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Response of Wheat Varieties and some Rabi Weeds to Allelopathic Effects of Sorghum Water Extract

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ABSTRACT

A field trial was carried out to evaluate the response of four wheat varieties (Inqlab-91, Parwaz-94, Shahkar-95 and Punjab-96) and some rabi weeds to foliar application of sorghum water extract (SWE) as natural herbicide. One foliar application of SWE at 30 or two sprays each at 30 and 60 days after sowing inhibited the density and biomass of weeds species as *Chenopodium album* by 26-32 and 39-48%, *Phalaris minor* by 21-34%, *Avena fatua* by 21-27 and 26-35%, *Convolvulus arvensis* by 26-36 and 35-40%, *Rumex dentatus* by 27-38 and 35-46%, respectively. It promoted the density and growth of *Melilotus parviflora*. Total density and total weed biomass was reduced by 23-30 and 28-36%, respectively. Grain yield of different wheat varieties was enhanced by 10-22% with one and two foliar sprays of SWE. Wheat leaf area, productive tillers, grain number, 1000-grain weight and harvest index were improved with SWE sprays. Parwaz-94 was found to be more responsive to SWE showing maximum (22%) increase in grain yield. While, the overall performance of Punjab-96 was better than other varieties.

Key Words: Wheat varieties; Rabi weeds; Sorghum water extract

INTRODUCTION

Allelopathy is a natural and environment friendly approach for weed management (Purvis *et al*., 1985; Cheema & Ahmad, 1992). Sorghum (*Sorghum bicolor*) is well recognized allelopathic crop (Putnam & DeFrank, 1983). Mature sorghum plants possess a number of water soluble allelochemicals. Guenzi and McCalla (1966) identified five allelochemicals in sorghum residues. Netzley and Butler (1986) discovered that living sorghum roots exude a long chain hydroquinone called Sorgoleone, which exhibits phytoxicity. The sorghum allelochemicals are phytotoxic to growth of certain weeds in wheat crop such as *Chenopodium album, Phalaris minor*, *Avena fatua, Convolvulus arvensis* and *Rumex dentatus* etc., however they also influence the wheat growth (Purvis *et al*., 1985; Cheema & Ahmad, 1992).

Incorporation of sorghum roots increased wheat yield by 7-8% and suppressed the weeds biomass in the range of 25-50% (Cheema & Ahmad, 1992). In a recent study, it was noticed that a single spray of sorghum water extract (SWE; 1:20) applied at 30 days after sowing (DAS) increased wheat yield by 14% and suppressed weed biomass by 20-40% (Cheema *et al*., 1997). The allelopathic effects of sorghum allelochemicals are selective, species specific and concentration dependent (Rice, 1984). It is quite possible that varieties of a crop may respond differentially to the sorghum allelochemicals. It was, therefore, considered appropriate to evaluate the response of different wheat varieties to sorghum allelochemicals, to explore the feasibility of using SWE as a natural herbicide for reducing weeds growth and its impact on some wheat varieties.

MATERIALS AND METHODS

Sorghum plant herbage was harvested at maturity, dried and chaffed (2 cm pieces) and stored under shade. Chaffed sorghum material was soaked in distilled water (1:20) for 24 hours at room temperature and then filtered to collect SWE (Hussain & Gadoon, 1981). Wheat cultivars Inqlab 91, Parwaz-94, Shahkar-95 and Punjab-96 were sown in 25 cm spaced rows with single row hand drill on November 21, 1996. Prior to this mungbean was grown in the field. The experiment was laid out in RCBD in split-plot arrangement, with four replications, randomizing the wheat cultivars in main plots and SWE treatments in sub-plots. The net plot size was 5 x 2 m. Spray volume was determined @ 300 L ha^{-1}. SWE was applied as foliar spray with nap sack hand sprayer using T Jet nozzle over crop and weeds either 30 DAS (one spray) or 30 and 60 DAS (two sprays) while control plots were kept without spray. A basal dose of 125-85-60 kg NPK ha^{-1} in the form of urea, single super phosphate and sulphate of potash, respectively, was used. Half of N and all of P_2O_5 and K_2O were applied at sowing, and remaining half N with first irrigation 20 DAS, subsequent irrigations were applied at booting, earing and grain development stages. Weed population (Individual & total) were recorded 60 and 90 DAS from randomly selected two quadrates (50 cm x 50 cm) from each plot. Weed fresh and dry weight (individual and total) was recorded after each weed counting (Cruz *et al*., 1986). Wheat germination and number of total tillers (productive and unfertile tillers) were counted from a randomly selected unit area (m^2). For measuring wheat leaf area, a 20 cm crop row segment area was used to calculate per unit area (m^2). Wheat leaf area was measured periodically (45, 90 and 135 DAS) with leaf area meter (Licor Model 3100). For recording spike length, number of grains spike^{-1} and plant height, ten tillers were randomly selected from each plot. A random sample from each lot of the experimental unit was obtained to record 1000-grain weight. Wheat bundles were threshed manually to record grain and straw yield per plot, and then converted into yield ha^{-1}.

The data collected on different parameters were analysed statistically by employing Fisher's analysis of variance technique and difference among the treatment's means were compared by using Least Significant Difference (LSD) test at 0.05 P (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Weed density. Foliar application of SWE (Single & double sprays) significantly suppressed the density of weed species as *Chenopodium album* by 27-32%, *Phalaris minor* by 22-34%, *Avena fatua* by 22-27%, *Convolvulus arvensis* by 26-36% and *Rumex dentatus* by 28-39%. However, density of *Melilotus parviflora* was stimulated by 15-18% over control (Table I). Single spray of SWE applied at 30 DAS reduced the total weed density by 23-24% over control. In case of two sprays, total weed density was suppressed by 30% in comparison with control. Findings of this study indicate that foliar application of SWE generally had a suppressive influence against the weed population either by killing the existing ones or inhibiting the germination of weeds, possibly due to the existence of allelochemicals in SWE. These findings are in accordance with those of Ahmad *et al*. (1991), and Cheema and Ahmad (1992). More reduction in weeds population by two sprays as compared to single one indicate the concentration or amount dependent behavior of sorghum allelochemicals, also suggested by Rice (1984) and Almeida (1985). Promotion of *Melilotus* population and inhibition of other weeds density confirms the findings of McWhorter (1984), and Cheema and Ahmad (1992) who reported the stimulatory or inhibitory effects of allelochemicals depending upon the species tested.

Weed fresh weight (g). A perusal of data in Table II indicated the overall suppressive influence of SWE on fresh mass of all weeds except *Melilotus* spp. The reduction in total fresh weed mass was 27-28% compared with control or single spray. Further reduction in weeds fresh weight (32%) against control was observed due to application of second spray. However, the decrease in fresh mass with second spray was only 6% over the single spray, which was statistically significant. The growth of *M. parviflora* was enhanced under SWE treatments and or 52 and 61% more fresh mass was recorded on 60 and 90 DAS, respectively. These results are harmonious with findings of Rice (1984) who reported the concentration (amount) and species specific behavior of allelochemicals on weed flora.

Weed dry weight (g). Similar species specific and concentration dependent allelopathic behavior of SWE was observed regarding individual and total weed dry mass (Table III). Spraying of SWE 30 DAS reduced total weed dry mass by 27-28% against control. In case of second spray, total weed dry weight was suppressed up to 36% as

Table I. Influence of foliar spray of sorghum water extract on individual and total weed density (50 cm x 50 cm)

Treatments	*C. album*		*P. minor*		*Avena fatua*		*C. arvensis*		*R. dentatus*		*M. parviflora*		Total weed density	
	60 DAS	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**
S_0 = Control (no spray)	18.97a	20.97a	13.47a	15.50a	22.59a	23.38a	15.38a	19.09a	21.56a	26.03a	10.79b	11.81b	104.4a	116.81a
S_1 = SWE (one spray)	13.41b (29.32)	15.34b (26.84)	9.94b (26.20)	12.16b (21.54)	17.34b (23.24)	18.28b (21.81)	11.31b (26.46)	13.25b (30.59)	15.59b (27.69)	18.60b (28.54)	12.66a (17.37)	13.59b (15.08)	80.09b (23.33)	89.25b (23.59)
S_2 = SWE (two sprays)	13.84b (27.04)	14.25b (32.04)	9.75b (27.61)	10.22b (34.06)	17.22b (23.77)	17.23b (26.73)	10.91b (29.06)	12.16b (36.30)	15.44b (28.38)	16.00c (38.53)	12.58a (16.70)	13.90a (17.50)	79.13b (24.25)	81.94c (29.85)
L.S.D. Value	1.21	1.19	1.31	1.24	2.19	1.11	1.11	1.77	1.40	1.23	1.30	1.59	3.05	2.63

Means followed by different letter are significantly different at 0.05 P; Figures given in parenthesis show per cent increase or decrease over control; SWE=Sorghum water extract; DAS=Days after sowing

Table II. Influence of foliar spray of sorghum water extract on individual and total weed fresh weight (g) 50 cm x 50 cm

Treatments	*C. album*		*P. minor*		*Avena fatua*		*C. arvensis*		*R. dentatus*		*M. parviflora*		Total weed density	
	60 DAS	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**
S_0 = Control (no spray)	22.83a	35.38a	20.50a	56.35a	31.84a	83.09a	10.60a	32.00a	28.51a	26.03a	10.57b	14.42c	124.37a	281.09a
S_1 = SWE (one spray)	16.01b (29.87)	22.18b (37.30)	15.71b (23.36)	35.49b (37.01)	25.37b (20.32)	63.09b (24.07)	7.27b (31.47)	22.37b (30.09)	18.99b (33.39)	18.60b (28.54)	16.32a (54.39)	21.68b (50.34)	89.67b (27.90)	201.37b (28.36)
S_2 = SWE (two sprays)	15.29b (33.02)	21.20b (40.07)	15.36 (25.07)	32.64b (42.07)	25.44b (20.10)	56.33b (32.20)	7.23b (31.85)	19.87c (37.90)	18.90b (33.70)	16.00c (38.53)	15.97a (51.08)	23.36a (61.99)	89.36c (28.14)	189.10 (32.72)
L.S.D. Value	1.53	1.63	1.42	4.64	3.09	7.82	1.33	1.20	1.19	1.23	1.50	1.25	2.19	2.41

Means followed by different letter are significantly different at 0.05 P; Figures given in parenthesis show per cent increase or decrease over control; SWE=Sorghum water extract; DAS=Days after sowing

Table III. Influence of foliar spray of sorghum water extract on individual and total weed dry weight (g) 50 cm x 50 cm

Treatments	*C. album*		*P. minor*		*Avena fatua*		*C. arvensis*		*R. dentatus*		*M. parviflora*		Total weed density	
	60 DAS	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**	**60 DAS**	**90 DAS**
S_0 = Control (no spray)	4.43a	7.68a	6.07a	15.02a	10.87a	26.55a	2.21a	6.40a	7.64a	15.07a	2.35a	2.98c	33.46a	73.73a
S_1 = SWE (one spray)	2.96b (33.18)	4.53b (41.01)	4.29b (29.32)	10.38b (30.89)	7.50b (31.00)	19.75b (25.61)	1.43b (35.29)	4.16b (35.00)	4.64b (39.26)	9.37b (37.95)	3.636a (54.46)	4.42b (48.32)	24.19b (27.70)	52.58b (28.68)
S_2 = SWE (two sprays)	2.65b (40.18)	3.99b (48.04)	4.26b (29.81)	8.94c (40.47)	7.32b (32.65)	17.28b (34.91)	1.40b (36.65)	3.74c (41.56)	4.96b (35.07)	8.17c (45.78)	3.52a (49.78)	5.14a (72.48)	24.00b (28.27)	47.13c (36.07)
L.S.D. Value	0.37	0.95	0.76	0.98	0.82	2.67	0.23	0.37	0.60	0.78	0.19	0.28	1.26	1.50

Means followed by different letter are significantly different at 0.05 P; Figures given in parenthesis show per cent increase or decrease over control; SWE=Sorghum water extract; DAS=Days after sowing

Table IV. Influence of foliar spray of sorghum water extract on yield components and grain yield of wheat varieties

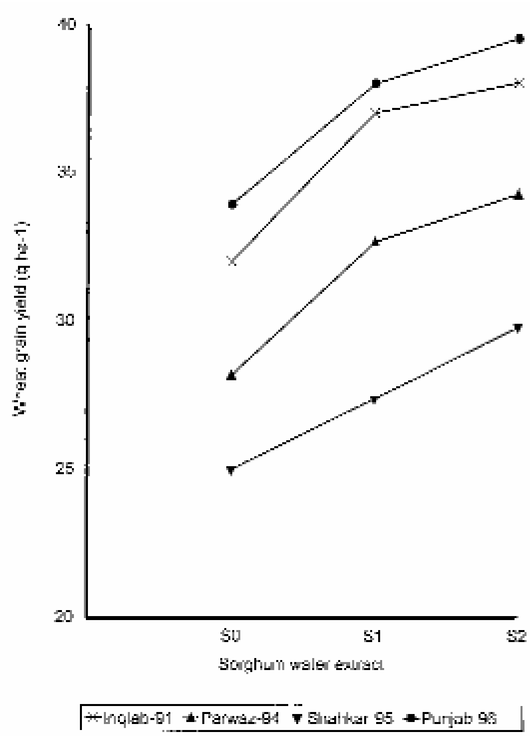
Treatment	Leaf area m^{-2} (m^2)			Plant height (cm)	Unfertile tillers (m^{-2})	Fertile tiller (m^{-2})	Spike length (cm)	Grain per spike	1000-grain weight (g)	Straw yield (q/ha)	Grain yield (q/ha)	Harvest index (%)
	45 DAS	**90 DAS**	**135 DAS**									
S_0 = Control (no spray)	1.89b	3.82b	1.73c	97.01a	39.81a	338.03b	9.16b	37.26b	34.47b	68.15a	29.73b	30.46b
S_1 = SWE (one spray)	2.04a	4.23a	1.94b	92.85b	22.81b	352.63a	11.30a	40.28a	36.76a	63.07b	33.76a (13.55)	34.73a
S_2 = SWE (one spray)	2.04a	4.33a	2.02a	91.71b	21.91b	354.41a	11.99a	41.33a	40.44a	61.22c	35.27a (18.63)	36.77a
L.S.D. Value	0.8	0.10	0.06	2.59	4.00	10.41	0.71	1.50	0.74	2.94	1.69	2.39

Means followed by different letter are significantly different at 0.05 P; Figures given in parenthesis show percent increase or decrease over control; SWE=Sorghum water extract; DAS=Days after sowing

compared to control. The inhibitory effect of second spray was significantly greater than single spray. Regarding the individual weeds, the dry weight of *C. album* was reduced by 39-41%, *P. minor* by 29-40%, *A. fatua* by 25-34%, *C. arvensis* by 35-42% and *R. dentatus* by 35-46% as a result of SWE spraying. However, growth of *Melilotus parviflora* was promoted with single or double sprays of SWE by 48 and 72%, respectively. The reduction in total weed dry matter production with SWE spraying clearly indicate the allelopathic potential and presence of species specific and concentration dependent allelochemicals in SWE. These results are in line with the work of Lehle and Putnam (1983), and Cheema and Ahmad (1992) who reported that sorghum residues suppressed weeds due to presence of allelochemicals.

Response of wheat. The data pertaining to wheat grain yield and different yield contributing characters (Table IV) revealed that grain yield was increased significantly, by various SWE treatments. Single spray of SWE applied 30 DAS resulted in 13.5% more grain yield over control. In case of two sprays, an increase of 18.6% in grain yield was obtained over control. The increase in grain yield under SWE treatments might be attributed to higher leaf area, more fertile tillers, longer spikes, more grain spike^{-1} and heavier grains (Table IV). These yield contributing parameters were promoted either because of suppressive allelopathic effects of SWE on weed density and biomass, or on wheat plant height and straw production which in turn, possibly furnished better nutrient availability for wheat plant growth and development, higher photosynthetic rate and

Fig. 1. Influence of foliar spray of sorghum water extract on grain yield of four wheat varieties



greater translocation of photosynthates to the grains which ultimately resulted in more grain yield. These results are harmonious with those of Baloch (1993) and Weston (1996) who reported that increased grain yield might be related to reduced weed infestation. Ahmad *et al*. (1991) obtained 13% more grain yield than control when sorghum roots + stem were incorporated in soil with application of enough basal fertilizer dose.

Parwaz-94 showed more response to SWE giving 16% and 22% higher grain yield than control with application of single and two sprays of SWE, respectively (Fig. 1). The least response (9%) to single spray was noticed in case of Shahkar-95. Among various wheat varieties, Punjab-96 appeared to be the superior variety as it gave higher grain yield than other varieties. The interaction of SWE sprays and varieties was non-significant. The results of this study revealed that foliar spray of SWE is not only effective in suppressing common wheat weeds but also increases wheat grain yield of different varieties by 10-22%.

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