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ALLELOPATHIC EFFECTS OF SUNFLOWER WATER EXTRACT ON WEED CONTROL AND WHEAT PRODUCTIVITY

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ABSTRACT

Allelopathic influence of sunflower plant water extract (1:10 w/v) against weeds and wheat sown after sorghum crop was studied under field conditions at Fodder Research Institute, Sargodha (Pakistan), during 2005-06. Treatments applied were sunflower plant water extract at pre-emergence, at 25 DAS (days after sowing), pre-emergence + 25 DAS, 25+35 DAS, pre-emergence + 25 + 35 DAS and control. Wheat variety Inqlab-91 was sown on 13th November, 2005. The inhibitory effects of pre-emergence application on germination of Phalaris minor were higher, whereas wheat remained unaffected at this stage of application. Application of water extract at pre-emergence + 25 DAS, 25 + 35 DAS and pre-emergence + 25 + 35 DAS suppressed the growth of Phalaris minor Retz., Chenopodium album L., Coronopus didymus L. and Avena fatua L. Inhibitory effects were species specific and increased with increasing the water extract application frequency. All the treatments except pre-emergence + 25 + 35 DAS increased the wheat yield significantly over control.

Key words: Allelochemicals, allelopathy, *Chenopodium album, Coronopus didymus, Phalaris minor,* sunflower extract.

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INTRODUCTION

Weeds compete for light, nutrients, moisture and space with the crop and thus cause severe losses to yield. Losses in wheat due to weeds range 17-25% (Shad, 1987) and in monetary terms it may be as high as Rs.28 billions (Hassan and Marwat, 2001). At present weeds in wheat crop are controlled by cultural practices and chemicals. Cultural practices are weather dependent while chemicals are not environmentally safe (Kassasion, 1971) and may affect the nutritive value of some crops (Saghir and Bhatti, 1970). Some weeds, which were earlier susceptible, are now herbicide resistant (Ahmad, 1996). This situation demands that efforts should be made to develop an alternative technology for weed control. Allelopathy could be an appropriate potential technology for this purpose.

The production of allelochemicals in crop plants and their release into the soil could influence the germination and growth of plant species (Rice, 1984). These effects are selective, depending upon the concentrations and residue type, either inhibitory or stimulatory to the growth of companion or subsequent crops or weeds (Bhowmik and Doll, 1984; Cheema, 1988; Cheema *et al*., 2004; Einhelling *et al*., 1985; Hall *et al*., 1982; Jalili *et al.,* 2007; Khan and Vaishya, 1992; Kimber, 1973; Naseem,1997; Naseem *et al*., 2003; Purvis *et al*., 1985).

Allelopathy may be used as a tool in weed management by applying the residues of allelopathic weeds or crop plants as mulches, growing them in successions and leaving their residues in the field (Altieri and Doll, 1978; Drost and Doll, 1980; Putnam and DeFrank, 1979). Allelopathy is a novel approach to keep the environment safe and to develop sustainable agriculture (Yongqing, 2005). Sorghum (Cheema, 1988; Putnam and DeFrank, 1979) and sunflower (Leather, 1982, 1983; Naseem, 1997; Wilson and Rice, 1968) are potent allelopathic plants and have been reported to have allelopathic effects on other plants. Recently Anjum and Bajwa (2005) reported that sunflower allelochemicals has a potential as possible alternative for achieving sustainable weed management. Similarly, Shahid, *et al*. (2006) reported that sunflower extract was the most inhibiting to germination, shoot and root length of wheat and to all species of weeds.

Both the sorghum and sunflower are important crops in Pakistan and wheat often follows them in a rotation. Therefore, a study was planned with the objectives to evaluate the allelopathic influence of sunflower water extract on weed density, growth and productivity of wheat.

MATERIALS AND METHODS

Sunflower (SF, 187) plants were harvested from ground level after the removal of their heads. These plants were dried at ambient temperature for 15 days. The dried material was chopped into 2 cm. pieces with an electric fodder cutter. To prepare water extract chopped material was soaked in water for 24 hours @ 1:10 (w/v) (Hicks *et* al., 1989). The decanted material was passed through cotton cloth to obtain water extract for use.

To asses the allelopathic effects of sunflower water extract on weeds and wheat under field conditions, an experiment was conducted at Fodder Research Institute, Sargodha, Pakistan, during the year 2005-06. After the harvest of sorghum (variety, JS-2002) crop, wheat cv. 'Inqlab-91' was sown on 13th November, 2005, with single row hand drill at 30 cm row to row distance. The experiment was laid out in Randomized Complete Block (RCB) Design having four replications with a plot size of 3x5 m^2. Fertilizer dose used was 114-80-50 NPK kg ha^{-1}. All the Phosphorus, potash and ½ nitrogen was applied at the time of seed bed preparation while remaining ½ nitrogen was applied with first irrigation. Wheat crop was given normal irrigations, while crop was harvested on 9th May, 2006. Detail of the Treatments was as under

i) SWE (sunflower plant water extract) at pre-emergence
ii) SWE at 25 DAS (days after sowing)
iii) SWE at pre-emergence + 25 DAS
iv) SWE at 25 + 35 DAS
v) SWE at pre-emergence + 25 + 35 DAS
vi) No extract (Control)

The data were recorded on germination counts m^{-2}, weed flora m^{-2} and dry weight 55 DAS of wheat. The data were also recorded some morphological and agronomic traits of wheat. All statistical analysis was performed using analysis of variance technique by means of 'MSTATC' computer software package. Differences among the treatment means were separated using the LSD–test at 5% probability level (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Weed flora of the experimental area comprised of *Chenopoduim album* L., *Coronopus didymus* L., *Phalaris minor* Retz., *Avena fatua* L. and *Convolvulus arvensis* L. Besides these species, a few plants of *Melilotus parviflora* L., *Rumax dentatus* L., *Anagallis arvensis* L. and *Fumaria indica* L. were also observed.

SWE (Sunflower plant water extract) did not affect the plant density of *C.album* L. (Table-1). However, SWE suppressed the plant density of *C. didymus* in plots where it was applied at pre-emergence (13.5-27%). Other treatments remained at par with each other. Similarly, SWE application at pre-emergence + 25 DAS and at pre-emergence + 25 + 35 DAS, lowered the population of *A.fatua* (13.5. and 27.0 %, respectively). Effect of other treatments was not different from the control. SWE extract at pre-emergence stage remarkably reduced the population of *P.minor* (47.3 to 50 %) as compared to control. Suppressive effect on *P.minor* density was higher than other the weeds infesting the experiment. Effect of SWE on the density of *C. arvensis* was not significant. SWE application at pre-emergence stage also lowered the density of total weeds, significantly.

Table-1. Effect of sunflower plant water extract (SWE) on weed population (m^{-2}).

Treatments	*C. album*	*C. didymus*	*A. fatua*	*P. minor*	*C. arvensis*	Total Weeds
Pre-em.†	21.75	15.50	8.00	5.00	3.75	59.50
25 DAS‡	19.50	20.25	8.50	10.00	2.50	71.50
Pre-em.+25 DAS	23.50	16.75	6.75	4.25	3.50	66.25
25+35 DAS	25.50	23.00	9.50	8.00	3.25	86.00
Pre-em. +25 +35 DAS.	24.25	13.25	7.75	4.75	4.25	63.25
Control	22.75	21.50	9.25	9.50	3.00	80.50
$LSD_{0.05}$	NS	5.29	1.62	2.89	NS	7.53

† Pre-em. = Pre-emergence application ‡DAS = Days after sowing

SWE treatments caused reduction in the dry weight of *C. album*, except when the SWE applied at pre-emergence, which was similar to the dry weight produced by control (Table-2). Less depressive effect on dry weight of *C.album* was observed in plots where SWE was applied at 25 DAS. All the SWE treatments depressed the growth of *C.didymus*. Maximum inhibitory effects were recorded in the plots where SWE was applied at pre-emergence+25+35 DAS. SWE treatments, except at 25+35 DAS, reduced the dry weight of *A.fatua,* significantly compared with control. SWE treatments markedly decreased the dry weight of *P.minor*. Suppressive effects on the growth of *P.minor* increased with the increase in water extract application frequencies. SWE application at pre-emergence+25+35 DAS retarded the maximum growth of *P.minor.* SWE at pre-

emergence+25+35 DAS and pre-emergence+25 DAS, promoted the growth of *C. arvensis* while other treatments of SWE did not affect the dry weight of *C.arvensis*. SWE affected the dry weight of total weeds. SWE at pre-emergence+25+35 DAS caused maximum reduction in dry weight of total weeds. Whereas, less depressive effect was observed in plots treated with at pre-emergence and 25 DAS.

Table-2. Effect of sunflower plant water extract (SWE) on dry weight of weeds (g m^{-2}).

Treatments	*C. album*	*C. didymus*	*A. fatua*	*P. minor*	*C. arvensis*	Total Weeds
Pre-em.†	3.56	0.54	1.64	0.57	0.62	**11.93**
25 DAS‡	3.27	0.62	1.72	1.20	0.45	**12.40**
Pre-em. +25 DAS	2.84	0.43	1.48	0.48	0.66	**8.98**
25+35 DAS	2.90	0.49	1.81	0.68	0.56	**9.12**
Pre-em. +25 +35 DAS.	2.57	0.36	1.28	0.36	0.74	**8.23**
Control	3.81	0.77	2.07	1.63	0.50	**13.97**
$LSD_{0.05}$	**0.34**	**0.12**	**0.35**	**0.14**	**0.15**	**0.67**

† Pre-em. = Pre-emergence application ‡DAS = Days after sowing

SWE did not affect the germination of wheat (Table-3). SWE applied at pre-emergence+25 DAS produced significantly more fertile tillers than control whereas effect of other treatments was non-significant with that of control. All the treatments of SWE promoted the plant height of wheat compared with control except the effect of SWE when applied at pre-emergence+25+35 DAS, which was at par with control. Similar trend was noticed in case of number of spikelets $spike^{-1}$. All the treatments except SWE at pre-emergence + 25 + 35 DAS produced more spikelets $spike^{-1}$ than control. Again the same recorded for number of grains per spike. Not any treatment of SWE has affected the 1000-grain weight of wheat. SWE treatments increased the wheat yield by 7.2 to 17.3% over control. SWE at pre-emergence+25 DAS gave the maximum grain yield of wheat (4.93 t ha^{-1}) compared with control, although this yield was non-significant with other SWE treatments. Difference among SWE application at pre-emergence+25+35 DAS and control was also non-significant. Again the similar trend was noted in case of wheat straw yield as was

observed in grain yield. SWE affected the plant density of *C.didymus*, *P. minor, A.fatua* and total weeds whereas the population of *C.album* and *C.arvensis* remained un-affected. Inhibitory effect was higher on *P. minor* density. These effects may be attributed due to the presence of allelopathic substances in the sunflower which were released into the water. These results are corroborated with the findings of Hall *et al*., (1982), Leather (1982; 1983) and Naseem *et al*. (2003). They found that sunflower reduced seed germination of some weeds.

SWE retarded the growth of *C.didymus*, *C.album. A.fatua, P. minor* and total weeds, while promoted the growth of *C.arvensis*. Growth of weeds decreased with increasing the SWE frequencies. Inhibitory or stimulatory effect of sunflower water extract appears to be the selective effect of sunflower allelochemicals which inhibited or promoted the growth of different weed species. Similar selective effects of allelochemicals have been reported by Cheema (1988), Khan and Vaishya (1992), Leather (1982, 1983) and Naseem (1997), who reported that allelochemicals have selective effect against weed germination and dry matter accumulation. Inhibitory effect increased with the increasing concentration of Phenolics (Cheema, 1988; Hall *et al*. 1982; Naseem, 1997).

SWE has no effect on germination of wheat, while promoted the number of fertile tillers, plant height, spikelets per spike, grains spike^{-1}, straw and grain yield of wheat, except in plots where SWE was applied thrice. These effects were probably due to the variation in concentration of allelopathins released from sunflower water extract. These findings are in line with the work of Cheema (1988), Kimber (1973) and Purvis *et al*. (1985), who reported the differential allelopathic effects. Allelopathic effect on plant growth depends on concentration of compounds (Einhelling *et al*., 1985; Rice, 1984; Wilson and Rice, 1968).

It may be extracted from the study that sunflower has allelopathic potential. It has selective effects on germination and growth of wheat and weeds. Inhibitory effect increased with increasing the concentrations of the allelochemicals. It has more suppressive effect on weeds than wheat and its potential could be exploited for weed management in wheat sown after sorghum crop.

Table-3. Effect of sunflower plant water extract (SWE) on yield and yield component of wheat.

Treatment	Germ. (m^{-2})	Tillers (m^{-2})	Plant height (cm)	Spike-lets $spike^{-1}$	Grains $spike^{-1}$	1000 grain wt. (g)	Straw yield (t ha^{-1})	Grain yield (t ha^{-1})	% increase over control
Pre-em.†	266.2	319.5	87.34	16.82	44.71	42.72	6.11	4.72	12.38
25 DAS‡	253.2	316.7	86.81	16.63	44.63	42.63	5.92	4.65	10.71
Pre-em. +25 DAS	261.7	324.0	89.66	17.12	45.65	43.03	6.27	4.93	17.38
25+35 DAS	249.5	322.2	88.79	16.94	45.49	42.94	6.22	4.86	15.71
Pre-em. +25 +35 DAS.	257.0	314.7	84.72	16.45	43.89	42.86	5.96	4.59	7.28
Control	252.5	309.5	79.94	15.89	42.18	42.83	5.54	4.20	-
$LSD_{0.05}$	NS	7.82	4.86	0.71	1.94	NS	0.47	0.44	-

† Pre-em. = Pre-emergence application ‡DAS = Days after sowing

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