Pak. J. Weed Sci. Res. 17(4): 417-424, 2011

EFFICACY AND ECONOMIC ANALYSIS OF PLANT AQUEOUS EXUDATES ON PHYSIOLOGICAL PARAMETERS OF WHEAT

Asghar Ali Khan[1], Inyat Ullah Awan[1], Muhammad Mansoor[2], Ejaz Ahmad Khan[1], Abdul Aziz Khakwani[1] and Mohammad Safdar Baloch[1]

ABSTRACT

A comparative study was designed to investigate various weed management strategies for wheat crop during 2005-06 at Agricultural Research Institute, Dera Ismail Khan. Water exudates of sorghum (Sorghum vulgare), brassica (Brassica napus), sunflower (Helianthus annuus) and rice (Oryza sativa) were used as a natural weed control approach, along with their combinations and herbicide application. Experiment comprised of twelve treatments, including control, water exudates of sorg[1]hum, sunflower, rice, brassica alone and their combinations. Buctril + Puma Super application was also included as treatment for comparison. Water exudates, their combinations and herbicides were applied 15, 25 and 45 days after sowing. All the treatments significantly affected number of tillers m^{-2}, number of grains $spike^{-1}$, spike weight (g), 1000 grain weight (g) and grain yield (t ha^{-1}). However plant height and biological yield remained non-significant in all treatments. In case of grain yield (5.70 t ha^{-1}) sunflower exudates application surpassed all treatments yet numerically lower and statistically at par values were recorded in Buctril + Puma super (5.55 t ha^{-1}) combination treatment. The increased grain yield in sunflower exudate application treatment was due to increased in spike weight (2.98 g) and 1000 grain weight (45.13 g). Relatively better performance in number of tillers and grains $spike^{-1}$ favored additionally concentrated sunflower exudates to out class all sole exudates, combination treatments and herbicide application. Maximum gypsum (1.26 t. $acre^{-1}$) requirement was recorded in untreated soil followed by brassica (1.22 t $acre^{-1}$) exudates treated samples. The minimum gypsum requirement of 0.344 t $acre^{-1}$ were reported in sorghum treated soil. The decrease in gypsum requirement in sorghum exudates treated sample may be due to the acidifying effect of this exudate which may have leached/washed down the sodium ions. Economic analysis of the treatments confirmed that use of exudates were more economical than herbicide application.

Key words: Wheat, allelopathic crop water exudates, Weed management.

---

[1]Department of Agronomy, Faculty of Agriculture, Gomal University, D.I. Khan
[2]Arid Zone Research Institute, PARC, Dera Ismail Khan.
Corresponding author: agrarian99@yahoo.com

INTRODUCTION

Allelopathy exists in nature since centuries, but it has drawn special attention over the last couple of decades. Recently, it is exploited as a weed control strategy, alternative to the synthetic chemical herbicide (Azania *et al.*, 2003; Jabran *et al.*, 2008). It is environmentally safe, can conserve the available resources and also may mitigate the problems raised by synthetic chemicals (Duke *et al.*, 2001). In this regard, sorghum crop (*Sorghum bicolor* L.) is one of the potential allelopathic crops (Jabran *et al.*, 2010a & b) containing a large number of secondary metabolites. Like sorghum, sunflower (*Helianthus annuus* L.) also has a strong allelopathic potential by which it can actively influence the growth of surrounding plants (Azania *et al.*, 2003). About 125 allelochemicals from different cultivars of sunflower, phytotoxic towards many weed species were isolated. (Macias *et al.*, 2002). This characteristic could be used in weed management strategies and allelopathic crops may help in the development of biological herbicides. On average weeds caused 20-30% losses in different crops in Pakistan. Losses due to weeds exceed beyond Rs. 120 billion on national level, whereas wheat alone accounts for more than 30 billion rupees. Losses due to weeds in major cereal crops of Pakistan exist in the range of Rs.40, 30 and 4 billion for rice, wheat and maize, respectively (Anonymous, 2005).

Increasing problems related to weed control, such as herbicide resistant weed biotypes and residual effects of herbicides, increase the demand for organic farming and increasing public concerns on environmental pollution issues require alternative farming systems which are less dependent on pesticide or based on naturally occurring compounds (Singh *et al.*, 2003; Waller, 2004; Jabran *et al.*, 2010a & b). Allelopathy, is being utilized in agriculture in various forms i.e. intercropping crops with allelopathic potential, allelopathic stubble mulches and an important approach is to use foliar sprays of different allelopathic crop water exudates for inhibiting weeds in field crops (Iqbal, 2003; Jabran *et al.*, 2008).

Reduction in weed biomass and increase in wheat yield was observed by the application of sorghum (*Sorghum bicolor* L.) water exudates (Cheema *et al.*, 2003). A large number of studies on allelopathy have been conducted in Pakistan; however, activities related with use of concentrated aqueous exudates for weed control in wheat are still not well documented internationally. Therefore, the aim of this study was to evaluate the effect of sorghum, sunflower, brassica and rice water exudates in comparison with full dose of some early post emergence herbicides for weed control in wheat crop.

MATERIALS AND METHODS

The experiment was laid out in randomized complete block design (RCBD) with four replications using a plot size of 8 m^2. Wheat variety "Uqaab 2000" was sown during the 1^{st} week of November 2005. Fertilizer applied to the crop was @ 120-90-60 Kg NPK ha^{-1}. Half of the nitrogen and full dose of the phosphorus were applied at the time of sowing, while remaining half was applied at first irrigation; applied 20 days after sowing (DAS) and the subsequent irrigations were adjusted according to the climatic conditions and need of crop.

The study comprised of water exudates of sorghum, sunflower, rice, brassica alone and combination of sorgaab + sunflower, sorgaab + brassica, sorgaab + rice, sunflower + brassica, sunflower + rice, brassica + rice with a dose of 12L ha^{-1}. Buctril + Puma super (500 ml ha^{-1} each) application was also included as treatment. Concentrated water exudates and herbicide doses were applied at 15, 25 & 45 DAS using knapsack hand sprayer fitted with T-jet nozzle. For comparison control, a weedy check was also maintained. For preparation of exudates sorghum, rice, sunflower and brassica plants stalks were harvested at maturity, dried and chaffed with fodder cutter into 2 cm pieces and were kept under cover to avoid possible leaching by rain water. Chaffed material was socked in distilled water (1 : 5 w/v) i.e. one kg plant material and five liter water for 72 hours and was filtrated to prepare normal plant water exudate. The prepared plant water exudates were then concentrated twenty times through boiling at 100 ^{0}C on a gas burner.

For recording the data on various physiological and yield contributing parameters of wheat ten plants were randomly selected from each plot. Plant height (cm), number of tillers m^{-2}, spike weight (g) and grains per spike were recorded. Three samples of 1000-grain each were taken randomly from the bulked seed of each plot, weighed and then averaged to measure 1000-grain weight (g). Grain yield were recorded on plot basis by mechanical threshing and converted into t ha^{-1}. Data obtained were analyzed statistically by using statistical package MSTATC (Freed and Scott, 1986). Analysis of variance (ANOVA) was performed by using Fisher's analysis of variance technique while multiple comparisons among treatment means were made using least significant difference (LSD) test at $P \leq 0.05$ (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

All plant water exudates alone and their combinations significantly affected all parameters under study except plant height and biological yield (Table-1). The maximum number of tillers m^{-2} (277.3) and number of grains $spike^{-1}$ (56.25) were recorded in sunflower exudate applied treatment and statistically at par but numerically lower values were recorded in the plots where Buctril + Puma super were applied at 500 ml of each herbicide. Sunflower exudate application surpassed all treatments in grain yield (5.70 t ha^{-1}) yet numerically lower and statistically at par values were recorded in Buctril + Puma super (5.55 t ha^{-1}) combination treatment. The increased grain yield in sunflower exudate application treatment was due to increased spike weight (2.98 g) and 1000 grain weight (45.13 g). Better performance in number of tillers and grains $spike^{-1}$ favored the concentrated sunflower exudate to out class all treatments. The reason for increase in grain yield over control was the control of weeds. Moreover, the allelopathic effects of crop water exudate promoted the wheat growth which ultimately increases grain yield (Jabran *et al.*, 2008).

The increase in grain yield in concentrated sunflower exudate (5.70 t ha^{-1}) applied plots over control was approximately 30%. Azania *et al*. (2003) also reported similar results while exploring allelopathy for natural weed management. Better yield contributing parameters may be due to the harmonic effect of exudate, Ilhan *et al.* (2005) also reported that higher concentration of allelochemicals act as herbicide, showing thereby inhibitory effects. While lower concentration of exudates has stimulatory effect. In our experiment exudates applied directly to inter row spacing mainly focusing weeds was in higher concentration thereby showing inhibitory effect. When it leached down its concentration decreased in root zone of wheat crop and it showed stimulatory effects in lower concentration. The combination of sorghaab + sunflower @ 12 L ha^{-1} was found to be the next treatment which produced grain yield (5.25 t ha^{-1}). Cheema *et al*. (2002) depicted same results during a study on efficacy of sorgaab for weed control in wheat grown at different fertility levels. Moreover, the grain yield in all allelopathic water exudates was higher as compared to control (Table-1).

Soil analysis is presented in Table-2, which showed that soil is alkaline and calcareous in nature. Soil analysis showed that salinity is in safe limit while increased sodacity has been noticed. Soil is deficient in organic matter as well as N. The pH of five samples varied from 8.1 to 8.3 being lower in sorghum exudates applied soil while higher in brassica exudate treated soil samples. Soil analysis further depicted that the untreated soil showed maximum gypsum requirement (1.26 t. $acre^{-1}$) followed by brassica (1.22 t ac^{-1}) exudate treated soil. Minimum gypsum requirement of 0.344 t ac^{-1} was recorded in sorghum treated soil. The decrease in gypsum requirement in sorghum exudate treated sample may be due to the acidifying effect of this exudate which has leached/washed down the sodium ions.

Table-1. Effect of different plant water exudates on some physiological parameters of wheat.

Treatments	Plant height cm	No. of tillers m^2	No. of grain $spike^{-1}$	Biological yield t ha^{-1}	Spike wt (g)	1000 grain wt (g)	Grain yield t ha^{-1}
Control	106.5	223.8e	47.25b	12.78	2.23 d	38.35g	4.00g
Sorgaab alone	105.3	258.5bc	46.75b	14.40	2.45 bcd	44.00a-d	5.25ab
Sunflower alone	106.8	277.3a	56.25a	16.72	2.98 a	45.13a	5.70a
Rice alone	106.5	247.8cd	49.00b	16.00	2.38 bcd	44.72ab	4.42fg
Brassica alone	106.0	255.0bcd	45.50bc	16.07	2.33 cd	39.83g	4.47ef
Sorgaab + Sunflower	106.0	273.0a	49.25b	14.17	2.65 abc	44.35abc	5.25ab
Sorgaab + Brassica	106.3	247.5d	46.25bc	14.73	2.63 bc	42.25def	4.57ef
Sorgaab + Rice	106.0	262.2b	42.75c	15.78	2.63bc	41.93f	5.07bcd
Sunflower + Brassica	106.3	253.5bcd	46.00bc	15.13	2.35 cd	42.00ef	4.90b-e
Sunflower + Rice	106.0	251.8bcd	46.25bc	16.60	2.45 bcd	43.13b-f	4.82c-f
Brassica + Rice	106.5	247.8cd	46.00bc	13.32	2.60 bc	42.60c-efif	4.75c-f
Buctril + Puma super	106.0	274.5a	53.75a	16.33	2.70 ab	43.88 a-e	5.55a
LSD 0.05	NS	10.78	3.76	NS	0.334	1.95	0.454

Table-2. Results of soil analysis after water exudates application.

Sample	pH	Ec (ds/m)	Ca + Mg	CO_3	HCO_3	Cl	O.M. %	N %	Gypsum required t $acre^{-1}$
			Meq/L						
Before spray	8.2	0.675	9.9	Nil	2.50	2.42	0.82	0.041	1.26
Sorghum exudate	8.1	0.660	7.5	Nil	2.11	2.11	0.84	0.042	0.344
Sunflower exudate	8.2	0.625	7.1	Nil	2.35	2.35	0.78	0.039	0.688
Brassica exudate	8.3	0.780	10.5	Nil	3.12	3.12	0.79	0.040	1.22
Rice Exudates	8.2	0.63	7.5	Nil	2.21	2.15	0.86	0.039	0.69

Table-3. Benefit cost ratio (BCR) of different treatments.

Treatment	Grain yield (t ha^{-1})	Total variable cost Rs. ha^{-1}	Gross Income Rs. ha^{-1}	Total Cost Rs. ha^{-1}	Net income Rs. ha^{-1}	BCR
Control	3.63	-	74415	28352	46063	1.62
Sorgaab alone	4.25	335	87125	28707	58773	2.05
Sunflower alone	7.05	335	144525	28707	116173	4.05
Rice alone	5.66	335	116030	28707	87678	3.05
Brassica alone	6.1	335	125050	28707	96698	3.37
Sorgaab + Sunflower	4.86	335	99630	28707	71278	2.48
Sorgaab + Brassica	4.3	335	88150	28707	59798	2.08
Sorgaab + Rice	5.28	335	108240	28707	79888	2.78
Sunflower + Brassica	6.28	335	128740	28707	100388	3.50
Sunflower + Rice	6.38	335	130790	28707	102438	3.57
Brassica + Rice	4.1	335	84050	28707	55698	1.94
Buctril + Puma super	6.68	1520	136940	29872	108588	3.64

Buctril super 750 ml ha^{-1} @ Rs. 750/bottle of 600 ml (Rs. 870); Puma super 625 ml ha^{-1} @ Rs. 480/bottle of 500 ml (Rs. 650)
Price of 125 kg seed ha^{-1} @ Rs. 25 kg^{-1}; Income (straw) = Rs. 2000 app. ha^{-1}

No significant differences in organic mater and nitrogen contents were noted in treated samples. The economic analysis of the treatments confirms that use of exudates was more economical than herbicides application as shown by Benefit Cost Ratio in Table-3.

CONCLUSION

The study suggests that at par results among concentrated water exudate of sunflower and herbicide application can reduce reliance on the synthetic herbicides and will decrease the cost of production and increase the farm income.

REFERENCES CITED

Anonymous. 2005. Weed Science Society of Pakistan. www.wssp.org.pk.

Azania, A.A.P.M., C.A.M. Azania, P.L.C.A. Alives, R. Palaniraj, H.S. Kadian, Bhowmik, P.C. and Inderjit, M. 2003. Challenges and opportunities in implementing allelopathy for natural weed management. Crop Prot. 22: 661-671.

Cheema, Z.A., A. Khaliq and K. Ali. 2002. Efficacy of sorgaab for weed control in wheat grown at different fertility levals. Pak. J. Weed Sci.Res. 8 (1-2): 33-39.

Cheema, Z.A., J. Iqbal and A. Khaliq. 2003. Reducing isoprotron dose in combination with sorgab for weed control in wheat. Pak. J. Weed Sci. Res. 9: 153-160.

Duke, S.O., B.E. Scheffler and F.E. Dayan. 2001. Allelochemicals as herbicides. 1st Allelopathy Symp., Vigo, Spain.

Freed, R.D. and D.E. Scott. 1986. MSTATC. Crop and Soil Sci. Deptt., Michigan State University Michigan, USA.

Ilhan U., M. Arslan and A. Uludag. 2005. Allelopathic effects of some *Brassica* species on germination and growth of cut leaf ground-cherry (*Physalis angulata* L.). J. Biol. Sci., 5: 661-665.

Inderjit, M., Olofsdotter and J.C. Streibig. 2001. Wheat (*Triticum aestivum*) interference with seedling growth of perennial ryegrass (*Lolium perenne*): influence of density and age. Weed Technol. 15: 807–812.

Iqbal, M. 2003. Response of recent wheat varieties and some rabi weeds to the allelopathic effects of sorghum water exudate. M Sc. Thesis, Agron. Dept. Univ. Agric., Faisalabad.

Jabran, K., M. Farooq, M. Hussain, H. Rehman and M.A. Ali. 2010a. Wild oat (*Avena fatua* L.) and canary grass (*Phalaris minor* Ritz.) management through allelopathy. J. Plant Prot. Res. 50: 41-44.

Jabran, K., Z.A. Cheema, M. Farooq and M. Hussain. 2010b. Lower doses of pendimethalin mixed with allelopathic crop water exudates for weed management in canola (*Brassica napus*). Int. J. Agric. Biol. 12: 335–340.

Jabran, K., Z.A. Cheema, M. Farooq, S.M.A. Basra, M. Hussain and H. Rehman. 2008. Tank mixing of allelopathic crop water exudates with pendimethalin helps in the management of weeds in canola (*Brassica napus*) field. Int. J. Agric. Biol. 10: 293-296.

Macias, F.A., R.M Varela, A. Torres, J.L.G. Galindo and J.M.G. Molinillo. 2002. Allelochemicals from sunflowers: chemistry, bioactivity and applications. Allelopathy in Aquatic and Terrestial Ecosystems. Birkhäuser Verlag, Basel-Boston-Berlin, pp. 73-87.

Singh, H.P., D.R. Batish and R.K. Kohli. 2003. Allelopathic interactions and allelochemicals: New possibilities for sustainable weed management. Crit. Rev. Plant Sci. 22: 239-311.

Steel, R.G.D., J.H. Torrie and D. Dickey. 1997. Principles and Procedures of Statistics: A Biometrical Approach (3rd ed.). McGraw Hill Book Co. Inc. New York, pp. 172-177.

Waller, G. R. 2004. Introduction-reality and future of allelopathy. In F.A. Macias, J.C.G. Galindo, H.M.G. Molinilla and H.G. Cutler (eds.) Allelopathy: Chemistry and Mode of Action of Allelochemicals. pp. 1-12.