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Effect of different herbicides on weed growth and yield performance of wheat

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ABSTRACT

A field experiment was conducted at Chatha, Jammu during winter season of 2004-05 and 2005-06 to study the effect of different herbicides and its mixtures on weeds and yield of wheat (*Triticum aestivum*). Unchecked weeds growth caused 40.3% reduction in grain yield of wheat. Application of sulfosulfuron (25 g) + 2,4-D (500 g/ha) reduced weed population and biomass significantly and thereby caused increase in crop growth and grain yield of wheat. This was at par with tank-mix application of clodinafop (60 g) + metsulfuron-methyl (2 g/ha), isoproturon (750 g) +2,4-D (500 g/ha) and fenoxaprop (120 g) + metribuzin (100 g/ha). Maximum grain yield was recorded in weed-free (5.05 t/ha), but the highest B:C ratio was observed with isoproturon+2,4-D (1.79). There was a significant positive correlation between N uptake by crop and grain yield of wheat (0.99), but a negative correlation was observed between grain yield and density and N removal by weeds.

Key words: Correlation coefficient, Crop growth, Grain yield, Herbicide mixture, Weeds, Wheat

In Jammu and Kashmir, wheat (*Triticum aestivum* L.) is grown on 0.28 mha with an average productivity of 1.82 t/ha (Anonymous 2006). Weeds are one of the major constraint causing yield losses to the extent of 50% (Azad 2003). The crop is infested with heavy population of *Phalaris minor*, *Avena ludoviciana*, *Chenopodium album*, *Vicia sativa* and *Melilotus indica*. Due to continuous use of isoproturon, *Phalaris minor* has become resistant to this herbicide (Malik and Singh 1995). New herbicides such as sulfosulfuron and clodinafop-propargyl have shown high efficacy against grasses in wheat (Singh *et al*. 2003). The knowledge of residual effect of any herbicide formulation in cropping system is of utmost importance because the left-over residues of a herbicide treatment may affect the succeeding crop. Hence, a comprehensive study was undertaken to keep the weeds below threshold level and assess the effect of different herbicide mixtures on crop growth and yield performance of wheat.

MATERIALS AND METHODS

A field experiment was conducted during winter season of 2004-2005 and 2005-2006 at the Research Farm, Chatha of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (32^0 40' N latitude and 74^0 58' E longitude at an altitude of 332 m above mean sea level). Soil of the experimental field was low in organic C (0.48%) and available N (210 kg/ha), medium in available P (15.5 kg/ha) and K (135 kg/ha) and neutral in pH (7.1). Treatments consisting of weedy check, weed-free, isoproturon, sulfosulfuron, clodinafop, fenoxaprop-p-ethyl, 2,4-D, metsulfuron-methyl, metribuzin and their combinations were arranged in a randomized block design with 3 replications. Herbicides were sprayed by knapsack sprayer fitted with flat fan T-jet nozzle using a spray volume of 500 l/ha of water 30 days after sowing (DAS). Wheat *cv.* '*PBW-343*' was sown in first week of November in rows 20 cm apart using 100 kg seed/ha. Recommended doses of 100 kg N + 60 kg P_2O_5 + 60 kg K_2O/ha were uniformly applied. Full dose of P and K, and half N were applied as basal at the time of sowing, whereas rest of the N was given in two equal splits as top dressing at 22 days after sowing at crown root initiation stage and 105 days after sowing at booting. Crop was raised under irrigated condition. Observations on weed composition and dry matter were recorded from 2 random quadrat of 0.25 m^2 in each plot at 90 DAS. Weed control efficiency was calculated based on weed dry weight under different treatments. For economic analysis, cost of cultivation, net returns and B:C ratio were computed. Correlation of grain yield with weed parameters and yield attributes was calculated using SPSS 5 software.

RESULTS AND DISCUSSION

Weed population and dry weight

The experimental field was infested with broadleaved weeds, *viz.*, *Trachyspermum* sp., *Anagallis arvensis*, *Eu-*

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phorbia helioscopia, Medicago denticulata, Melilotus indica, Vicia sativa, Chenopodium album, Rumex maritimus, Lathyrus aphaca, Fumaria parviflora and *Cirsium arvense,* while the grassy weeds were *Poa annua, Phalaris minor* and *Avena ludoviciana*. Maximum weed population and dry weed biomass was recorded in weedy check. Application of tank mixture of sulfosulfuron + 2,4-D was found at par with fenoxaprop + metribuzin, clodinafop + metsulfuron and isoproturon + 2,4-D as well as single application of metribuzin in reducing total weed population and dry weight at 90 DAS compared with weedy check (Table 1). Application of isoproturon and sulfosulfuron also proved equally effective in reducing weed biomass. Accordingly, maximum weed control efficiency was observed with sulfosulfuron + 2,4-D (93.2%), followed by metribuzin alone (91.5-93.1%), isoproturon + 2,4-D (90.8%) and clodinafop + metsulfuron (90.6%).

Crop growth and yield

Tank-mix of sulfosulfuron + 2,4-D, isoproturon + 2,4-D, clodinafop + metsulfuron and fenoxaprop + metribuzin besides alone application of isoproturon and sulfosulfuron resulted in significant increase in dry matter production of wheat compared with weedy check (Table 2). Similarly, tank-mix application of sulfosulfuron + 2,4-D increased leaf area index significantly and was at par with fenoxaprop + metribuzin, isoproturon + 2,4-D, clodinafop + metsulfuron or alone application of sulfosulfuron and isoproturon. Maximum crop growth rate was observed in weed-free plots. Tank-mix application of sulfosulfuron + 2,4-D resulted in significant increase in crop growth rate at par with fenoxaprop + metribuzin, isoproturon + 2,4-D, clodinafop + metsulfuron or alone application of sulfosulfuron at 60-90 DAS. Net assimilation rate showed a decreasing trend between 60-90 DAS but increased thereafter up to 120 DAS. There was no significant effect on net assimilation rate due to different treatments.

Application of sulfosulfuron + 2,4-D, fenoxaprop + metribuzin, isoproturon + 2,4-D and clodinafop + metsulfuron and metribuzin increased number of grains/ear, whereas isoproturon and sulfosulfuron proved equally effective in increasing the number of spikes/m row length, and grain and straw yield of wheat significantly over weedy check. This was because of significant reduction in weed population and biomass, which enhanced N uptake over weedy check. Significantly higher harvest index was observed with all herbicides, whereas lower weed index was recorded with sulfosulfuron + 2,4-D, followed by isoproturon + 2,4-D and clodinafop + metsulfuron. Similar findings were reported by Singh *et al.* (1998) and Singh *et al.* (2003).

Table 1. Population and dry weight of weeds as influenced by various herbicides (pooled data of 2 years)

Treatment	Total weed population at 90 DAS (no./m^2)	Total weed dry weight at 90 DAS (g/m^2)	N-uptake weeds (kg/ha)	N-uptake by wheat (kg/ha)	Weed control efficiency at 90 DAS (%)
Weedy check	18.9 (360.0)	11.8 (140.5)	6.0 (35.9)	75.1	0.0
Weed free	0.71 (0.0)	0.7 (0.0)	0.7 (0.0)	123.2	100.0
Isoproturon 1000 g/ha	9.1 (82.3)	4.5 (20.2)	3.1 (9.2)	105.8	85.6
Sulfosulfuron 25 g/ha	8.0 (63.8)	4.3 (18.9)	2.5 (6.1)	108.8	86.6
Clodinafop 60 g/ha	11.8 (139.8)	7.4 (55.8)	5.4 (29.0)	92.2	60.4
Fenoxaprop 120 g/ha	11.1 (123.5)	7.5 (56.0)	5.4 (29.1)	100.5	60.2
2,4-D 750 g/ha	13.4 (180.1)	9.4 (87.7)	2.2 (4.8)	97.8	37.4
Metsulfuron-methyl 4 g/ha	12.6 (160.8)	9.3 (86.7)	2.1 (4.7)	100.3	38.1
Metribuzin 175 g/ha	6.7 (44.7)	3.5 (12.6)	2.0 (3.5)	104.6	91.5
Metribuzin 200 g/ha	5.8 (34.0)	3.1 (9.8)	1.8 (2.8)	103.7	93.1
Sulfosulfuron + 2,4-D 25 + 500 g/ha	5.9 (35.2)	3.1 (9.6)	1.4 (1.6)	116.2	93.2
Isoproturon + 2,4-D 750 + 600 g/ha	7.0 (49.0)	3.6 (12.9)	1.7 (2.8)	114.0	90.8
Clodinafop + 2,4-D 60 + 500 g/ha	13.1 (172.8)	9.7 (95.2)	3.3 (11.7)	98.5	32.1
Clodinafop + metsulfuron 60 + 2 g/ha	6.2 (38.0)	3.7 (13.4)	1.7 (2.6)	111.8	90.5
Fenoxaprop + metribuzin 120 + 100 g/ha	6.1 (37.3)	3.9 (15.0)	2.3 (5.8)	111.4	89.1
LSD (P=0.05)	1.6	1.6	0.8	9.2	

Data subjected to ($\sqrt{x+0.5}$) transformation, and figures in parentheses are original values

Table 2. Growth and yield attributes of wheat as influenced by various herbicides (pooled data for 2 years)

Treatment	LAI at 90 DAS	Crop growth rate at 60-90 DAS (g/day)	Net assimilation rate at 60-90 DAS ($g/cm^2/day$)	Spikes /m	Grains /spike	1000-grain weight	Grain yield (t/ha)	Straw yield (t/ha)	Weed index (%)	Harvest index (%)
Weedy check	3.03	1.53	1.18							
Weed free	4.58	2.31	1.18	68.2	43.8	41.8	5.05	8.64	-	36.9
Isoproturon 1000 g/ha	4.20	2.04	1.18	61.5	38.0	39.7	4.32	8.14	14.6	34.6
Sulfosulfuron 25 g/ha	4.37	2.14	1.14	62.5	39.3	39.8	4.49	8.20	11.1	35.3
Clodinafop 60 g/ha	3.80	1.82	1.14	55.0	35.3	37.5	3.88	7.62	23.2	33.7
Fenoxaprop 120 g/ha	3.91	1.90	1.16	59.5	36.1	38.2	4.18	7.85	17.3	34.7
2,4-D 750 g/ha	3.84	1.87	1.16	57.9	35.3	37.7	4.03	7.76	20.3	34.1
Metsulfuron-methyl 4 g/ha	3.89	1.90	1.16	59.5	35.7	38.6	4.16	7.86	17.6	34.6
Metribuzin 175 g/ha	3.93	2.05	1.24	59.0	39.2	40.6	4.23	7.97	14.9	35.0
Metribuzin 200 g/ha	3.92	2.05	1.25	56.3	37.6	40.5	4.25	7.96	15.9	34.7
Sulfosulfuron + 2,4-D 25+500 g/ha	4.48	2.25	1.17	66.2	41.6	40.3	4.78	8.45	5.3	36.1
Isoproturon + 2,4-D 750 + 600 g/ha	4.40	2.19	1.16	65.5	40.6	40.0	4.66	8.40	7.8	35.7
Clodinafop + 2,4-D 60 + 500 g/ha	3.81	1.84	1.14	56.0	35.0	37.7	4.02	7.72	20.4	34.2
Clodinafop+metsulfuron 60 + 2 g/ha	4.45	2.22	1.12	64.5	41.0	40.2	4.67	8.28	7.6	36.0
Fenoxaprop+metribuzin 120 + 100 g/ha	4.23	2.17	1.19	63.8	40.6	40.1	4.52	8.29	10.5	35.3
LSD (P=0.05)	0.54	0.15	NS	5.6	5.1	0.9	0.51	0.39		2.7

Table 3. Correlation coefficient between different growth and yield attributes of wheat and weeds (based on mean of 2 years)

Parameter	CGR 60-90 DAS	NAR 60-90 DAS	Spikes /m	Grains /spike	1000-grain weight	Weed density at 90 DAS	N-uptake by weeds	N-uptake by crop	Straw yield	Grain yield
Dry matter accumulation	0.885*	0.105	0.948*	0.966*	0.889*	-0.885*	-0.758*	0.986*	0.971*	0.989*
CGR at 60-90 DAS	-	0.494*	0.859*	0.900*	0.731*	0.825*	-0.621	0.899*	0.926*	0.902*
NAR at 60-90 DAS	-	-	0.088	0.183	0.025	-0.182	-0.010	0.161	0.2380	0.144
Spikes/m	-	-	-	0.924*	0.769*	-0.760*	-0.660*	0.952*	0.940*	0.947*
Grains/spike	-	-	-	-	0.865*	-0.875*	-0.703*	0.958*	0.948*	0.953*
1000-grain weight	-	-	-	-	-	-0.941*	-0.813	0.878*	0.828*	0.884*
Weed density at 90 DAS	-	-	-	-	-	-	0.710*	-0.876*	-0.861*	-0.892*
N-uptake by weeds	-	-	-	-	-	-	-	-0.752*	-0.697*	-0.744*
N-uptake by crop	-	-	-	-	-	-	-	-	0.982*	0.993*
Straw yield	-	-	-	-	-	-	-	-	-	0.977*

*Significant at P=0.05

Nitrogen uptake by weeds and wheat

Tank-mix application of sulfosulfuron + 2,4-D was at par with fenoxaprop + metribuzin, isoproturon + 2,4-D, clodinafop + metsulfuron and single application of metribuzin, 2,4-D and metsulfuron-methyl resulted in significant reduction in N removal by weeds at harvest (Table 1). This was due to lower weed dry biomass as a result of significant weed control by these herbicides. Singh *et al.* (2003) also reported similar findings. On the other hand, application of sulfosulfuron + 2,4-D, fenoxaprop +

metribuzin, isoproturon + 2,4-D and clodinafop + metsulfuron besides alone application of sulfosulfuron resulted in significant increase in N uptake of wheat compared with weedy check. This was due to lower weed dry weight as a result of significant control of the weeds by these herbicides, which made more N available to the crop (Azad 1997).

Correlation studies

All growth parameters and yield attributes of wheat had significantly positive correlation with grain yield but weed density and N-uptake by weeds were negatively correlated (Table 3). Highest positive correlation was recorded between N-uptake by crop and grain yield of wheat (0.993*). Grain yield also had positive relationship with dry matter accumulation of crop (0.989*), straw yield (0.977*), grain/ear (0.953*), effective tillers/m (0.947*), crop growth rate (0.902*). The correlation coefficient was negative between grain yield and weed density at 60 DAS (-0.892*), 90 DAS (-0.892*) and N-uptake by weeds at harvest (-0.744*).

It was concluded that tank-mix application of sulfosulfuron + 2,4-D, Isoproturon + 2,4-D, clodinafop + metsulfuron, fenoxaprop + metribuzin or alone application of isoproturon and sulfosulfuron were best best treatments for control of weeds in wheat.

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