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Weed Management in Wheat Field (*Triticum aestivum*) using Allelopathic Crop Water Extracts

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ABSTRACT

Allelopathic crop water extracts of sorghum and sunflower in combination with phenoxoprop-*p-ethyl* and bromoxinil+MCPA were evaluate for weed management in wheat (*Triticum estivum* L.) during winter, 2005-2006 at Agronomy Research Farm, University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan. Crop water extracts @ 30 L ha^{-1} (sorghum 15 L & sunflower15 L) were tank mixed with reduced rates (250, 333 & 500 g a.i. ha^{-1}) of bromoxinil+MCPA and phenoxoprop *p-ethyl* and were sprayed 30 days after sowing. Recommended doses of phenoxoprop-*p-ethyl* and bromoxinil+MCPA (1000 g a.i. ha^{-1}) were used as standard. A weedy check was also maintained for comparison. Combined application of sorghumwater extract (sorgaab) and sunflower extract (sunfaab) each @ 15 L ha^{-1} with 1/3rd (333 g a.i. ha^{-1}) dose of phenoxoprop-*p-ethyl* showed maximum weed supprssion at 45 and 65 days of spray (DAS). Bromoxinil+MCPA alone did not show effective weed control at lower rates. Sorgaab and sunfaab 15 L ha^{-1} each in combination with 1/3rd dose of phenoxoprop *p-ethyl* resulted in maximum grain yield and net benefits, but bromixinil+MCPA alone was effective only at higher rates. Increase in yield was only due to effective weed control and improvements in yield contributing components of wheat crop. Furthermore, herbicides were more effective in combination with allelopathic crop water extracts as compared to alone. Based on these findings, it is suggested that dose of phenoxoprop *p-ethyl* can be reduced up to 67% in combination with sorghum and sunflower water extracts for effective weed control in wheat.

Key Words: Allelopathic plant water extracts; Allelochemicals; Phenoxoprop-*p-ethyl*; Bromoxinil; Weed management; Yield; Wheat

INTRODUCTION

Weeds compete with crop plants for water, nutrients, space and light and also give refuge to pests and diseases; interfere with crops by releasing certain allelochemicals in the rhizosphere (Rice, 1984) and ultimatly decreased the crop yield. Average grain yield of different crops in Pakistan may be increased up to 37% if weeds are properly controlled (Baloch, 1993). Delay sowing and heavy weeds infestations are the chief yield limiting factors of wheat (*Triticum aestivum* L.) crop in Pakistan. Only due to high weed infestation, average yield losses in wheat crop are about 25-30% in Pakistan (Nayyar *et al*., 1994).

Herbicides are frequently used to increase crop yield through effective weed control, but excessive and non-judicious use of herbicides has posed many environmental and health problems (Jabran *et al*., 2008). In certain cases, target weeds are not controlled due to herbicide resistance in weeds due to continuous use of same herbicide for several years in different parts of the world. According to an international survey, over 295 biotypes of 177 weed species have evolved resistance to herbicides (Heap, 2005).

These environment and health hazards and resistance development issues, therefore, have forced to develop some environment friendly technologies for weed control (Jabran *et al.*, 2008). One approach is the combination of allelochmicals with reduced doses of herbicides to control weeds (Rice, 1984; Bames, 1987; Putnam, 1988).

In order to decrease the use of herbicides, crops with potent allelopathic potential are helpful e.g., sorghum residues decreased normal weed population up to 95% (Putnum & Duke, 1978). Use of allelopathic material in combination with reduced rates of herbicides is the major area of present research in Pakistan. Several studies conducted by Cheema and associates (Ahmad *et al*., 2000; Cheema *et al*., 2005; Jabran *et al.,* 2008) have revealed that weed inhibition with sorgaab (sorghum water extracts) ranged between 40-50%, which is less than weed control achieved with herbicides (80-100%). Cheema *et al*. (2003) evaluated sorgaab for its efficiency as natural weed inhibitor in wheat crop. They concluded that the herbicidal treatments reduced weed density and biomass by 69% and 73%, respectively and it increased wheat yield by 40%. Cheema *et al*. (2002) found that the total weed density and weed

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biomass were reduced by 21-30% and 25-35%, respectively by foliar spray of sorghum water extracts. They further revealed that grain yield of different wheat varieties were increased in the range of 13.5-18.6%. Three sprays of sorgaab treatment were more economical as compared to weedicides due to higher rate of return. They also stated that sorgaab @ 10 L ha^{-1} + 2/3 pendimethalin @ 1.0 kg a.i. ha^{-1} reduced total weed population by 92.57% and total fresh and dry weight by 80.96%, which was statistatically at par with full dose of pendimethalin @ 1.5 kg a.i. ha^{-1}. Khaliq *et al*. (2002) revealed that two foliar sprays of combined water extracts of sorghum, brassica, sunflower and eucalyptus suppressed total weed density and dry weight by 13-35% and 18-42%, respectively. One third and half dose of herbicide combined with sorgaab and sunfaab (sunflower water extracts) increase the maize grain yield upto 52% and 53%, respectively, while full dose of atrazine increase maize seed yield by 59% over control.

Although, earlier plenty of literature is available reporting application of allelopathic plant water extracts of different crops including sorghum and sunflower with reduced rates of herbicides for effective weed control in different crops. But no study was conducted to explore the the possibility to use the reduced doses of fenoyxyprop-*p-ethyl* and bromoxynil+MCPA (now a days most commonly used herbicides in wheat crop) in combination with allelopathic water extracts of sorghum and sunflower for effective weed control in wheat crop. This study was therefore conducted to determine a suitable combination of sorgaab (sorghum water extracts) and sunfaab (sunflower water extracts) with reduced doses of fenoyxyprop-*p-ethyl* and bromoxynil+MCPA for controlling weeds in wheat crop and as well as for avoidance of resistance in weeds.

MATERIALS AND METHODS

The present study was carried out at Agronomic Research Area, University College of Agriculture, Bahauddin Zakariya University, Multan during winter, 2005-2006 to explore the allelopathic effects of sorghum (Sorgaab) and sunflower (Sunfaab) water extracts with low rates of bromoxinil+MCPA and phenoxoprop *p-ethyl* for weed control in wheat crop. The experiment was laid out in randomized complete block design (RCBD) having four replications in a net plot size of 7 m x 2 m. Seeds of wheat variety "Bhakker-2003" were obtained from Punjab Seed Carporation with initial seed moisture contents of 8.5%. Crop was sown on well prepared seedbed on 27th December, 2005 through conventional broadcast technique using aseed rate of 150 kg ha^{-1} (high seed rate was used due to too late sowing). Nitrogen and phosphorus were applied @ of 150 and 100 kg ha^{-1}, respectivly using Urea and DAP as source. Whole phosphorus and half of nitrogen were added at sowing, while remaining nitrogen was added with first irrigation. Crop water extracts were prepared following Cheema *et al.* (2000). The crop water extracts @ 30 L ha^{-1} (15 L sorgaab & 15 L sunfaab) were tank mixed with reduced rates (250, 333 & 500 g a.i. ha^{-1}) of bromoxinil + MCPA and phenoxoprop *p-ethyl* and were sprayed after 30 days of sowing i.e., after first irrigation in moist soil using a knapsack hand sprayer fitted with T-jet nozzle. The volume of spray (350 L ha^{-1}) was determibed by by calibration. Recommended doses of phenoxoprop-*p-ethyl* and bromoxinil+MCPA (1000 g a.i. ha^{-1}) were used as standard. A weedy check was also maintained for comparison.

Weed density and weed dry weight were recorded at 45 and 65 days after spraying (DAS) using two quadrates of 0.25 m^2, averaged and then converted into one square meter (1 m^2) from each experimental unit. Weeds were harvested at ground level, cleaned, air dried under shade for 24 h and then oven dried at 70^{o}C untill constant weight before recording their dry weight. Two randomly selected quardrates of one square meter were taken at maturity from each plot and total number of productive and un-productive tillers were counted and then averaged to record total number of fertile and un-fertile tiller m^{-2}. Height of ten randomly selected plants from each plot was taken from base to the top of spike at maturity and then averaged to get plant height at maturity. Length of ten randomly selected spikes was measured from each plot at maturity and averaged to record spike length. These randomly selected spikes were threshed manually and total seeds obtained were counted, averaged to recored number of seeds per spike. The crop was harvested on 30th April, 2006 and was kept under sunlight for three days to dry. Biological yield of each plot was recorded by using spring balance and then converted into kg ha^{-1}. The crop was threshed manually and the seeds obtained were weighed and converted into kg ha^{-1}. Five random sample of 1000 grains were counted from each plot, weighed and then averaged to get 1000-grain weight (g).

The collected data were analyzed by SAS software of data analysis and differences among the treatment means were compared by least significant difference (LSD) test at 0.05 probability level (Steel *et al*., 1997). The treatments were compared by employing economic and marginal analysis. Marginal rate of return MRR (%) was calculated by dividing the change in the net benefit by change in cost that vary expressed in percentage (CIMMYT, 1988).

RESULTS

Weed density was significantly suppressed in all treatments as compared to control (weedy check) plots. Forty five days after spraying (DAS), maximum weed reduction was observed in plots treated with phenoxoprop *p–ethyl* @ 1000 g a.i. ha^{-1} that gave 84.73% weed control over weedy check (Fig. 1). But after 65 DAS maximum weed reduction was observed in plots sprayed with Sorgaab and Sunfaab @ 15 L ha^{-1} each + 1/3 dose of phenoxoprop *p-ethyl* (333 g a.i. ha^{-1}) that gave 79.79% weed control as compared to control. The combination of bromoxinil + MCPA with sorgaab and sunfaab was also very useful in suppressing weed density instead of bromixinil + MCPA alone, but it was effective only at higher dose i.e., 500 g a.i.

Fig. 1. Effect of sorgaab and sunfaab in combination with bromoxinil+MCPA and phenoxoprop *p-ethyl* and these herbicides alone on total weeds density

T_1= Control (Weedy check), T_2= Sorgaab+sunfaab each @ 15 L ha^{-1}+1/4 (250 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*, T_3 = Sorgaab+sunfaab each @ 15 L ha^{-1} + 1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* T_4= Sorgaab+sunfaab each @ 15 L ha^{-1}+1/2 (500 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* T_5= Sorgaab+sunfaab each @ 15 L ha^{-1} + 1/4 (250 g a.i. ha^{-1}) dose of bromoxinil+MCPA T_6 = Sorgaab+sunfaab each @ 15 L ha^{-1} + 1/3 (333 g a.i. ha^{-1}) dose of bromoxinil+MCPA T_7 = Sorgaab+sunfaab each @ 15 L ha^{-1} + 1/2 (500 g a.i. ha^{-1}) dose of bromixinil+MCPA T_8 = Phenoxoprop *p-ethyl* @ 1000 g a.i. ha^{-1} T_9 = Bromoxinil+MCPA @ 1000 g a.i. ha^{-1}

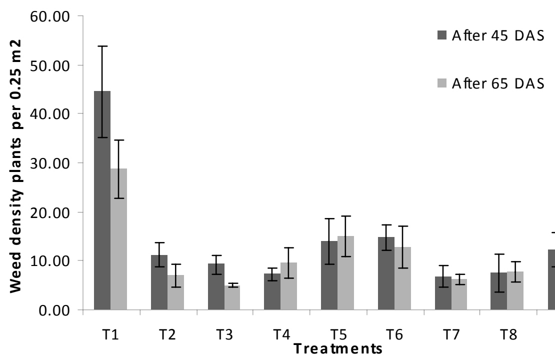
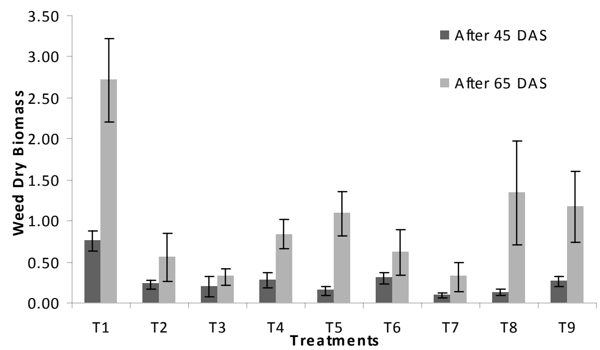


Fig. 2. Effect of sorgaab and sunfaab in combination with bromoxinil+MCPA and phenoxoprop *p-ethyl* and these herbicides alone on dry biomass

T_1 = Control (Weedy check), T_2 = Sorgaab+sunfaab each @ 15 L ha^{-1} + 1/4 (250 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*, T_3 = sorgaab + sunfaab each @ 15 L ha^{-1} + 1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* T_4 = sorgaab + sunfaab each @ 15 L ha^{-1} + 1/2 (500 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* T_5 = sorgaab + sunfaab each @ 15 L ha^{-1}+1/4 (250 g a.i. ha^{-1}) dose of bromoxinil + MCPA T_6 = sorgaab + sunfaab each @ 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) dose of bromoxinil + MCPA T_7=sorgaab + sunfaab each @ 15 L ha^{-1} + 1/2 (500 g a.i. ha^{-1}) dose of bromixinil + MCPA T_8 = Phenoxoprop *p-ethyl* @ 1000 g a.i. ha^{-1} T_9=Bromoxinil+MCPA @ 1000 g a.i. ha^{-1}



ha^{-1} (78.78% weed control at 65 DAS) (Fig. 1). Minimum weeds dry weight was recorded in plots treated with sorgaab+sunfaab each 15 L ha^{-1} + 1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*, which was 88% and 88.25% less than control (weedy check) at 45 DAS and 65 DAS, respectively (Fig. 2).

Maximum number of fertile tillers were recorded in plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop p-ethyl, but it was statically at par with all other treatments except weedy check having minimum number of fertile tillers. Maximum plant height was observed in weedy check, but it was at par with all other treatments except in the plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/2 (500 g a.i. ha^{-1}) dose of bromixinil+MCPA, but it was also at par with all other treatments except weedy check and the plots treated sorgaab+sunfaab each 15 L ha^{-1}+1/4 (250 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*. The spike length, number of spikelets per spike and number of grains per spike showed non-significant relationship among all treatments. Maximum 1000-grain weight grain yield was recorded in plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*, but it was statically at par with all other treatments except weedy check having minimum 1000-grain weight and grain yield, but it was also at par with all other treatments excluding the plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*. Similarly, mximum biological yield was recorded in plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*, but it was statically at par with all other treatments including weedy check except the plots treated Bromoxinil+MCPA @ 1000 g a.i. ha^{-1} (full dose of herbicide) and Sorgaab + Sunfaab each 15 L ha^{-1}+1/2 (500 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* having minimum biological yield.

Economic analysis revealed that maximum net benefits were recorded in the plots treated with sorgaab+sunfaab each 15 L ha^{-1} + 1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*. This also gave the maximum marginal rate (MMR) of return (Table III).

DISCUSSION

It is strongly recommended from the findings obtained by this experiment that herbicide dose (phenoxoprop *p-ethyl*) can be reduced up to 67%, when it was used in combination of allelopathic water extracts of sorghum (sorgaab) and sunflower (sunfaab). Sorgaab+sunfaab each 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) in combination with 1/3rd dose of phenoxoprop *p-ethyl* reduced the weed density and weed dry weight, which was 88% and 88.25% less than control (weedy check) at 45 DAS and 65 DAS, respectively (Fig. 2). It might be due to the fact that herbicide had synergistic effect to control weeds, when mixed with allelopathic crop water extracts. These results confirm the earlier work of Cheema *et al*. (2003), who reported that herbicide dose can be reduced up to 67% with sorgaab and sunfaab. Similarly, the plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) in combination with 1/3rd dose of phenoxoprop *p-ethyl* resulted in maximum number of fertile tillers and plant height than all other treatments. This might be due to minimum competition among weeds and wheat plants

Table I. Effect of sorgaab and sunfaab in combination with bromoxinil+MCPA and phenoxoprop *p-ethyl* and these herbicides alone on yield and yield components of wheat

Observations	T1	T2	T3	T4	T5	T6	T7	T8	T9	LSD at 5%
No. of fertile tillers m^{-2}	198.5 b	217.0 ab	227.5 a	219.5 ab	209.4 ab	211.0 ab	223.0 a	220.0 a	218.5 ab	22.96
Plant height (cm)	84.97 a	83.52 a	81.53 ab	81.29 ab	83.34 ab	80.46 ab	78.38 b	83.05 ab	82.03 ab	5.06
Spike length (cm)	10.55	11.06	11.02	10.70	11.02	11.04	10.87	10.85	10.90	NS
No. of grains per spike	34.90	33.00	32.70	33.10	35.05	32.80	32.45	35.80	35.05	NS
No. of spikelets per spike	19.60	19.65	19.35	19.25	19.35	19.65	19.25	19.85	19.45	NS
Biological yield (kg ha^{-1})	7036 abc	7068 ab	7750 a	6631 bc	6936 abc	6786 abc	7440 ab	7530 ab	5932 c	1100.8
1000 grain weight (g)	35.30 b	37.13 ab	38.83 a	37.68 ab	36.89 ab	37.41 ab	37.77 ab	36.39 ab	38.73 a	2.89
Grain yield (kg ha^{-1})	3418 c	4314 abc	4798 a	4351 abc	3761 bc	4135 abc	4660 ab	4336 abc	3448 c	932.50

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

Table II. Economic analysis of the effect of sorgaab and sunfaab in combination with bromoxinil+MCPA and phenoxoprop *p-ethyl* and these herbicides alone on yield and yield components of wheat

Observation	T1	T2	T3	T4	T5	T6	T7	T8	T9	Remarks
Grain yield	3418	4314	4798	4351	3761	4135	4660	4336	3448	kg/ha
Adjusted yield	3076	3883	4318	3916	3385	3722	4194	3902	3103	10% less At farmer level
Gross income (Rs)	30760	38830	43180	39160	33850	37220	41940	39020	31030	Rs. 400/40 kg
Cost of herbicides	-	210	280	420	324	432	648	840	1297	*
Cost of sorgaab and sunfaab	-	100	100	100	100	100	100	-	-	Preparation cost
Spray application cost	-	100	100	100	100	100	100	100	100	One man/ha/day
Sprayer rent	-	50	50	50	50	50	50	50	50	Rs. 50
Cost that vary	-	460	530	670	574	682	898	990	1447	Rs. /ha
Net benefits	30760	38370	42650	38490	33276	36538	41042	38030	29583	Rs. /ha

* Phnoxiprop *p-ethyl* = Rs. 340 per acre: Bromoxinil + MCPA = Rs. 525 per acre

T_1= Control (Weedy check), T_2 = sorgaab+sunfaab each @ 15 L ha^{-1} + 1/4 (250 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*, T_3 = sorgaab+sunfaab each @ 15 L ha^{-1} + 1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* T_4 = sorgaab+sunfaab each @ 15 L ha^{-1} + 1/2 (500 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* T_5 = sorgaab+sunfaab each @ 15 L ha^{-1} + 1/4 (250 g a.i. ha^{-1}) dose of bromoxinil+MCPA T_6 = sorgaab+sunfaab each @ 15 L ha^{-1} + 1/3 (333 g a.i. ha^{-1}) dose of bromoxinil+MCPA T_7 = sorgaab+sunfaab each @ 15 L ha^{-1} + 1/2 (500 g a.i. ha^{-1}) dose of bromixinil+MCPA T_8 = Phenoxoprop *p-ethyl* @ 1000 g a.i. ha^{-1} T_9 = Bromoxinil+MCPA @ 1000 g a.i. ha^{-1}

Table III. Marginal and dominance analysis

Treatments	Cost that varies	Marginal cost	Net benefits	Marginal net benefit	Marginal Rate of Return
Control (weedy check)			30760		
Sorgaab+sunfaab each @15 L ha^{-1} +1/4 (250 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*	460	460	38370	7610	1654
Sorgaab+sunfaab each @ 15 L ha^{-1} +1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*	530	70	42650	4280	6114
Sorgaab+sunfaab each @ 15 L ha^{-1} +1/4 (250 g a.i. ha^{-1}) dose of bromoxinil+MCPA	574	44	33276 D		
Sorgaab+sunfaab each @ 15 L ha^{-1} +1/2 (500 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*	670	96	38490	5214	5431
Sorgaab+sunfaab each @ 15 L ha^{-1} +1/3 (333 g a.i. ha^{-1}) dose of bromoxinil+MCPA	682	12	36538 D		
Sorgaab+sunfaab each @ 15 L ha^{-1} +1/4 (500 g a.i. ha^{-1}) dose of bromixinil+MCPA	898	216	41042	4504	2085
Phenoxoprop *p-ethyl* @ 1000 g a.i. ha^{-1}	990	92	38030 D		
Bromoxinil+MCPA @ 1000 g a.i. ha^{-1}	1447	457	29583 D		

MMR (%) = change in the benefit/change in cost

Variable cost = the cost of purchased inputs labour and machinery ha-1 that vary between the experimental treatments

Net benefit = Gross income-variable cost, D=Dominated due to less benefits than the preceding treatments

because weed density and total dry biomass was low (Fig. 1 & 2), so wheat plants get proper nutrition for their proper growth and results in more fertile tillers and vigorous growth resulting in more plant height. Maximum plant height was also due to the less competition and shading effect of weeds, wheat plant gained height (Salisbury & Ross, 1992).

Grain weight is an important yield contributing factor and individual grain weight can be increased, decreased or un-affected due to input applied and environmental stresses (Whinguiri & Kemp, 1980). Maximum grain weight might be due to effective weed control of weeds in plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3rd dose of phenoxoprop *p-ethyl* and full dose of phenoxoprp *p- ethyl*. So, wheat plants got maximum nutrition and water from available resources of soil. Same result was obtained by Cheema and Khaliq (2000) i.e., significant effect of sorgaab on 1000-grain weight in wheat crop.

Similarly maximum biological yield might be due to effective weed control and wheat plants get proper nutrition for their proper growth and results in more plant height. Erman *et al*. (2003) also reported that effective weed control increases biological yield. Maximum grain yield resulted in plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3rd (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl* due to more number of fertile plant tillers and higher 1000-grain weight (Table I). More number of fertile tillers and maximum 1000-grain weight might be due the effective weed control i.e., lower weed density and biomass production in these plots (Fig. 1 & 2). Therefore, the wheat plants faced minimum competition for nutrients, light and water. Similar finding were earlier reported by Jabran *et al*. (2008) in canola. They reported that sorghum (sorgaab) and sunflower (sunfaab) crop water extracts 15 L ha^{-1} each tank mixed with half dose of pendimethalin increased the seed yield in canola crop compared with weedy check and full dose of pendimethalin.

Economic analysis revealed that maximum net benefits were recorded in the plots treated with sorgaab+sunfaab each 15 L ha^{-1}+1/3 (333 g a.i. ha^{-1}) dose of phenoxoprop *p-ethyl*. This also gave the maximum marginal rate (MMR) of return (Table III). Earlier, Jabran *et al*. (2008) also reported that sorghum (sorgaab) and sunflower (sunfaab) crop water extracts 15 L ha^{-1} each tank mixed with half dose of herbicide (pendimethalin, 600 g a.i. ha^{-1}) increased the net benefits in canola crop compared with weedy check and full dose of herbicide (pendimethalin, 1200 g a.i. ha^{-1}).

In conclusion, sorgaab and sunfaab 15 L ha^{-1} each in combination with 1/3 dose of phenoxoprop *p-ethyl* resulted in maximum grain yield by effective control of weeds and increased the net benefits, but bromixinil+MCPA was effective only at higher rates. Furthermore, herbicides were more effective in combination with allelopathic crop water extracts as compared to alone. Based on these findings, it is suggested that dose of phenoxoprop *p-ethyl* can be reduced up to 67% in combination with sorghum and sunflower water extracts for effective weed control in wheat.

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