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USE OF CONCENTRATED AQUEOUS PLANT EXUDATES AS WEED CONTROL MEASURE IN WHEAT CROP

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ABSTRACT

A field trial was conducted at Agricultural Research Institute, Dera Ismail Khan, Pakistan during 2005-06 to investigate the efficacy of various weed management strategies for wheat crop. In this regard, the wheat variety "Uqaab 2000" was used in a randomized complete block design. The study comprised of 12 treatments viz., water exudates of sorghum, sunflower, rice, brassica alone, combination of sorgaab + sunflower, sorgaab + brassica, sorgaab + rice, sunflower + brassica, sunflower + rice, brassica + rice @ 12 L ha^{-1}, Buctril-M + Puma super 75 EW (500 ml ha^{-1} each) and control. Water exudates, their combinations and herbicides were applied (15, 25 and 45 days after sowing). All the treatments significantly affected weed density, fresh and dry weed biomass. Lowest weed density was noticed at all stages of the crop in Buctril ® M + Puma super 75 EW treated plots which remained statistically at par with sunflower as sole application and combination of sorgaab + sunflower. However, maximum weed density, fresh and dry weed biomass were recorded in control plots followed by combination of exudates brassica + rice, which indicated the harmonic effect of allelochemicals found in these two crops. The effect of allelochemicals found in sunflower can be utilized as bio-herbicide. Benefit cost ratio confirmed that the use of exudates was more economical than herbicide application.

Key words: Allelopathy, water exudates, weed management, wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the basic component of human diet. It is the most widely grown cereal grain crop in the world, except in the rice-eating regions of Asia. It is main staple food of the people of Pakistan and backbone of the country's economy. In Pakistan, it ranks first among the cereal crops and occupies about 66% of the

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annual food cropped area (Anonymous, 2010). A decrease in wheat production severely affects the economy of Pakistan and adds into the miseries of the inhabitants. A better progress has been made in increasing per hectare yield of wheat in the country during the last few years. The bumper wheat harvests of 2009-2010 have changed the nation's status from wheat importing to exporting country. But, still Pakistan harvests lower yield per unit area as compared to advanced wheat growing countries. Besides other factors, lack of proper weed management is the most important one. Weeds stress the cultivated crop through interference and by providing habitat for other harmful organisms. They compete with crops for space, soil nutrients, moisture, solar radiation, and carbon dioxide. Weeds not only reduce the crop yield but also deteriorate the quality.

Annual losses to wheat crop due to weed infestation are reported to be in billions, these enormous losses warrant an efficient control of weeds for lucrative economic returns. Therefore, weed management is a dire need for obtaining good crop and high economic returns. Now weed management technology has entered a scientific phase and even though chemical weed control is important, however, now integrated weed management is emphasized and desired. The use of chemicals is usually easy, time saving, highly effective but un-economical approach to weed control. However, it is environmentally less safe as mechanical, cultural and biological methods of weed control (Iqbal, 2007).

Integrated weed management package is recommended for sustainable production and safe environment. It has been observed that a combination of lower dose of synthetic herbicide and allelo-chemical was more effective in controlling weeds than their isolated applications (Cheema *et al*., 2003). While, Inderjit *et al.* (2001) observed that chemical weed control method is very effective along with cultural weed control. Dayan (2006) while studying sorgoleone (allelo-chemical found in Sorghum), reported that its efficacy against weeds proved its use as naturally safe herbicide. Enough work on integrated weed management has not published hence the present study was initiated to determine the integrated impact of weed management on the wheat crop production with the objectives to investigate the efficacy of concentrated plant water exudate with relatively lower dose of herbicide in weed suppression, and to find out more effective, economical, culturally acceptable and eco-friendly weed management strategy for wheat crop.

MATERIALS AND METHODS

The experiment was laid out in a randomized complete block (RCB) design with four replications using a plot size of 8 m^2. The wheat variety "Uqaab 2000" was sown and fertilizer was applied @ 120-90-

60 kg ha^{-1} NPK. Half of the nitrogen and full dose of the phosphorus and potash were applied at the time of sowing, while remaining half nitrogenous fertilizer was applied at first irrigation. The study comprised of 12 treatments include water exudates of sorghum, sunflower, rice, brassica alone, combination of sorgaab + sunflower, sorgaab + brassica, sorgaab + rice, sunflower + brassica, sunflower + rice, brassica + rice @ 12 L ha^{-1}, Buctril-M + Puma super 75 EW (500 ml ha^{-1} each) and control. Concentrated water exudates and herbicide doses were applied at 15, 25 & 45 days after sowing (DAS) using knapsack hand sprayer fitted with T-jet nozzle. For comparison, the control as 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 soaked 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 concentrated twenty times through boiling at 100 ^{0}C on a gas burner.

Data on weed density was recorded four times from randomly selected area at 20, 40, 60 and 80 days after sowing (DAS). While fresh and dry weed biomasses were recorded by taking two samples at harvest from randomly selected area at 20, 40, 60 and 80 DAS. Weeds were cleaned and their fresh weight was recorded and then allowed to dry under shade for ten days and later oven dried at 80 °C till a constant weight was achieved.

Data were analyzed by using MSTATC. Analysis of variance (ANOVA) was performed by using Fisher's analysis (Fisher, 1954) of variance technique while mean comparisons were made using least significant difference (LSD) test (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

All the combination of water exudates and their various combinations significantly affected all the weed parameters under the study (Table-1).

Weed density (m^{-2})

Lowest population of weeds, during 20, 40, 60 and 80 DAS, and also least values for fresh and dry biomass was noticed in Buctril + Puma super treated plots and it was at par with combination of sorgaab + sunflower followed by sunflower exudate applied plots. Similar results were reported by Cheema *et al*. (2002). However, maximum weed density was recorded in control. Higher weed density in brassica + rice concentrated exudate applied plots may be due to stimulatory effect on crop and weeds.

Table-1. Effect of various plant water exudates on weeds associated with wheat crop.

Treatments	20 days after sowing			40 days after sowing			60 days after sowing			80 days after sowing		
	WD	FW	DW	WD	FW	DW	WD	FW	DW	WD	FW	DW
Control	14.18 a	19.77 a	12.68 a	19.88 a	27.73 a	15.15 a	23.45 a	34.10 a	19.65 a	30.35 a	41.40 a	23.85 a
Sorgaab alone	11.73 b	17.43 b	11.00 b	17.17 b	25.10 b	14.28 a	20.88 b	28.17 b	18.52 b	27.77 b	35.47 b	22.73 b
Sunflower alone	5.025 hij	7.38 gh	9.68 c	15.65 c	18.85 g	8.38 fgh	14.43 hi	21.73 fg	12.52 h	21.33 hi	29.02 fg	16.73 hi
Rice alone	9.125 cd	13.45 c	8.40 d	14.73 cd	23.13 c	11.93 c	18.45 cd	26.08 d	16.38 cd	25.35 cd	33.38 d	20.58 c
Brassica alone	8.050 de	12.30 cd	7.43 e	13.73 de	21.25 d	11.13 cd	17.45 de	26.27 cd	15.38 de	24.35 de	33.35 cd	19.57 d
Sorgaab + Sunflower	4.475 ij	6.60 hi	4.75 ij	12.90 ef	18.38 g	7.68 gh	13.67 i	22.02 efg	11.98 hi	20.58 I	29.33 efg	16.17 ij
Sorgaab + Brassica	6.650 fg	10.48 ef	6.53 f	12.35 fg	20.52 def	9.93 e	16.05 fg	23.35 e	15.18 e	22.95 fg	30.65 e	18.63 ef
Sorgaab + Rice	6.075 fgh	9.73 f	5.58 gh	11.32 fgh	19.50 efg	9.28 ef	15.38 fgh	22.67 ef	13.77 fg	22.27 fgh	29.98 ef	17.98 fg
Sunflower + Brassica	5.500 ghf	8.28 g	5.13 hi	11.20 gh	22.98 c	8.75 fg	14.90 gh	22.50 ef	13.05 gh	21.80 gh	29.80 ef	17.25 gh
Sunflower + Rice	9.950 c	17.15 b	6.28 fg	10.73 hi	19.13 fg	13.10 b	19.27 c	27.77 bc	17.22 c	26.17 c	35.08 bc	21.42 c
Brassica + Rice	7.227 ef	11.15 de	4.13 jk	9.97 i	20.83 d	10.30 de	16.50 ef	25.45 d	14.80 ef	23.40 ef	32.78 d	19.00 de
Buctril + Puma super	4.050 j	5.33 i	3.55 k	9.75 i	18.15 g	7.38 h	13.45 i	20.80 g	11.40 i	20.35 i	28.10 g	15.60 j
LSD 0.05	1.276	1.293	0.742	1.222	1.517	1.060	1.166	1.567	1.112	1.166	1.571	0.937

WD = Weed density, FW = Fresh weight, DW = Dry weight

Table-2. Benefit cost ratio of various weed management measures in wheat.

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	3.5
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

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

However in case of sorgaab + sunflower and sunflower alone, inhibitory effect on weeds and at the same time stimulatory effect on wheat crop was noted. It seems that due to lower amounts of allelochemicals leached down in soil profile (root zone of wheat crop) showed harmonic effect, as reported by Weston (1996) that higher amount allelochemicals showed inhibitory effect, while lower concentration showed stimulatory effect. Azania *et al*. (2003) and Jabran *et al.* (2008) also reported similar results while exploring allelopathy for natural weed management. Our results are also supported by the findings of Cheema *et al*. (2003), they reported that combination of different allelochemicals gives better results than their sole application.

Fresh weed biomass (g m^{-2})

Major broad leaved weeds in the field were *Convolvulus arvensis* (field bind weed), *Chenopodium album* (Common lambsquarters), *Medicago denticulata* (common medic), *Melilotus indica* (Indian sweet clover), *Rumex dentatus* (Prickly dock) and canary grass were dominant in the experimental area. Data on the fresh weed biomass depicted that it was significantly affected by all weed management strategies under study, however, the combination having Buctril + Puma super out classed all treatments in reduction of fresh weed biomass during all stages i.e. 20, 40, 60 and 80 days after sowing. It is also obvious from data table that fresh biomass of weeds increased with the increase in age of the crop. Second best combination regarding reduced fresh biomass was Sorgaab + sunflower followed by sunflower exudate alone application @ 12 L ha^{-1}. Highest fresh weed biomass was recorded in control treatment where none of the weed management practice was applied. These results are in line with findings of Cheema *et al*. (2003), Cheema *et al*. (2002) and Singh *et al.* (2003). They reported reduced weed biomass with application of water extracts of sorghum and sunflower. Moreover, Duke *et al.* (2001) floated the idea of higher concentration of extract acts as herbicide disturbing the plant processes like nutrients uptake, membrane permeability and photosynthesis. Rice (1984) also reported that natural compounds (allelochemicals) from plants offer excellent potential for new herbicidal solutions, or lead compounds for new herbicides.

Dry weed biomass (g m^{-2})

Dry weed biomass was also significantly influenced by different combinations of allelopathic crop water extracts and herbicide combination. Lowest dry weed biomass was recorded in Buctril + Puma super and Sorghum + sunflower each @ 12 L ha^{-1} gave the maximum reduction in dry weed biomass, and remained statistically at par followed by sunflower exudate's alone application. Results are supported by Jabran *et al.* (2010a) that sorghum water extract can be used for effective weed control. These results also support the hypothesis that allelopathic water extracts can be used to inhibit weeds or in combination with lower herbicide rate, thereby can considerably decrease their dose by 70 % (Jabran *et al.,* (2010b). Moreover, the concept of having additive or complementarily effects of allelopathic materials in mixture was noted as compared to their separate use. Macias *et al*. (2002) reported that herbicide dose can be reduced in combination with allelopathic crop water extracts. Growth inhibition due to allelochemicals is also reported by Hejli and Koster (2004), they reported sorgoleone (an allelo-chemical in sorghum) as phyto-toxic to several plant species. They also suggested impairment of essential plant processes, e.g. solute and water uptake, driven by proton pumping across the root cell plasmalemma should also be considered as a mechanism contributing to observed plant growth inhibition by sorgoleone. While explaining the growth inhibition, they further reported that disruption of electron transport functions in isolated mitochondria and chloroplasts as one of the reason for growth inhibition.

Benefit cost ratio analysis of the treatments showed that use of exudates proved more economical than herbicidal application. Results revealed that at par rating among concentrated water exudate of sunflower and buctril + puma super application can be a possible replacement for synthetic herbicides which will also decrease the cost of production.

CONCLUSION

It can be concluded from the findings that relatively better control of weeds through plant water exudates of sunflower can help in formulation of bio-herbicide which would prove to be more economical, eco-friendly, culturally acceptable and effective weed management strategy.

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