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EFFECTS OF SOWING DATES AND WEED MANAGEMENT ON WEED GROWTH AND NUTRIENTS DEPLETION BY WEEDS AND UPTAKE BY WHEAT (*TRITICUM AESTIVUM* L.) UNDER SHIWALIK FOOTHILLS PLAINS OF JAMMU

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Abstract

A field experiment was conducted to study the effect of sowing dates and weed management practices on weed growth and nutrients depletion by weeds and uptake by wheat. The results revealed that crop sown on 15th November significantly reduced the weed density and its dry matter was compared to crop sown on 25th December. Among weed management treatments, ready mix application of sulfosulfuron + metsulfuron at 30 g/ha + 2 g/ha followed by metribuzin (210 g/ha) showed significantly lowest density and dry weight of weeds. Wheat crop sown on 15th November showed significantly lowest nutrient depletion by weeds and highest yield, nutrients uptake by wheat crop. Significantly lowest nutrient depletion by weeds, highest growth parameters, yield attributes, yield and nutrient uptake by wheat crop were recorded with the ready mix application of sulfosulfuron + metsulfuron at 30 g/ha + 2 g/ha. Regression equation revealed that unit increase in the weed control efficiency increased the grain yield by 25.56 kg/ha.

Introduction

Wheat (*Triticum aestivum* L.) the most important staple food crop of India provides food security to about 77 per cent of the country's population. Wheat crop is grown in almost all the pockets of the country either irrigated or rainfed, but the productivity by and large is higher in irrigated ecosystems which are mainly situated in the Indo-Gangetic plains. The low productivity of wheat can be attributed to several limiting factors. However, sowing time and weed management are most important. Among all the non-monetary inputs, sowing time assumes the great significance as it brings the drastic reduction in yield of wheat 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). Delay in sowing increased grain yield losses of wheat due to stiff crop-weed competition and weather conditions favouring some problematic weeds besides and reduced vegetative development of the crop (Singh *et al*. 2007). The decreasing trend in the grain yield due to delayed sowing might be associated with significantly lowest number of spike/m^2, less number of grains/spike and 1000-grain weight (Mishri and Kailash 2005). Besides the sowing time, weeds impose competition for nutrients, solar radiation, water and it sets in at the early crop growth stages and their relative density plays significant role in reducing yield of crops. As regards the various weed control measures, manual eradication has proved its superiority over all the measures in managing weeds, however the adoption of this technique has not gained popularity amongst the wheat growers as it is time consuming, labour

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intensive, expensive and many a times becomes impractical because of scarcity of labour during peak labour need periods. Timely weeding is most important to minimize the yield of losses and therefore under such circumstances the only effective tool left is to control weeds through the use of chemicals. Management of weeds through the use of chemicals has also been found as effective as realized under manual eradication in various crops including over and above benefits in saving extra costs involved in use of labour on manual eradication of weeds. For controlling weeds in wheat number of pre- and post emergence herbicides have already found their place in cultivation package of wheat. However, continuous use of some of the herbicides may result in development of herbicidal resistance in weeds over the time. Hence, keeping the above facts in view, the present investigation was undertaken to assess the performance of sowing dates and herbicidal weed management options for providing effective control in wheat.

Materials and Methods

A field experiment was conducted during *rabi* season of 2012 - 13 and 2013 - 14 at the research farm of Division of Agronomy, SKUAST-J (32^o - $40^{o'}$ N latitude and 74 - $58^{o'}$ E longitude and an altitude of 332 m above mean sea level).The soil of experimental site was sandy clay loam in texture with slightly alkaline in reaction (pH 7.35), medium in organic carbon (5.4 g/kg) and in available phosphorus (11.26 kg/ha) and potassium (146.2 kg/ha) but low in available nitrogen (245.7 kg/ha). The experiment was conducted in spilt-plot design with three replications. The treatments consisted of two sowing dates *viz.*, 15th November and 25th December as main plot 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 as sub-plot. 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 applied at 30 DAS by knapsack sprayer fitted with flat fan T-jet nozzle using a spray volume of 500l/ha. Weedy check plots remained infested with native population of weeds till harvest. Data on weed density were recorded from an area enclosed in the quadrate of $0.5m^2$ randomly selected at two places in each plot. Weeds collected from 0.5 m^2 area at two places were first sun dried for 2-3 days and then oven dried at 70^0C till the constant weight was recorded. The weed dry matter obtained at 60 DAS was expressed in gram per square meter (g/m^2). The data on weed density and weed dry weight thus obtained were subjected to square root transformation ($\sqrt{x+1}$) as wide variations existed among the treatments before statistical analysis. The N, P and K uptake by grain and straw of wheat and also weed samples were calculated by multiplying per cent nutrient content with their respective dry matter accumulation as per the formula given below:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{Dry matter accumulation (kg/ ha)}}{100}$$

The data obtained on various parameters - weed count, weed density, yield attributes and yield, nutrient uptake by crop and nutrient removal by weeds were tabulated and subjected to analysis of variance techniques as described by Cochran and Cox (1963). The key for degree of freedom used in analysis of variance is given below:

Source of variation	Degree of freedom
Replications (r-1)	3-1 = 2
Main plot (A-1)	2-1 = 1
Error (a) = (r-1) (A-1)	(3-1) (2-1) = 2
Sub plot (B-1)	(7-1) = 6
Main plot (A-1) × sub plot (B-1)	(2-1) (7-1) = 6
Error (b) = A(r-1) (B-1)	2(3-1) (7-1) = 24
Total (rab-1)	(3 × 2 × 7-1) = 41

Results and Discussion

The experimental field was infested mainly with broad leaved weeds including *Anagallis arvensis, Chenopodium album, Fumaria parviflora* and *Cirsium arvense* and one grassy weed *Poa annua* during both the years of experiment. Crop sown on 15th November recorded significantly lowest weed density and dry weight of all the weed species as compared to crop sown on 25th December (Table 1). Among the herbicidal treatments, the lowest individual and total weed density, individual and total weed biomass were recorded with ready mix post emergence application of sulfosulfuron + metsulfuron @ 30 g/ha + 2 g/ha which was statistically at par with post emergence application of metribuzin 210 g/ha (Table 1). This might have happened due to broad spectrum activity of herbicide and its greater efficiency to inhibit the synthesis of branched chain amino acids as a result of which weeds died rapidly. These results are in close conformity with Bhullar *et al.* (2012) and Jat *et al.* (2014).

Crop sown on 15th November was of significantly highest plant height, dry matter accumulation as compared to crop sown on 25th December (Table 2). This might be attributed to the relatively better and congenial environment available throughout the crop growth period from sowing to harvest in 15th November sown wheat. Likewise, crop sown on 15th November was of significantly highest number of ears/m^2, number of grains/ear and 1000-grain weight as compared to that of 25th December. The possible reasons for better yield attributes in 15th November sown wheat can be due to favourable crop growing conditions that provided more photosynthetic area and higher leaf area index for better interception of solar radiation as well as availability of other essential natural inputs thus leading to greater chances of producing longer ears containing larger number of grains. Similar findings were also reported by Akhtar *et al.* (2002), Shirpukar *et al.* (2008) and Jat *et al.* (2013). Among the herbicidal treatments, significantly highest plant height, dry matter accumulation, significantly highest number of ears/m^2, number of grains/ear and 1000-grain weight (Table 2) were recorded with the ready mix application of sulfosulfuron + metsulfuron @ 30 g/ha + 2 g/ha as post-emergence which was statistically at par with post-emergence application of metribuzin @ 210 g/ha This might have happened due to enhancement in most of the growth parameters under suitable environment situation provided by substantial reduction in intergeneric competition due to weed suppression thereby resulting in better plant growth and yield attributes. These results are in close agreement with those reported by Singh *et al.* (2013) and Sheoran *et al.* (2013).

Significantly lowest nutrients depletion by weeds was recorded in normal sown crop (15th November) as compared to crop sown on 25th December (Table 3). This might have happened due to reduced intensity and dry matter of weeds which led to significantly lowest NPK uptake by weeds. Among herbicidal treatments**,** significantly lowest uptake by weeds were recorded with

Table 1. Effect of sowing time and weed management practices on species wise density and dry matter of weeds (pooled data of 2 years).

Treatments	Weed count of individual spp. (No./2) at 120 DAS					Weed dry weight of individual spp.(g/m^2) at 120 DAS				
	A. arvensis	*C. album*	*F. parviflora*	*C. arvense*	*P. annua*	*A. arvensis*	*C. album*	*F. parviflora*	*C. arvense*	*P. annua*
Sowing dates										
15th November	6.31 (38.7)	5.97 (34.6)	5.77 (32.4)	1 (0.00)	7.30 (52.3)	5.06 (24.63)	4.85 (22.60)	4.64 (20.57)	1 (0.00)	6.58 (42.36)
25th December	7.78 (59.6)	7.52 (55.5)	7.36 (53.2)	7.16 (50.3)	7.78 (59.6)	6.22 (37.74)	6.05 (35.72)	5.89 (33.68)	5.54 (29.71)	7.12 (49.74)
LSD (p = 0.05)	1.27	1.37	1.48	1.53	0.36	1.06	1.17	1.14	1.26	0.43
Weed management										
Metribuzin 210 g/ha	6.42 (40.3)	6.14 (36.7)	5.95 (34.5)	5.60 (30.4)	6.66 (43.4)	5.79 (32.62)	5.62 (30.58)	5.43 (28.56)	5.05 (24.59)	5.85 (33.26)
Sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha	6.37 (39.7)	6.07 (35.8)	5.70 (31.6)	5.41 (28.3)	6.62 (42.9)	5.61 (30.57)	5.43 (28.55)	5.27 (26.73)	4.87 (22.76)	5.80 (32.75)
Mesosulfuron + iodosulfuron 12 g/ha + 2.4 g/ha	6.76 (44.8)	6.42 (40.3)	6.52 (41.6)	5.97 (34.6)	7.09 (49.3)	6.14 (42.85)	5.97 (34.76)	5.80 (32.64)	5.45 (28.67)	6.38 (39.78)
Clodinafop-propargyl 60 g/ha	7.64 (57.5)	7.37 (53.4)	7.38 (53.6)	7.04 (48.5)	7.38 (53.6)	6.67 (43.61)	6.53 (41.59)	6.37 (39.56)	6.05 (35.59)	6.71 (44.06)
Pinoxaden 100 ml/ha	7.78 (59.6)	7.52 (55.5)	7.48 (55.0)	7.15 (50.2)	7.43 (54.3)	6.73 (44.38)	6.58 (42.36)	6.43 (40.32)	6.11 (36.35)	6.75 (44.57)
Weedy check	7.96 (62.5)	7.62 (59.7)	7.59 (56.7)	7.26 (51.7)	8.19 (66.1)	6.78 (44.97)	6.62 (42.95)	6.47 (40.91)	6.16 (36.94)	7.53 (55.79)
Weed free	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)
LSD (p = 0.05)	0.32	0.27	0.32	0.23	0.24	0.18	0.23	0.19	0.29	0.22

Data were subjected to $\sqrt{x + 1}$. Figures in the parenthesis are original values.

Table 2. Effect of sowing time and weed management practices on crop growth, yield attributes and yield of wheat crop (pooled data of 2 years).

Treatments	Plant height (cm)	Dry matter accumulation (g/m^2)	No. of ear/m^2	No. of grains/ear	1000-grain weight (g)	Grain yield (q/ha)	Straw yield (q/ha)
Sowing dates							
15th November	96.56	972.25	278.9	36.18	38.24	38.06	56.70
25th December	92.17	873.54	243.9	31.85	34.74	32.43	50.02
LSD (p = 0.05)	2.37	35.19	3.78	3.01	3.40	3.71	3.58
Weed management							
Metribuzin 210g/ha	96.78	1034.73	264.5	35.02	39.03	40.16	58.63
Sulfosulfuron + metsulfuron 30 g/ha + 2 g/ha	96.85	1040.71	265.3	35.72	39.74	41.40	61.27
Mesosulfuron + iodosulfuron 12 g/ha + 2.4 g/ha	94.20	919.56	261.2	32.13	36.18	34.79	50.44
Clodinafop-propargyl 60 g/ha	91.91	854.44	257.7	29.36	32.96	31.10	44.78
Pinoxaden 100 ml/ha	89.63	848.39	257.2	29.69	32.02	29.95	42.83
Weedy check	87.31	720.37	248.6	23.91	27.42	21.72	32.58
Weed free	99.90	1142.25	281.0	39.24	42.16	47.57	70.87
LSD (p = 0.05)	2.28	31.34	3.02	2.72	2.41	3.35	2.65

Table 3. Effect of sowing time and weed management practices on nutrient removal by weeds and their uptake by wheat crop (pooled data of 2 years).

Treatments	Nutrient uptake by grain (kg/ha)			Nutrient uptake by straw (kg/ha)			Nutrient uptake by weeds (kg/ha)		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
Sowing dates									
15th November	60.64	12.65	21.93	44.25	9.97	108.16	16.04	8.79	42.36
25th December	51.07	10.73	17.87	40.38	8.89	99.07	18.21	10.79	44.62
LSD (p = 0.05)	2.78	1.84	2.43	2.47	0.38	2.60	2.08	1.39	1.53
Weed management									
Metribuzin 210 g/ha	65.08	13.57	23.29	46.75	10.19	111.52	17.85	8.57	40.03
Sulfosulfuron + met-sulfuron 30 g/ha + 2 g/ha	66.52	13.98	24.01	47.02	10.38	112.81	17.73	8.23	39.78
Mesosulfuron + iodo-sulfuron 12 g/ha + 2.4 g/ha	54.63	11.69	19.48	41.03	9.26	101.94	29.06	9.15	44.10
Clodinafop-propargyl 60 g/ha	48.69	9.94	16.78	38.83	8.69	96.82	34.48	9.53	47.56
Pinoxaden 100 ml/ha	46.60	9.45	16.17	38.20	8.56	95.27	32.25	9.55	48.63
Weedy check	32.93	7.08	11.51	33.59	7.39	85.17	39.71	12.15	54.68
Weed free	76.61	16.12	28.07	50.75	11.50	121.76	0.00	0.00	0.00
LSD (p = 0.05)	2.12	1.65	2.18	2.21	0.24	2.43	2.15	0.36	2.74

application of sulfosulfuron + metsulfuron post-emergence @ 30 g/ha + 2 g/ha which was statistically at par with application of metribuzin post-emergence @ 210 g/ha**.** The lowest NPK uptake by weeds in relatively superior herbicidal treatments could probably attributed to efficient control of mixed weed flora which might have reduced the crop-weed competition for nutrient uptake resulting in lowest dry matter accumulation by weeds. These results are in close conformity with the findings of Jat *et al. (*2013).

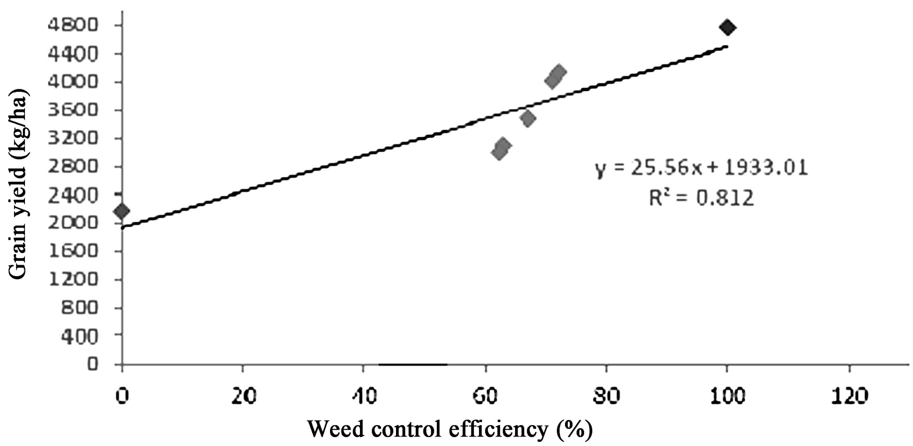

Fig. 1. Relationship between weed control efficiency and grain yield.

Yield and nutrients uptake were significantly influenced by sowing dates. Crop sown on 15th November produced significantly highest yield and nutrient uptake (Table 3) as compared to crop sown on 25th December. The highest yield and nutrient uptake in 15th November sown wheat might be attributed to vigorous growth and better root system of wheat which had helped in adequate supply of these nutrients resulting in higher biological and economic yield coupled with numerically higher nutrient contents of N, P and K. (Table 3). Almost a similar trend was observed with respect to nutrient uptake (NPK) by wheat straw. Similar results were also reported by Sharma and Kumar (2005). Among the weed control treatments, significantly highest yield (Table 2) and nutrient uptake (Table 3) was found under weed free treatment and lowest in weedy check plot. Among herbicidal treatments, ready mix application of sulfosulfuron + mertsulfuron @ 30 g/ha + 2 g/ha as post-emergence produced significantly highest yield and nutrients uptake which was found to be at par with application of metribuzin @ 210 g/ha as post-emergence. The regression equation predicted linear increase in the grain yield with a unit increase in the weed control efficiency (Fig. 1). The extent of increase could be 2556 kg/ha in grain yield for weed control efficiency.

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