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Effect of weed-control practice and irrigation levels on weeds and yield of wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted to study the effect of different weed-control practices and irrigation levels on weeds and yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) in winter 2002-03 and 2003-04 in Pakistan. The experiment comprised four weed-control practices, viz. weedy check, pre-emergence application of pendimethalin, post-emergence application of isoproturon + carfentrazone ethyl and manual weed control (two hoeings), and four irrigation levels, viz. 0.50, 0.75, 1.00 and 1.25 irrigation water (IW): cumulative pan evaporation (CPE). The manual hoeing resulted in minimum weed density and dry weight of weeds, and gave maximum grain yield of 62.46 and 61.45 q/ha due to more spike-bearing tillers, 1,000-grain weight and number of grains/spike, but was statistically similar to post-emergence application of isoproturon + carfentrazone ethyl. The effect of irrigation levels on weed density and dry weight of weeds was non-signifcant in 2002-03 but was significant in 2003-04. The maximum grain yield was obtained at 1.25 IW:CPE.

Key words: Wheat, Weeds, Irrigation, Weed control, Herbicide

Wheat (*Triticum aestivum* L. emend. Fiori & Paol.) is the most important cereal crop in Pakistan. It is sown in 8.22 million ha with total production of 19.50 million tonnes. The average yield of 2,375 kg/ha (Anonymous, 2005) is, however, lower than its potential yield. Among various factors that affect the yield of wheat, availability of water and weed management are of supreme importance. Water is a key input for all recommended agronomic practices and therefore efficient utilization of irrigation water is essential for wheat. Weeds compete with crops for water and conditions become severe under its scarcity. The yield increases significantly with increase in the level of irrigation. Appropriate weed-control measures can improve the water-use efficiency in wheat. Pandey and Verma (2002) reported significant increase in yield and yield attributes of wheat due to herbicide application and manual hoeing. Choubey *et al.* (1998) reported increase in weed population and dry weight with increase in irrigation level from 0.60 to 1.00 IW:CPE. The present study was therefore conducted to study the effect of different weed-control practices and irrigation levels on the weeds and yield of wheat.

MATERIALS AND METHODS

The field experiment was conducted at Agronomic Research Area, University of Agriculture, Faisalabad in Pakistan to study the effect of weed-control practices and irrigation levels on wheat. The weed-control practices were : weedy check, pendimethalin @ 1,031 g ai/ha (pre-emergence), isoproturon + carfentrazone ethyl @ 750 g ai/ha (post-emergence) and manual weed control (two hoeings at 20 and 40 days after sowing); and the irrigation levels were: 0.50, 0.75, 1.00 and 1.25 irrigation water (IW):cumulative pan evaporation (CPE). The soil was sandy clay-loam with 6.7 and 6.3 ppm P, 0.042 and 0.036 per cent N, and 190 and 193 ppm K, containing 0.84 and 0.83 per cent organic matter and 32 and 31 per cent water-holding capacity in 2002-03 and 2003-04 respectively. The crop was given four irrigations at tillering, booting, anthesis and grain-filling stages in all the treatments, whereas the amount of water applied was calculated on the basis of IW:CPE ratio for each treatment. During the growing season 125.6 and 59.0 mm rainfall was received in 2002-03 and 2003-04 respectively. The experiment was laid out in split-plot design, keeping irrigation levels in main plots and weed-control practices in subplots, it was replicated thrice. Wheat 'Inqlab 91' was sown manually in rows 25 cm apart with single-row hand-drill using a seed rate of 125 kg/ha on 7 November 2002 and 14 November 2003. The crop was fertilized with 150 kg N and 100 kg

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P_2O_5/ha in the form of urea and diammonium phosphate (DAP) respectively. All the phosphorus and half the nitrogen were side-drilled at sowing time and the remaining half nitrogen was top-dressed at tillering with first irrigation. Pendimethalin was sprayed just after sowing but before the emergence of crop, whereas isoproturon + carfentrazone ethyl was sprayed after first irrigation, using a flat fan nozzle-fitted knapsack sprayer after calibrating the volume of water. In manual weed control, two hoeings at 20 and 40 days after sowing (DAS), were performed. Weeds from two randomly selected areas of 1 m^2 were removed, counted and dried in oven at 70°C for recording weed density and dry weight at 40 days after sowing and at harvest.

RESULTS AND DISCUSSION

Weed density

The effect of weed-control practices on total weed density 40 days after sowing and at harvest was significant in both the years (Table 1). The significantly maximum weed density was recorded in the weedy check (W_1), followed by post-emergence application of isoproturon + carfentrazone ethyl (W_3), which was statistically similar to pre-emergence application of pendimethalin (W_2). The minimum weed density was recorded in manual hoeing (W_4). The effect of irrigation levels on weed density at 40 days after sowing was non significant in both the years; however the effect of irrigation levels on weed density at harvest was non-significant during 2002-03 and was significant in 2003-04. The maximum weed density at harvest was obtained at IW:CPE ratio 1.00 (I_3) and the minimum with IW:CPE 1.25 (I_4). The weed density increased with increase in irrigation level up to IW:CPE ratio 1.00. Further increase in irrigation level significantly decreased the weed density.

Mortality of weeds with herbicide and hoeing resulted in lower weed density than in the weedy check.Uniform germination of weeds after sowing the wheat crop might be the main reason for similar weed density 40 days after sowing. These results are in line with those of Das and Yaduraju (1999), who reported non-significant differences between low and high frequencies of irrigation for weed density in wheat. Our results are however different from those of Hooda and Agrawal (1991), who reported a decrease in weed density with increased irrigation level. These contradictory results can be attributed to differences in climatic conditions, fertility status and texture of soils. The increase in weed density at harvest with increased irrigation level might have been due to better supply of moisture. Choubey *et al.* (1998) also reported significant increase in weed population with increase in irrigation frequency from IW:CPE ratio 0.6 to 1.0.

Dry weight of weeds

Different weed-control practices significantly affected the total dry weight of weeds (Table 1). The maximum dry weight 40 days after sowing and at harvest was recorded in weedy check (W_1) and the minimum in manual hoeing (W_4). The effect of irrigation level on dry weight of weeds 40 days after sowing was non-significant in both the years and at harvest in 2002-03. The interaction between weed-control treatments and irrigation levels was significant only in 2002-03 for dry weight of weeds 40 days after sowing and in 2003-04 for dry weight of weeds at harvest.

Unchecked growth and more fresh weight in weedy

Table 1. Effect of different weed-control practices and irrigation levels on weed density and dry weight of weeds 40 days after sowing and at harvest in wheat

Treatment	Weed density (no./m^2)				Dry weight of weeds (g/m^2)				Weed-control efficiency (%)	
	40 DAS		At harvest		40 DAS		At harvest			
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Weed-control practice										
W_1 – Weedy check	87.0	72.5	122.3	157.2	29.5	25.7	136.4	161.1		
W_2 – Pendimethalin (pre-em.) @ 1,031 g ai/ha	12.7	11.7	16.7	19.7	4.4	3.9	38.3	32.6	86.3	87.4
W_3 – Isoproturon + carfentrazone ethyl (post-em.) @ 750 g ai/ha	16.1	13.1	23.5	24.4	4.8	4.1	39.9	34.3	80.8	84.3
W_4 – Manual hoeing(2)	5.7	5.5	10.2	12.4	1.7	1.7	21.4	18.7	91.7	92.0
CD (P=0.05)	3.3	3.1	12.9	1.3	1.1	1.0	17.4	2.8		
Irrigation level (IW:CPE ratio)										
I_1 – 0.50	32.6	25.5	42.1	53.2	10.8	8.4	60.0	57.7		
I_2 – 0.75	31.1	25.9	39.0	54.1	10.7	8.9	56.7	69.0		
I_3 – 1.00	29.3	26.2	48.0	56.7	9.5	9.1	60.7	63.6		
I_4 – 1.25	28.6	25.2	43.7	49.7	9.4	8.9	58.6	56.3		
CD (P=0.05)	NS	NS	NS	1.1	NS	NS	NS	2.4		

check were the main reasons for higher dry weight 40 days after sowing and at harvest. Hooda and Agrawal (1991) and Das and Yaduraju (1999) also reported significantly maximum dry weight of weeds. Non-significant differences among irrigation levels can be attributed to similar fresh weight (data not given). At harvest the lower dry weight under 0.50 IW:CPE ratio might have been due to the limited supply of water in this treatment. Increase in dry weight with increased irrigation level might have been due to availability of moisture, resulting in better weed growth in 2003-04. The decrease in dry weight with further increase in irrigation level might have been due to better growth of wheat plants, which created competition for utilization of resources and suppressed the growth of weeds.

Weed-control efficiency

The weed-control efficiency of different weed-control methods varied from 80.78 to 91.68 per cent in 2002-03 and 84.32 to 92.02 per cent in 2003-04. The minimum weed-control efficiency was recorded with post-emergence application of isoporturon + carfentrazone ethyl (W_3) and the maximum with manual hoeing (W_4) in both the years. Pre-emergence application of pendimethalin resulted in better weed-control efficiency than post-emergence application of isoproturon + carfentrazone ethyl.

Yield attributes

The effect of different weed-control practices and irrigation levels on the number of spike-bearing tillers, number of grains/spike and 1,000-grain weight was significant (Table 2) during both the years. The interaction between weed-control practices and irrigation levels for yield attributes was also significant in both the years. In 2002-03 different weed-control practices differed significantly for the number of spike-bearing tillers at IW:CPE 0.50 and 1.00; however, the differences between weed-control practices were non-signifiant at IW:CPE 0.75 and 1.25. The maximum number of spike-bearing tillers, number of grains/spike and 1,000-grain weight were obtained from manual hoeing at IW:CPE 1.25 ($W_4 \times I_4$), and the minimum in weedy check at IW:CPE 0.50 ($W_1 \times I_1$). The weedy check treatment (W_1) produced the minimum and manual hoeing (W_4) the maximum number of grains/spike and 1,000-grain weight at all the irrigation levels. In 2003-04 the differences between weed-control practices were non-significant at IW:CPE ratio 0.50 (I_1) for number of spike-bearing tillers, whereas at other irrigation levels the weed-control practices showed significant differences. At IW:CPE ratios 1.00 and 1.25 (I_3 and I_4) the minimum number of spike-bearing tillers was recorded by weedy check treatment (W_1). However, at the irrigation level of

Table 2. Effect of different weed-control practices and irrigation levels on yield attributes, grain yield, water-use efficiency and net return in wheat

	No. of spike-bearing tillers (m^2)		Grains/spike		1,000-grain weight (g)		Grain yield (q/ha)		Water-use efficiency (kg/ha-mm)		Net returns (Rs/ha)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Weed-control practice												
W_1	383.3	379.0	43.2	42.4	39.6	38.8	47.9	47.2	15.9	15.8	35,254	39,182
W_2	386.8	375.8	45.7	43.7	44.0	42.4	56.2	53.9	18.6	18.1	40,708	45,375
W_3	392.1	366.0	48.7	45.7	44.6	44.0	59.7	55.4	19.8	18.6	42,832	45,784
W_4	391.7	369.8	48.5	46.7	46.8	45.0	62.5	61.4	20.7	20.6	45,636	50,487
CD (P=0.05)	6.1	10.2	0.5	0.2	1.0	0.3	3.9	6.7	1.3	2.3		
Irrigation level (IW" CPE ratio)												
I_1	366.1	352.5	40.4	37.9	38.4	39.3	45.7	42.6	15.1	14.3		
I_2	397.0	355.7	45.8	42.9	43.6	42.3	52.5	52.9	17.4	17.7		
I_3	392.7	365.4	48.3	47.2	45.1	42.1	62.9	58.6	20.9	19.6		
I_4	398.0	375.8	51.6	50.4	48.1	46.6	65.3	63.8	21.6	21.4		
CD (P=0.05)	10.1	10.4	1.0	0.4	1.1	0.5	3.9	4.3	1.3	1.5		

Details of treatments are given in Table 1

IW:CPE ratio 0.75 (I_2) the minimum number of spike-bearing tillers was recorded with post-emergence herbicide application of isoproturon and carfentrazone (W_3) compared with other weed-control practices at the same irrigation level.

The lesser competition and greater availability of water, nutrients and light resulted in more number of spike bearing tillers, number of grains/spike and 1,000-grain weight. The results aer similar grain those reported by Das and Yaduraj (1999) and Pandey and Verma (2002).

Grain yield

Effect of different weed-control practices on grain yield of wheat was significant in both the years (Table 2). In 2002-03 the maximum grain yield (62.46 q/ha) was recorded in manual weed control (W_4), but it was statistically on a par with the application of isoproturon + carfentrazone ethyl as post-emergence (W_3). The significantly minimum grain yield (47.98 q/ha) was recorded in weedy check (W_1). Similar trend was recorded in the second year as well. Different irrigation levels also significantly affected the grain yield of wheat in both the years. The significantly minimum grain yield (45.68 q/ha) was recorded in IW:CPE 0.50 (I_1), and it increased significantly with each increase in irrigation level up to IW:CPE 1.00; however, further increase in irrigation level did not increase the grain yield significantly. However, in 2003-04 the grain yield increased significantly with each increase in irrigation level, and the maximum grain yield (66.80 q/ha) was obtained at IW:CPE 1.25 (I_4). The interaction between weed-control practices and irrigation levels was non-significant in both the years.

The interaction between weed-control practices and irrigation levels was significant for yield attributes, but it remained non-significant for grain yield, perhaps because the maximum values for different yield attributes varied among different treatment combinations. As grain yield represents the cumulative effect of all yield attributes, the interaction for grain yield appeared non-significant.

Water-use efficiency

Effect of different weed-control practices on water-use efficiency was significant in both the years (Table 2). In 2002-03 the maximum water-use efficiency (20.72 kg/ha-mm) was recorded in manual weed control (W_4), which was statistically on a par with the post-emergence application of isoproturon + carfentrazone ethyl (W_3). The significantly minimum water-use efficiency (15.92 kg/ha-mm) was recorded in weedy check (W_1). Similar trend was observed in the second year also. The irrigation levels also affected the water-use efficiency significantly in both the years. Maximum water-use efficiency was recorded at IW:CPE 1.25 (I_4), which was statistically on a par with that at IW:CPE 1.00 (I_3). The significantly minimum water-use efficiency was recorded at IW:CPE 0.50 (I_1). More water-use efficiency in manual weed control was due to lower weed density, resulting in lesser loss of water by weeds and consequently more grain yield. The results are in line with those of Dhindwal *et al.* (1993). The increase in water-use efficiency with increase in irrigation level might be due to greater grain yield. These results are in consonance with those of Singh and Bhan (1998).

Net returns

All weed-control practices gave higher net field benefit than weedy check (W_1). The maximum net benefit (Rs 45,636 and Rs 50,487/ha) was obtained with manual hoeing (W_4), followed by post-emergence application of isoproturon + carfentrazone ethyl (Rs 42,832 and Rs 45784/ha).

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