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Effects of sowing dates and weed management on productivity of irrigated wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted during *rabi* 2012–13 and 2013–14 at research farm of SKUAST-Jammu to study the effect of sowing dates and weed management practices on productivity of wheat (*Triticum aestivum* L.). Among sowing dates, 15th November sown crop recorded lowest total weed density and total dry weight of weeds as compared to crop sown on 25th December. Crop sown on 15th November also recorded highest yield attributes and grain yield which ultimately led to maximum net returns of ₹51316/ha and B:C ratio (1.06). Significantly low weed density and dry matter of weeds and higher grain yield were recorded with ready mix application of sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha. Maximum weed control efficiency, crop resistance index and lowest weed index, weed persistence index were observed with the application of sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha. Significantly highest sedimentation value, crude protein and glutenin content was also recorded with the ready mix application of sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha as post emergence. Maximum benefit:cost ratio was also obtained with the application of sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha

Key words: Crop resistance index, Crude protein, Sowing dates, Weed-control efficiency, Weed index, Weed persistence index

Wheat (*Triticum aestivum* L.) is a major cereal crop grown in India and staple food for billions of people around the world. India is among the top ten producers of wheat in the world; it is grown on an area of about 30.6 million ha with total production of about 98.38 million tonnes (Anonymous 2018). The productivity and quality of wheat depends on the environmental conditions and the agronomic practices especially sowing time and weed management strategies which play a significant role in achieving higher productivity of wheat crop. Yield potential of wheat is not being exploited fully on account of many biotic and abiotic factors. Among various factors, sowing time and weeds infestation are the most important constraints which affect crop productivity. Drastic reduction in yield of wheat has been recorded with the delay of sowing beyond optimum time. It has been estimated that timely sowing of wheat is of utmost importance for obtaining higher yield and productivity (Mukherjee 2012). Besides sowing time, infestation of weeds in a crop adversely affect crop production in a number of ways. Weeds compete with crop for available moisture, nutrients, space and light and provide shelter to harmful insect-pests which results in yield reduction. Weeds cause yield reduction up to 15–50% depending upon the weed density and type of weed flora (Kumar *et al.* 2011) and duration of infestation. Chemical weed control is a preferred practice due to scarce and costly labour as well as lesser feasibility of mechanical or manual weeding. Therefore, a systematic study on weed dynamics in the crop is essential for strategic weed management. Timely planning and effective weed control is vital and may be achieved by use of herbicides in wheat subjected to various weed densities depending upon weed seed bank diversity in soil. Hence, present investigation was done to assess the effect of sowing dates and weed management practices on productivity and profitability of wheat in foothill plains of Jammu.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2012–13 and 2013–2014 at the research farm of Sher-e-Kashnir University of Agriculture Science and Technology, Jammu (32°40'N and 74°58'E at an altitude of 332 m amsl).The soil was sandy clay loam in texture, slightly alkaline in reaction (*p*H 7.35) with electrical conductivity of 0.18 dS/m, medium in organic carbon (5.4g/kg), phosphorus (11.26 kg/ha) and potassium (146.7 kg/ha)and low in available nitrogen (245.7 kg/ha).The experiment was laid out in spilt-plot design with three replications. The treatments consisted of two

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sowing dates, viz. 15th November and 25th December and seven weed management practices, viz. metribuzin (post-emergence) 210 g/ha,sulfosulfuron + metsulfuron (post-emergence) 30 g/ha + 2 g/ha, mesosulfuron + iodosulfuron (post-emergence) 12 g/ha + 2.4 g/ha, clodinafop-propargyl (post emergence) 60 g/ha, pinoxaden (post-emergence) 100 ml/ha, weedy check and weed free. Wheat cultivar '*RSP-561'* was sown at row to row spacing of 20 cm. The crop was fertilized with 100:50:25 kg of $N:P_2O_5:K_2O$/ha. Full doses of phosphorus and potassium along with one-third of nitrogen were applied as basal dose at the time of sowing. Remaining half quantity of nitrogen was applied in two equal splits – at crown root initiation stage and just before ear initiation stage. All the herbicides were sprayed at 30 DAS by knapsack sprayer fitted with flat fan T-jet nozzle using a spray volume of 500 l/ha. Weedy check plots remained infested with native population of weeds till harvest. The weed count and weed dry matter accumulation were recorded using quadrate of 1 m^2 size.The weeds were dried in oven till a constant weight was observed and then transformed into g/m^2 by using the appropriate formula. The data on weed count and weed dry weight were subjected to square root transformation ($\sqrt{X+1}$) to normalize their distribution (Gomez and Gomez 1984). Weed control efficiency (WCE), Weed index (WI), Weed persistence index (WPI) and Crop resistance index (CRI) were worked out by the formula given by Mishra and Mishra (1997) and Walia (2014).The sedimentation value, glutenin content and crude protein was estimated according to the method given by Zeleny (1947) and Lowry *et al.*(1951). The net returns were computed by deducting the total cost of cultivation from the gross returns and Benefit: Cost ratio was calculated by dividing the net returns with the cost of cultivation.

RESULTS AND DISCUSSION

Weed population, weed dry weight and weed indices: The experimental field was infested with *Anagallis arvensis*, *Chenopodium album*, *Fumaria parviflora*, *Cirsium arvense* among the broad leaved weeds and *Poa annua* among the grassy weeds. The minor density of *Phalaris minor*, *Medicago denticulata* and *Convolvulus arvensis* was also observed. *Anagallis arvensis* had the highest proportion of weed flora during both the years of experimentation. Among the sowing dates, crop sown on 15th November recorded lowest weed density and weed biomass as compared to crop sown on 25th December (Table 1). Data further revealed that crop sown on 15th November recorded numerically highest value of weed control efficiency, crop resistance index and lowest value of weed index as well as weed persistence index (Table 1). This might have happened due to the fact that availability of conducive temperature which inhibited the growth of weeds provided better ability

Table 1 Effect of sowing dates and weed management practices on weed growth, yield, quality and economics of wheat (pooled data of 2 years)

Treatment	Total weed count 120 DAS (No./m^2)	Total weed biomass 120 DAS (g/m^2)	WCE (%)	WI (%)	WPI (%)	CRI (%)	Grain yield (q/ha)	Sedimentation value (ml)	Crude protein (%)	Glutenin (%)	Net returns (₹/ha)	B:C ratio
Sowing Date												
15th November	12.79 (162.6)	10.44 (108.11)	52.67	24.98	0.76	2.83	38.06	44.92	8.65	5.07	51316	1.06
25th December	14.64 (213.6)	11.15 (123.46)	45.95	46.68	0.81	2.23	32.43	41.65	7.43	4.95	47027	1.01
LSD (P=0.05)	1.75	0.66	-	-	-	-	3.71	2.29	1.16	0.08	-	-
Weed Management												
Metribuzin 210 g/ha	9.21 (83.9)	8.23 (66.83)	71.18	15.58	0.84	4.96	40.16	39.51	10.57	4.88	72284	2.88
Sulfuron + Met 30 g/ha + 2 g/ha	9.11 (82.0)	8.03 (63.53)	72.19	12.97	0.82	5.16	41.40	40.10	10.78	4.90	74238	2.89
Mesosulfuron + Iodo 12 g/ha + 2.4 g/ha	9.72 (93.6)	8.74 (75.53)	66.93	26.87	0.843	3.83	34.79	46.13	8.32	4.68	58424	2.25
Clodinafop 60 g/ha	10.08 (100.8)	9.24 (84.39)	63.05	34.62	0.85	3.21	31.10	28.98	5.74	4.45	51790	2.03
Pinoxaden 100 ml/ha	10.18 (102.7)	9.32 (86.01)	62.35	37.04	0.88	3.10	29.95	28.63	5.35	4.42	49017	1.88
Weedy check	15.36 (235.1)	15.14 (228.45)	0.00	54.34	1.00	1.00	21.72	22.25	3.01	4.18	35814	1.36
Weed free	1 (0.00)	1 (0.00)	100	-	-	-	47.57	44.56	12.47	5.10	64495	1.43
LSD (P=0.05)	0.29	0.39	-	-	-	-	3.35	1.06	1.64	0.15	-	-

The data of total weed count and total weed dry weight were subjected to $\sqrt{x+1}$. Figures in the parenthesis are original values to utilize natural resources in favour of crop sown on 15th November. The results are in close proximity to the findings of Jat *et al.* (2013).

All the weed management treatments significantly reduced the total weed density and total dry weight of weeds as compared to weedy check. The highest weed density and weed dry matter at 120 DAS were recorded in weedy check plots (Table 1). However, among the herbicidal treatments, the lowest total weed density and total weed biomass were recorded with ready mix post emergence application of sulfosulfuron + metsulfuron 30 + 2 g/ha, which was statistically at par with post emergence application of metribuzin 210 g/ha (Table 1). Application of clodinafop-propargyl 60g/ha and pinoxaden 100 ml/ha was not effective in arresting the total weed population and total dry matter accumulation of weeds. Higher weed control efficacy and long lasting effects of sulfosulfuron + metsulfuron was found effective in reducing weed population and weed dry matter due to inhibition of branched chain amino acids as a result of which weeds died rapidly. These results are in close conformity with those reported by Bhullar *et al.* (2012) and Jat *et al.* (2014). Accordingly, highest weed control efficiency and crop resistance index were also observed with the application of ready mix post emergence application of sulfosulfuron + metsulfuron 30 + 2 g/ha (Table 1). However, lowest value of weed index and weed persistence index was recorded with the application of sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha which was closely followed by metribuzin post-emergence 210 g/ha in the increasing order. The lowest weed index and weed persistence index in efficient herbicidal treatments can probably be ascribed to minimized weed density but also averted weed dry matter and reduction in crop-weed competition. These results were in conformity with the findings of Jat *et al.* (2013) and Bhullar *et al.* (2012)

Wheat yield: Crop sown on 15th November recorded highest grain yield (Table 1). This could have happened owing to fact that favourable environmental conditions were available for longer duration to earlier sown crop which ultimately led to significant increase in the grain yield of wheat. These results corroborate with the findings of Jat *et al.* (2013).

Significantly lowest grain yield was recorded under weedy check and significantly highest grain yield to the tune of 47.57 q/ha was recorded in weed free which was significantly higher than that among other treatments (Table 1). Among the herbicidal treatments, significantly highest grain yield was recorded with the application of sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha as post-emergence which was statistically at par with metribuzin 210 g/ha as post-emergence (Table 1). This may be due to herbicides which were by and large broad spectrum in nature, and were able to check the growth of vide varieties of weeds thus resulting in higher grain yield. Similar finding were also reported by Chaudhray and Iqbal (2013**)** and Dev *et al.* (2013).

Correlation Studies: All the yield attributes of wheat have a significant positive correlation with grain yield but negative correlation with weed density and dry weight of weeds, number of earheads/m^2, number of grains/earhead, 1000-grain weight and grain yield of wheat crop (Table 2). The highest positive correlation was observed between weed density and weed dry weight. Among the yield attributes, the highest positive correlation was observed with grains/earhead followed by number of earheads/m^2 and grain yield. Number of earheads/m^2 and grain yield was negatively correlated with weed density and weed dry weight. Similar results were also reported by Chand and Punia (2017).

Qualitative traits and Economics: The 15th November sown crop recorded significantly highest sedimentation value, crude protein and glutenin content in wheat as compared to 25th December sown wheat. This might have happened owing to high nitrogen uptake by wheat crop (Table 1). Application of metsulfuron+ sulfosulfuron 30 g/ha + 2 g/ha recorded significantly highest sedimentation value, crude protein content and glutenin which was statistically at par with application of metribuzin 210 g/ha. This could be attributed to greater fraction of available nitrogen to wheat plants in the absence of weeds and its mobilization to spikelets. These results are in close conformity to the findings of Jat *et al.* (2013).

Relative economics of wheat calculated on grain yield basis (Table 1) revealed that 15th November sown wheat fetched higher net returns and B: C ratio as compared to 25th December sown wheat which might have happened due to prevailing favourable temperature required for wheat crop consequently resulting in higher yield responsible for the corresponding higher net returns and B:C ratio. Further, these findings are also in close conformity with Alam *et al.* (2013). Highest net returns and B:C ratio were obtained with the application of sulfosulfuron + metsulfuron 30 g/

Table 2 Correlation matrix of weed infestation and yield and yield attributes of wheat (pooled data of 2 years)

Parameter	Weed count at 120 DAS	Weed biomass at 120DAS (g/m^2)	Earheads/ m^2	Grains/ Earhead	1000-grain weight (g)	Grain yield (q/ha)
Weed Density at 120 DAS	1	0.926**	-0.673*	-0.674*	-0.709*	-0.772*
Weed dry weight at 120 DAS (g/m^2)	0.926**	1	-0.654	-0.828**	-0.839**	-0.874**
Earheads /m^2	-0.673*	-0.654	1	0.801**	0.768*	0.793*
Grains/Earhead	-0.674*	-0.828**	0.801**	1	0.987**	0.981**
1000-grain weight (g)	-0.709*	-0.839**	0.768*	0.987**	1	0.991**
Grain yield (q/ha)	-0.772*	-0.874**	0.793*	0.981**	0.991**	1

ha + 2 g/ha as post-emergence in wheat which was closely followed by metribuzin 210 g/ha. Higher yield of wheat crop might have been responsible for higher net returns and B:C ratio. These results are in close conformity to Dev *et al.* (2013) and Jat *et al.* (2013).

Based on two years of study, it was concluded that wheat crop sown on 15th November along with the application of sulfosulfuron + metsulfuronas 30 g/ha + 2 g/ha post-emergence was found effective in reducing weed population and resulted in higher benefit cost ratio.

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