing grain yield. The application of one spray of conc sorgaab @ 12 L ha^{-1} combined with sulfosulfuron @ 15 g a. i. ha^{-1} at 30 DAS proved best combination in terms of these weed control (87-98%) and high grain yield (82-93%).

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