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WEED MANAGEMENT IN SUNFLOWER WITH ALLELOPATHIC WATER EXTRACT AND REDUCED DOSES OF A HERBICIDE

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ABSTRACT

Field studies were undertaken at the Agronomic Research Area, Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan, during 2006-07, to investigate the effectiveness of allello-chemicals of sorghum and sunflower water extracts. The experiment was laid out in Randomized Complete Block Design with four replications. The approved sunflower variety 'Pioneer 64 – A93, in plot size of 4×2.8 m^2 was planted on 10th March 2007. The experiment comprised of six treatments and a weedy check (control). The treatments were Sorgaab (sorghum water extract)+ Sunflower water extract each at 18 L ha^{-1} (early Post-emergence), Sorgaab+ Sunflower water extract each at 15 L ha^{-1} (early pre-emergence), pendimethalin at 825 ml ha^{-1} full dose (pre-emergence), pendimethalin @ 413g ha^{-1} half dose (pre-emergence), Sorgaab + Sunflower water extract each at 18 L ha^{-1} + pendimethalin @ 413ml ha^{-1} (half dose) (pre-emergence) and Sorgaab + Sunflower water extract each at 15 L ha^{-1} + pendimethalin @ 13 ml ha^{-1} (half dose) as pre-emergence. Data were recorded on weed density, fresh and dry weed biomass, number of plants m^{-2}, achene yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%). The lowest weed density AND consequently the highest biological yield (7443 kg ha^{-1}) was observed in plots receiving full dose of pendimethalin @ 825 g ha^{-1}. It was followed by plot using full dose of Sorgaab + sunflower + pendimethalin, where the biological yield was 7235 kg ha^{-1}. Minimum yield (6025 kg ha^{-1}) was recorded in the weedy check plots. Sorghum and sunflower water extracts are very useful in allelopathic control of weeds in different crops. This weed control strategy is environment friendly and also reduces the cost of production.

Key words: Weed, Allelopathic crop, pendimethalin. Sunflower, herbicide.

INTRODUCTION

Pakistan has made a tremendous progress in cereal production particularly during the last few years; however, the country is facing chronic shortage of edible oil. At present total consumption of edible oil is 2.0 millions tons and local production is only 0.582 million tons, which meets 29% of the domestic requirements, while remaining 71% is met through import of edible oil. Being an important food item on

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the import list, huge foreign exchange in spent on the import of edible oil (Anonymous, 2007).

Edible oil in the country comes from conventional and non-conventional oilseed crops. Sunflower (*Helianthus annuus*) is one of the most important oilseed crops of the world due to its wide range of adaptability and very high protein contents. However, due to low yield of sunflower in the country, the edible oil demand could not be fufilled. Among the many reasons of low yield, improper weed management is one of the major reasons. Weeds can be controlled manually, mechanically and chemically. However, the control of weeds by manual labour and other mechanical method is laborious, time consuming and expensive. Chemical weed control method has been found cheaper, more effective and time saving.

Allelopathy is one of the potential areas of research to control weeds. It has been shown that allelopathy can be used for pest, weeds, insects, nematodes and pathogens management. Allelopathic crops when used as cover crops, mulch, smother crops, green manures, or grown in rotational sequences are helpful in reducing noxious weeds and plant pathogens, improve soil quality and crop yield.

Sorgaab water extract alone and in combination with herbicides S-metolachlor and pendimethalin for controlling weeds to mungbean was investigated in a study (Khaliq *et al.*, 2002). It was observed that S-metolachlor @ 1.15 kg ha^{-1}+ sorgaab (conc.) @ 10 L ha^{-1} and pendimethalin @ 825 ml ha^{-1} + sorgaab (conc.) @ 10 L ha^{-1} reduced dry weed biomass by 78% and 75%, respectively. Cheema *et al.* (2003a) showed that sorgaab @ 6 L ha^{-1} or 12 L ha^{-1} combined with fenoxaprop –p-ethyl @375 ml ha^{-1} reduced dry weed biomass by 87%. 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.

The present study was designed with the following objectives:

- To conduct the systematic study to control weeds by allelochemicals.
- To research the possibilities of reducing herbicides with Sorghum and sunflower water extract.
- To investigate the efficacy of sorghum and sunflower water extracts.
- To study the increase in sunflower yield with allelochemicals.

MATERIALS AND METHODS

A field study to investigate the efficacy of concentrated Sargaab (Sorghum water extracts) in combination with other allelopathic water extracts as sunflower and with reduced doses of pendimethalin (Stomp 330E) pre-emergence for weed control in sunflower crop was carried out at the Agronomic Research Area, Faculty of Agriculture, Gomal University Dera Ismail Khan, Pakistan, during the year 2007 to determine the weed management in sunflower with allelopathic water extracts and reduced dose of herbicides. The experiment was laid out according to Randomized Complete Block Design (RCBD) with seven treatments (Table-1) and four replications using a net plot size of 4 × 2.8 m^2. The approved sunflower variety 'Pioneer 64-A93' was planted on 10th March, 2007 on a well prepared seed bed in furrows, 70cm apart. The water extract was prepared as suggested in procedure explained by Cheema *et al*., (2002). Allelopathic crop was harvested at maturity, dried for few days under shade and then chopped into 2cm pieces. This chopped material was soaked in water in a ratio of 1:10 (w/v) for 24 hours and water extract was collected by passing through sieves. The filtrates were boiled at 100°C for reducing the volume by 20 times. The concentrated crop water extract was stored at room temperature.

Table-1. Detail of treatments used in the experiment.

Treatment	Extract/Herbicide dose
T1	Control (Weedy check)
T2	Sorgaab + Sunflower water extract each at 18 L ha^{-1} (early Post-emergence)
T3	Sorgaab+ Sunflower water extract each at 15 L ha^{-1} (pre-emergence)
T4	Pendimethalin @ 825 ml ha^{-1} full dose (pre-emergence)
T5	Pendimethalin @ 413 ml ha^{-1} half dose (pre-emergence).
T6	Sorgaab + Sunflower water extract each at 18 L ha^{-1} + pendimethalin @ 413ml ha^{-1} (half dose) (pre-emergence).
T7	Sorgaab + Sunflower water extract each at 15 L ha^{-1} + pendimethalin @ 413 ml ha^{-1} (half dose) (pre-emergence).

Nitrogen and Phosphate were applied at the rate of 100 kg N ha^{-1} and 75 kg P_2O_5 ha^{-1} in the form of urea and Di-ammonium Phosphate, respectively. All the phosphate fertilizer was applied at the

time of sowing, while nitrogen fertilizer was applied in two split applications; half at the time of sowing and the remaining half at the time of first irrigation.

The data were recorded on weed density m-2,at 50, 70 and 105 DAS (Days after sowing), Fresh and dry weed biomass (g m^{-2}) 70 and 105 DAS, No. of plants at harvest (m-2),biological and achene yield (kg ha^{-1}) and harvest index %.

Statistical Analysis:

Data collected for each parameter were individually subjected to Fisher's analysis of variance technique and least significant difference (LSD) test at 5% probability level was employed to compare the differences among treatments means by using MSTATC software package.

RESULTS AND DISCUSSION

Weed density (m^{-2})

The experimental site was infested with *Chenopodium album* and *Melitotus indica* but a few plants of *Amaranthus viridis, Coronopus didymus, Rumex dentatus* and *Solanum nigrum*. Weed population was significantly suppressed in all the treatments as compared to control (weedy check). At 50 DAS, the lowest Number of weeds m^{-2} were recorded in T4 (8), the treatment receiving full dose of pendiethalin. It was followed by T7 (12.75) and T6 (14) [Table-2]. T6 was in turn statistically comparable with T5. The Treatment T2 where sorgaab + sunflower extracts were applied at 18 L ha-1 each was successful to reduce the weed population adequately. In terms of percentage as compared to the weed check full dose of pendimethalin (825ml ha^{-1}) gave the best control of weeds (86%), T7, T6 and T5 controlled weeds by 68, 65 and 62%, respectively (Table-2). Treatments T2 and T3 suppressed the weed density by 53 and 43%, respectively. Weed control in T4 at 70 DAS was 87% while 105 DAS still it was 81%, however, statistically more effective than all other treatments. Weed control in all the allelopathic water extracts and lower pendimethalin dose combinations at 70 DAS was 46-67%; although these percentages are less than T4, yet these were significantly higher than weedy check. The treatments combinations were T5, T6, T7, T2 and T3 in which weed suppression/reduction was 67, 66, 65, 51 and 46% respectively. The first three combinations were statistically at par with each other and the later two combinations were statistically at par with each other (Table-2).

At 105 DAS the treatment combination of T7, T5, T6, T2 and T3 controlled weeds by 73, 67, 46 and 36% respectively. However, in these combinations, treatment T5 and T6 was statistically at par with each other.

These results are contradictory to the findings of Cheem et al., (2003b) who suggested that Sorgaab with ½ dose of pendimethalin gave weed control equal to full dose of pendimethalin.

Table-2. Effect of allelopathic crop water extract with reduced doses of pendimethalin on weed density in sunflower.

Treatment			Density (m^{-2})			
S.No.	**Extract / Herbicide**	**Rate**	**50 DAS**	**70 DA**	**105DAS**	**Mean %**
T1	Control (weedy check)	-	39.75a	80.00a	21.50a	
T2	Sorgaab + Sunflower (early post emergence)	18 L ha^{-1}each	18.75c	14.75b	11.50c	56
T3	Sorgaab + Sunflower(early post emergence)	15 L ha^{-1}each	22.50b	16.25b	13.75b	42
T4	Pendimethalin (pre-emergence)	825 ml ha^{-1} full dose	8.00f	4.00d	4.00f	83
T5	Pendimethalin (as pre-emergence)	413 ml ha^{-1} (half dose)	15.00d	10.00c	7.00d	65
T6	Sorgaab + Sunflower + pendimethlain	18 L ha^{-1} each + 413 ml ha^{-1}	14.00de	10.25c	7.25d	72
T7	Sorgaab + Sunflower + pendimethlain	15 L ha^{-1} each + 413 ml ha^{-1}	12.75e	10.75c	5.75d	69
	LSD0.05		1.486	1.751	0.76	

DAS = Days after sowing; sorgaab; sorghum water extract
Sunflower W.E: Sunflower water extract
Any two means not sharing a letter in common differ significantly by LSD Test at 5% level of probability.

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

Data on weed biomass (Table-3) recorded 70 and 105 DAS showed that the fresh weights of weeds were reduced in all the treatments over control. Maximum suppression (90%) was observed in treatment T4 with full dose of pendimethalin at the rate of 825 ml ha^{-1}. It was followed by treatments T6, T5 and T7 in which the suppression in weight of weeds amounted to 59 each and 58%, respectively. These combinations were statistically at par with one another 70 DAS. In T4, fresh weeds biomass was reduced by 87% at 105 DAS. This treatment was more effective than other treatment combinations. Weed control in other treatment combinations of allelopathic water extract and lower doses of pendimethalin at 105 DAS was between 48-83% but significantly higher than the weedy check (Table-3).

As regards mean performance, pendimethalin at label dose was best with 88% weed control. The treatment combinations (T5, T6 and T7) half dose of pendimethalin (413 ml ha^{-1}) applied as pre-emergence, Sorgaab+sunflower each at 18 L ha^{-1} combined with ½ dose of pendimethalin and sorgaab + sunflower each at 15 L ha-1 combined with ½ dose of pendimethalin were better than other treatment combinations with 70-71% weed control. These results are also contradictory to the findings of Cheema *et al.*, (2003c) who suggested that sorgaab with ½ dose of pendimethalin gave weed control equal to label dose of pendimethalin.

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

The dry weed biomass was significantly reduced in all the treatments over the weedy check (Table-4). Date pertaining to dry biomass recorded at 70 and 105 DAS, show that maximum suppression in dry biomass (86%) was observed in (T4), where full dose of pendimethalin @ 825 ml ha-1 applied as pre-emergence. This treatment was followed by T5, T7, T6, T2 and T3 in which weeds were reduced by 68, 67, 66, 54 and 44%, respectively. The first three treatment combinations were statistically similar to one another 70 DAS. At 105 DAS, dry biomass in T4 (full dose of pendimethalin) was 84% lesser as compared to the weedy check. It was followed by other treatment combination including T6, T7, T5, T2 and T3, in which weed reduction was 79, 78, 78, 58 and 56%, respectively. The first three combinations were statistically at par with one another and the later two combinations were statistically at part with each other (Table-4). On an average pendimethalin label dose gave 85% control. The treatment combination of T5, T6 and T7 were better than the remaining combinations with 72-73% weed control.

These results are also contradictory to the findings of Cheema *et al.* (2003b,c,d) who suggested that sorgaab with ½ dose of pendimethalin gave weed control equal to the label dose of pendimethalin.

Table-3. Effect of allelopathic crop water extract with reduced doses of pendimethalin on weed fresh weight (g m^{-2}) in sunflower.

Treatment			Fresh Weight (m^{-2})		
S.No	**Extract / Herbicide**	**Rate**	**70 DAS**	**105DAS**	**Mean %**
T1	Control (weedy check)	-	14.750a	11.500a	
T2	Sorgaab + Sunflower (early post emergence)	18 L ha^{-1} each	8.300c	5.950c	46
T3	Sorgaab + Sunflower(early post emergence)	15 L ha^{-1} each	9.500b	6.925b	38
T4	Pendimethalin (pre-emergence)	825 ml ha^{-1} full dose	1.525e	1.475f	88
T5	Pendimethalin (as pre-emergence)	413 ml ha^{-1} (half dose)	6.050d	2.200d	70
T6	Sorgaab + Sunflower + pendimethlain	18 L ha^{-1} each + 413 ml ha^{-1}	6.075d	1.975e	71
T7	Sorgaab + Sunflower + pendimethlain	15 L ha^{-1} each + 413 ml ha^{-1}	6.250d	1.950e	70
	$LSD_{0.05}$		0.3452	0.2101	

DAS = Days after sowing; Sorgaab; Sorghum water extract
Any two means not sharing a letter in common differ significantly by LSD Test at 5% level of probability.

Table-4. Effect of allelopathic crop water extracts with reduced doses of pendimethalin on total weed dry weight (g m-2) in sunflower.

Treatment			Fresh Weight (m-2)		
S.No	**Extract/ Herbicide**	**Rate**	**70 DAS**	**105DAS**	**Mean %**
T1	Control (weedy check)	-	4.200a	3.375a	
T2	Sorgaab + Sunflower (early post emergence)	18 L ha^{-1}each	1.950c	1.400b	56
T3	Sorgaab + Sunflower(early post emergence)	15 L ha^{-1}each	2.350b	1.500b	50
T4	Pendimethalin (pre-emergence)	825 ml ha^{-1} full dose	0.580e	0.532c	85
T5	Pendimethalin (as pre-emergence)	413 ml ha^{-1} (half dose)	1.350d	0.730c	73
T6	Sorgaab + Sunflower + pendimethlain	18 L ha^{-1} each + 413 ml ha^{-1}	1.425d	0.718c	72
T7	Sorgaab + Sunflower + pendimethlain	15 L ha^{-1} each + 413 ml ha^{-1}	1.375d	0.735c	72
	$LSD_{0.05}$		0.2153	0.1558	

DAS = Days after sowing; Sorgaab; Sorghum water extract
Any two means not sharing a letter in common differ significantly by LSD Test at 5% level of probability.

Biological yield (kg ha^{-1})

Data presented in (Table-5) reveal that biological yield was increased by all the weed control treatments as compared to control. Maximum biological yield 7443 kg ha^{-1} was recorded in treatment T4. It was followed by the treatment T6 and T7 which gave the biological yield of 7235 kg ha^{-1} and 7211 kg ha^{-1}, respectively. These two treatments were statistically at par with each other. All other treatment gave statistically more biological yield than the Weedy check. These results support the idea of reducing herbicide dose in combination with allelopathic water extracts.

Table-5. Effect of allelopathic crop water extracts with reduced doses of pendimethalin on biological yield (kg ha^{-1}) in sunflower.

S.No.	Extract/Herbicide	Rate	kg ha^{-1}
T1	Control (weedy check)	-	6025f
T2	Sorgaab + Sunflower (early post emergence)	18 L ha^{-1}each	6525d
T3	Sorgaab + Sunflower(early post emergence)	15 L ha^{-1}each	6333e
T4	Pendimethalin (pre-emergence)	825 ml ha^{-1} full dose	7443a
T5	Pendimethalin (as pre-emergence)	413 ml ha^{-1} (half dose)	6850c
T6	Sorgaab + Sunflower + pendimethlain	18 L ha^{-1} each + 413 ml ha^{-1}	7235b
T7	Sorgaab + Sunflower + pendimethlain	15 L ha^{-1} each + 413 ml ha^{-1}	7211b
	$LSD_{0.05}$		29.19

Any two means not sharing a letter in common differ significantly by LSD Test at 5% level of probability.

Achene yield (kg ha^{-1})

The achene yield significantly increased in all the treatment as compared to control (Table-6). Minimum achene yield was recorded in weedy check (T1) which was due to weed–crop competition over nutrients, light, space and water. Maximum increase in achene yield (48%) was obtained in T6, followed by T7 and T4 which increased the grain yield by 46%. Other combinations of allelopathic water extracts and reduced doses of herbicide viz. T5, T2 and T3, increased the seed yield by 31, 24 and 14%, respectively over control. The maximum achene yield of 2653 kg ha^{-1}was obtained in treatment T6 (Sorgaab + Sunflower extract + half dose of pendimethalin). The results are in agreement to the finding of Cheema et al. (2003b,c,d) who reported that sorgaab with ½ dose of pendimethalin gave grain yield equal to the full dose.

Table-6. Effect of allelopathic crop water extracts with reduced doses of pendimethalin on Achene yield (kg ha^{-1}).

S.No	Extract/ Herbicide	Rate	kg ha^{-1}
T1	Control (weedy check)		1788g
T2	Sorgaab + Sunflower (early post emergence)	18 L ha^{-1}each	2223e
T3	Sorgaab + Sunflower(early post emergence)	15 L ha^{-1}each	2045f
T4	Pendimethalin (pre-emergence)	825 ml ha^{-1} full dose	2528c
T5	Pendimethalin (as pre-emergence)	413 ml ha^{-1} (half dose)	2350d
T6	Sorgaab + Sunflower + pendimethlain	18 L ha^{-1} each + 413 ml ha-1	2653a
T7	Sorgaab + Sunflower + pendimethlain	15 L ha^{-1} each + 413 ml ha^{-1}	2613b
	$LSD_{0.05}$		37.44

Any two means not sharing a letter in common differ significantly by LSD Test at 5% level of probability.

Harvest Index

Harvest index is an important parameter indicating photosynthetic efficiency of a crop in transformation of the photosynthate into its economic yield. Higher the harvest index value, higher will be the efficiency of a crop to convert dry matter into the economic yield.

Minimum harvest index was recorded in weedy check (T1). Data presented in Table-7 reveal that maximum harvest index (36.66%) was observed in T6, which is statistically at par with treatment T7. It was followed by the treatments T5, T2 and T4 which increased the harvest index by 34.31, 34.06 and 33.96%, respectively. Higher harvest index values in these treatments might be due to the better weed control. The results are supported by findings of Cheema (1988) and Khaliq *et al.* (2002) who reported increase in harvest index by incorporating sorghum allelopathy as weed control tactic.

Table-7. Effect of allelopathic crop water extracts with reduced doses of pendimethalin on Harvest index(%) in sunflower.

S.No.	Extract/ Herbicide	Rate	%
T1	Control (weedy check)	-	29.67a
T2	Sorgaab + Sunflower (early post emergence)	18 L ha^{-1}each	340.6b
T3	Sorgaab + Sunflower (early post emergence)	15 L ha^{-1}each	32.29c
T4	Pendimethalin (pre-emergence)	825 ml ha^{-1} full dose	33.96b
T5	Pendimethalin (as pre-emergence)	413 ml ha^{-1} (half dose)	34.31b
T6	Sorgaab + Sunflower + pendimethlain	18 L ha^{-1} each + 413 ml ha^{-1}	36.66a
T7	Sorgaab + Sunflower + pendimethlain	15 L ha^{-1} each + 413 ml ha^{-1}	36.23a
	$LSD_{0.05}$		0.6458

Any two means not sharing a letter in common differ significantly by LSD Test at 5% level of probability.

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