Indian J. Weed Sci. **42** (1 & 2) : 19-22 (2010)

Effect of Irrigation Levels and Chlorsulfuron Doses on Productivity and Water Use of Wheat

Kanwar Singh, R. K. Malik, S. K. Yadav, Ashok Yadav and Sher Singh
Department of Agronomy
CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

ABSTRACT

To evaluate the effect of irrigation levels and chlorsulfuron doses on productivity and water use of wheat, a field experiment was conducted at Research Farm of CCS Haryana Agricultural University, Hisar, India during **rabi** seasons of 1998-99 and 1999-2000. Five irrigations (21, 45, 65, 85 and 105 DAS) applied in wheat resulted in highest grain yield and consumptive water use compared to two (21 and 85 DAS) and three (21, 65 and 105 DAS) irrigations. However, the water use efficiency (WUE) was maximum with two irrigations. Increase in the WUE of wheat due to two irrigations over three and five irrigations was 13.7 and 31.8% during 1998-99 and 9.5 and 27.0% during 1999-2000, respectively. More frequent irrigations (five) resulted in more soil moisture extraction from upper and medium soil layers, while two irrigations extracted more water from deeper layers. Different herbicidal treatments had no marked effect on water use by wheat. Maximum grain yield of wheat (4553 and 4849 kg/ha) was attained in the plots treated with chlorsulfuron at 30 g/ha which was statistically at par with its lower dose (20 g/ha).

Key words : Crop-weed competition, herbicide efficacy, moisture, crop productivity

INTRODUCTION

The reduction in grain yield of wheat due to unchecked growth of *Phalaris minor*, *Avena ludoviciana*, *Rumex dentatus*, *Cirsium arvense* and *Chenopodium album* has been estimated to the extent of 25 to 60% and some times even more depending upon the intensity of weeds (Malik *et al*., 1989). Isoproturon, metribuzin, diclofop-methyl, tralkoxydim, 2,4-D, fluroxypyr, tribenuron and metsulfuron provide selective control of either grasses or broad leaf weeds (Balyan and Panwar, 1998). But to control complex weed flora in wheat, there is a need to evaluate some new herbicide (s) like chlorsulfuron which has great potential against broad leaf weeds in cereals including wheat. Irrigation is one of the most important factors for assured crop production as it permits better utilization of all other production factors. In most parts of India, the supply of irrigation water in quantity, time and space falls short of its demand. Hence, there is an imperative need for efficient use of this available scarce resource. Keeping above points in view, the present investigation was undertaken to evaluate the effect of irrigation levels and chlorsulfuron doses on productivity and water use of wheat.

MATERIALS AND METHODS

To evaluate the impact of irrigation and weed control methods on the productivity and water use of wheat, a field experiment was conducted during **rabi** seasons of 1998-99 and 1999-2000 at Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar. The soil of the experimental field was sandy loam in texture, low in organic carbon (0.28%) and available nitrogen (187 kg/ha), medium in available phosphorus (18 kg/ha), high in available potash (375 kg/ha) and alkaline in reaction (pH 8.0) with electrical conductivity of 0.36 dS/m. The experiment comprising three irrigation levels (two irrigations at 21 and 85 DAS, three irrigations at 21, 65 and 105 DAS and five irrigations at 21, 45, 65, 85 and 105 DAS) as main plot and six weed control treatments (weedy, chlorsulfuron @ 20, 30, 45 and 60 g/ha and isoproturon @ 1000 g/ha) as sub-plot was laid out in split-plot design with four replications. Wheat variety, WH 542 with seed rate of 100 kg/ha was sown on December 04 during 1998 and December 01 during 1999. All the herbicides were sprayed at 30 DAS with knapsack sprayer fitted with flat fan nozzle using 625 l water/ha. All other package of practices were followed as per recommendation for wheat crop.

Total rainfall during the entire crop season was 31.2 and 19.0 mm during 1998-99 and 1999-2000, respectively. Consumptive use and water use efficiency were computed as per method given by Dastane (1972).

RESULTS AND DISCUSSION

Effect on Grain Yield

Grain yield of wheat increased significantly with increasing number of irrigations during both the years (Table 1). Increase in grain yield due to five and three irrigations over two irrigations was 20.3 and 16.2% during 1998-99 and 23.9 and 18.9% during 1999-2000, respectively. Grain yield was significantly higher in plots treated with chlorsulfuron at 30 and 20 g/ha as compared to chlorsulfuron 45 or 60 g/ha, isoproturon 1000 g/ha, and weedy plots during both the crop seasons. The maximum grain yield (4553 and 4849 kg/ha) was obtained in the plots treated with chlorsulfuron at 30 g/ha which was statistically at par with chlorsulfuron 20 g/ha. This might be due to the fact that grain yield of wheat was dependent on the spectrum of weed flora and efficiency of herbicides against the existing weed flora. Increase in yield with chlorsulfuron at 20 and 30 g/ha could be attributed to the improved yield attributes of wheat. Bhushan and Kumar (1999) and Malik *et al.* (1999) also reported similar results.

Table 1. Effect of irrigation levels and weed control treatments on grain yield, consumptive water use and water use efficiency of wheat

Treatments	Grain yield (kg/ha)		Consumptive water use (mm)		Water use efficiency (kg/ha-mm)	
	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
Irrigation levels						
Two (21, + 85 DAS)	3705	3788	232	245	15.97	15.46
Three (21, 65 + 105 DAS)	4422	4672	321	334	13.78	13.99
Five (21, 45, 65, 85 + 105 DAS)	4649	4976	427	441	10.89	11.28
LSD (P=0.05)	105	138	-	-	-	-
Herbicide doses (g/ha)						
Weedy	3677	3909	335	349	10.98	11.20
Chlorsulfuron 20	4491	4797	329	342	13.65	14.03
Chlorsulfuron 30	4553	4849	330	344	13.80	14.10
Chlorsulfuron 45	4281	4446	322	334	13.30	13.31
Chlorsulfuron 60	4207	4307	320	333	13.15	12.93
Isoproturon 1000	4343	4565	324	338	13.40	13.51
LSD (P=0.05)	151	142	-	-	-	-

Effect on Consumptive Water Use and Water Use Efficiency

Increasing number of irrigations resulted in increased consumptive water use (CWU) and decreased water use efficiency (WUE) during both the years (Table 1). The highest CWU of 427 and 441 mm was found with five irrigations 1998-99 and 1999-2000, respectively. A marked reduction in CWU was observed with corresponding decrease in number of irrigations from five to two. The increased CWU with increase in number of irrigations might be due to the fact that surface layers under higher frequency of irrigations remained wet for a longer duration thereby creating the condition for higher rate of evaporation as compared to the dry regimes. Application of irrigation increased soil moisture content, which in turn increased the loss of water from soil via plant to atmosphere. Lesser stomatal resistance in higher levels of irrigation could have increased transpiration rate of crop (Sinha and Singh, 1977). Further, it appears that the increase in soil moisture status with five irrigations resulted in more vegetative growth thereby increasing loss of water by transpiration, which may be responsible for higher water use. The water use efficiency was highest (15.97 and 15.46 kg/ha-mm) in two irrigations followed by three (13.78 and 13.99 kg/ha-mm) and five irrigations

(10.89 and 11.28 kg/ha-mm) in 2000-01 and 2001-02, respectively. The higher WUE associated with low soil moisture status (two irrigations) was due to proportionately less increase in seed yield than the increase in water use because crop plants try to economize the water loss under limited water supply conditions (Yusuf *et al*., 1980).

Consumptive water use was highest in weedy plots and minimum in plots treated with chlorsulfuron at 60 g/ha during both the crop seasons (Table 1). Chlorsulfuron applied at 30 g/ha had maximum water use efficiency of 13.80 and 14.10 kg/ha mm during 1998-99 and 1999-2000, respectively. It was followed by chlorsulfuron at 20 g/ha, isoproturon 1000 g/ha, chlorsulfuron at 45 g/ha, chlorsulfuron at 60 g/ha and minimum in weedy plots.

Effect on Soil Moisture Extraction

Soil moisture extraction pattern showed that in less frequent irrigations (two irrigations) crop showed a tendency to extract more moisture from deeper soil layers (60-90 cm) as compared to more frequent irrigations (five irrigations) which extracted more water from upper (0-30 cm) and medium layers (30-60 cm) in both the years of investigation (Table 2). Higher moisture extraction from upper and medium soil layers under high moisture regime (five irrigations) may be attributed to more availability of water and better ramification of roots in the upper layers besides additive effects of higher transpiration from increased growth and more water loss from the soil surface through evaporation. As the quantity of water in upper most surface was decreased by reducing the number of irrigation, the loss of water by evaporation and absorption by plants might have also been reduced and, therefore, the extraction of water from the lower layers increased due to more penetration of roots in the lower depth because moisture stress promotes extensive root growth in lower layers (Parihar, 1990). The results are in close conformity with those of Kibe and Singh (2003).

Herbicide doses had a little effect on soil moisture extraction (Table 2). The contribution of moisture from 0-30 cm soil layer was maximum at chlorsulfuron 30 g/ha and minimum at chlorsulfuron 60 g/ha during both the years. From 30-60 cm soil layer, it was maximum in weedy plots and minimum at chlorsulfuron 30 g/ha.

Table 2. Effect of irrigation levels and weed control treatments on soil moisture extraction pattern (%) of wheat

Treatments	Soil moisture extraction pattern (%)					
	1998-99			1999-2000		
	0-30 cm	30-60 cm	60-90 cm	0-30 cm	30-60 cm	60-90 cm
Irrigation levels						
Two (21, + 85 DAS)	48.4	33.3	18.3	49.6	33.4	17.0
Three (21, 65 + 105 DAS)	51.9	33.7	14.4	52.4	33.8	13.8
Five (21, 45, 65, 85 + 105 DAS)	55.4	35.1	9.5	56.1	35.7	8.2
Herbicide doses (g/ha)						
Weedy	51.4	34.9	13.7	52.2	34.6	13.2
Chlorsulfuron 20	52.7	33.2	14.1	53.6	33.9	12.5
Chlorsulfuron 30	52.9	32.9	14.2	53.9	33.8	12.3
Chlorsulfuron 45	52.1	34.0	13.9	52.7	34.4	12.9
Chlorsulfuron 60	51.9	34.4	13.7	52.5	34.5	13.0
Isoproturon 1000	52.4	33.8	13.8	53.3	33.6	13.1

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