

Effect of different herbicides on weeds and yield of zero tilled wheat

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ABSTRACT

A field experiment was carried out to study the effect of doses and stage of application of various herbicides namely sulfosulfuron, isoproturon and metribuzin during *rabi* 2003-04 and 2004-05 at Pantnagar. All the herbicides reduced dry matter of weeds at 60 days more effectively when they were applied at higher rates and after first irrigation. Annual weeds and total weeds were higher in conventional tillage than zero tillage under weedy situation while perennial weeds were more in zero tillage. Under zero tillage, sulfosulfuron at 25 g/ha after first irrigation recorded highest grain yield *viz.*, 4431 kg/ha and 3924 kg/ha during 2003-04 and 2004-05, respectively. Weed control efficiency (94% during both experimental years) too was highest in this treatment. However, two hand weeding at 30 and 45 days stage under conventional tillage recorded highest yield among all the treatments. Use of herbicides under zero tillage fetched higher net returns than hand weeding at 30 and 45 days after sowing.

Key words : Zero tillage, Wheat, Weeds, Herbicides

Rice-wheat is the most popular cropping system in north India where climate is suitable for both the crops. In rice-wheat rotation, time available between harvest of rice and timely sowing of wheat crop is limited. This puts tremendous pressure on farmer for expediting seed bed preparation. Moreover, delayed sowing and poor quality seed bed affect germination and ultimately the crop yield (Ball 1989). Development of Pantnagar zero-till-ferti seed drill has helped the researchers and farmers to grow wheat crop directly in the harvested field of paddy without any tillage (Singh 2000). But, change in tillage leads to change in weed flora. For example, reducing the level of tillage usually leads to a proliferation of small-seeded weed species such as kochia (*Kochia scoparia* L.Schrad.) and Russian thistle (*Salsola iberica* Sennen and Pau) (Miller and Nalewaja 1985) while Dhiman *et al.* (2001) reported higher intensity of perennial weeds like *Paspalum distichum* and *Cynodon dactylon* under zero tillage condition. So, with the adoption of zero tillage sowing, efficient weed management occupies a distinct position in agronomic package.

Effective control of weeds in wheat can be achieved through herbicides like isoproturon (Yadav *et al.* 2004), sulfosulfuron (Saha *et al.* 2003) and metribuzin (Das and Yaduraju 2002). Among the above mentioned herbicides, isoproturon is being commercially used by farmers to control weeds in wheat crop for last 15 years. However Malik *et al.* (1995) reported resistance of *Phalaris minor* against isoproturon in our country and continuous use of isoproturon has shown a trend towards the dominance of *Phalaris minor* and *Avena* spp. It is therefore, important to study weed problem in zero tilled wheat and their

management through these herbicides. Considering these facts a field experiment was undertaken to study the effect of different herbicides in zero tilled wheat.

MATERIALS AND METHODS

A field experiment in randomized block design with 15 treatments replicated four times was conducted in the year 2003-04 and 2004-05 at Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, Uttaranchal to study the effect of three herbicides *viz.* metribuzin (140 g/ha and 175 g/ha before first irrigation and 210 g/ha after first irrigation), sulfosulfuron (20 g/ha and 25 g/ha before first irrigation and 25 g/ha after first irrigation), isoproturon (750 g/ha and 1000 g/ha before first irrigation and 1000 g/ha after first irrigation) and isogaard plus (isoproturon 750 g/ha tank mixed with 500 g/ha 2,4-D after first irrigation). One hand weeding at 30 days, two hand weeding at 30 and 45 days and weedy check treatments were also kept in zero tillage. Two hand weeding at 30 and 45 days and weedy check were kept in conventionally tilled wheat for comparison. The soil of experimental field was silty clay loam in texture with high in organic carbon (0.85), medium available phosphorus (21.7 kg/ha P) and potassium (201.6 kg/ha). Wheat cv *PBW-343* was sown on 24.11.03 and 27.11.04 by Pantnagar zero till ferti seed drill. Herbicides were applied on 22.12.03 and 25.12.04 (those applied before first irrigation) and also on 27.12.03 and 30.12.04 (those applied after first irrigation) using Knapsac sprayer with spray volume of 300 liters water/ha. 2,4-D was applied on 01.01.04 and 03.01.04 i.e. 4 days after application of isoproturon. Weed control efficiency

was calculated in relation to total weed dry matter by using the following formula:

$$WCI = \frac{(X - Y)}{X} \times 100$$

where,

X= dry matter of weeds in weedy plots Y= dry matter of weeds in treated plots.

For conventional and zero tilled plots, dry matter of weeds were taken from the respective weedy plots of conventional and zero tilled plots. The crop was raised following other recommended package of practices.

RESULTS AND DISCUSSION

Effect of treatments on weeds species

All the herbicide treatment and two hand weedings significantly reduced the dry matter of all the weed species viz. *Phalaris minor*, *Coronopus didymus*, *Cynodon dactylon* and *Melilotus indica* as compared to one hand weeding and weedy check. Weedy check plots in conventionally tilled wheat recorded higher dry matter of all weed species than zero tilled weedy check plots except with respect to *Cynodon dactylon* which was significantly higher in zero tilled wheat. All the herbicides were more effective when they were applied at higher rate and after first irrigation in reducing the density of all the weed species. It was due to fact that they were more toxic to weeds at higher rate and after first irrigation all those weeds were killed by herbicides which failed to germinate before first irrigation. Pandey *et al.* (2001) also found isoproturon applied after first irrigation was more effective against grassy and broad leaved weeds. Highest weed biomass was obtained with weedy check plots. The lowest total weed biomass and highest weed control efficiency was obtained with sulfosulfuron at 25 g/ha after first irrigation during first year but during second year both sulfosulfuron at 25 g/ha after first irrigation and isogaurd plus were having same weed control efficiency. This was due to effective control of different species of weeds by these herbicides.

Effect of treatment on crop

Grain yield was directly related to weed infestation and severely reduced by weed competition in weedy plots. Grain yield loss was 33.5% in conventionally tilled wheat and 21.3% in zero tilled wheat in weeds check plots compared to two hand weeded plots which was mainly due to more weed infestation in conventionally tilled wheat (Table 1). Bhardwaj *et al.* (2004) also reported substantially low density of weeds under zero tillage than conventional tillage. The highest grain yield viz., 4585 kg/ha and 4019 kg/ha was recorded under two hand

weeded plots in conventionally tilled wheat during first and second year, respectively. It was due to more number of spikes/m² at the time of harvest (Table 2). Similar finding were also reported by (Rath 2000). Among herbicides the highest grain yield was obtained in treatment where sulfosulfuron was applied at 1000 g/ha after first irrigation. Metribuzin although had better control of weeds at 210 g/ha but had statistically at par grain yield to lower doses of metribuzin because of its adverse effect on shoot population (Table 2). There was reduction of spikes/m² in treatment comprising metribuzin at 210 g/ha after first irrigation, grain yield however was compensated due to similar other yield attributes like grain number/spike and 1000 grain weight. Reduction in shoot population due to metribuzin was also reported by Singh (2001). Spike length and 1000-grain weight were statistically similar among all herbicide treatments and significantly higher compared to weedy check.

Nutrient uptake by crop and weeds

Nutrient uptake by crop was more in all weed control treatment compared to one hand weeding and weedy check. Nutrient uptake (N, P, and K) by crop was more in conventional tilled wheat than zero tilled wheat in two hand weeded plots although differences were not significant. Jain *et al.* (2007) also found non significant differences between zero tillage and conventional tillage wheat in terms of N P K uptake. Nutrient uptake by weeds was the manifestation of weed biomass in the field (Table 1 and 3). Weeds depleted more nitrogen, phosphorus and potassium in conventional tilled wheat than in zero tilled wheat under weedy condition. Use of all herbicides reduced nutrient uptake by weeds, also herbicides at higher rates and after first irrigation recorded even less nutrient uptake. Pandey *et al.* (2001) reported reduction in NPK depletion by adopting suitable weed control practice.

Economics

The highest net return (Rs15240/ha) was obtained with sulfosulfuron applied at 25 g/ha after first irrigation among all treatments. Zero tillage recorded lower grain yield in two hand weeded plots at 30 and 60 days however net returns were higher compared to conventionally tilled wheat under similar conditions (Table 2). Monetary returns were higher in zero tillage due to lower cost of cultivation (Jain *et al.* 2007). Singh *et al.* (2004) also reported similar findings. Data pertaining to economics also showed that herbicides were more economical than two hand weedings in zero tilled wheat because herbicides were much cheaper than the use of manual labour.

It may be concluded that under weed free situation, conventionally tilled wheat was superior to zero tillage wheat in terms of grain yield however net returns were

Table 1. Effect of treatments on dry matter (g/m²) of different weed species, total weed biomass (g/m²) and weed control efficiency (%) at 60 days stage

Treatments	<i>P. minor</i>		<i>C. didymus</i>		<i>M. indica</i>		<i>C. dactylon</i>		Weed control efficiency (%) at 60 days			Total weed biomass	
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	03-04	04-05	2003-04	2004-05	
Metribuzin 140 g/ha 1-2 DBFI	2.6 (11.9)	2.3 (8.9)	0.0 (0.0)	0.1 (0.2)	2.5 (11.1)	2.8 (15.7)	1.9 (5.8)	2.1 (7.3)	77	83	3.5 (32.3)	3.6 (36.9)	
Metribuzin 175 g/ha 1-2 DBFI	2.3 (8.7)	1.9 (5.7)	0.0 (0.0)	0.1 (0.1)	2.0 (6.6)	2.4 (9.6)	1.7 (4.3)	2.0 (6.7)	83	87	3.2 (23.8)	3.3 (27.1)	
Metribuzin 210 g/ha 1-2 DBFI	1.0 (2.0)	1.0 (1.7)	0.0 (0.0)	0.0 (0.0)	1.2 (2.3)	1.7 (4.3)	1.6 (4.2)	1.7 (4.6)	89	92	2.7 (14.6)	2.9 (16.6)	
Sulfosulfuron 20 g/ha 1-2 DBFI	1.3 (2.6)	1.3 (2.8)	1.8 (5.3)	1.9 (5.5)	2.8 (15.6)	2.6 (12.3)	1.6 (4.2)	1.8 (5.0)	80	88	3.4 (28.1)	3.3 (25.6)	
Sulfosulfuron 25 g/ha 1-2 DBFI	0.7 (1.0)	0.3 (0.5)	1.5 (3.6)	1.6 (4.0)	2.0 (6.3)	2.3 (8.8)	1.4 (3.2)	1.6 (4.1)	90	92	2.7 (14.1)	2.9 (17.4)	
Sulfosulfuron 25 g/ha 1-2 DAFI	0.0 (0.0)	0.0 (0.0)	1.4 (3.4)	1.5 (3.6)	1.3 (2.7)	1.7 (4.2)	1.2 (2.4)	1.7 (4.8)	94	94	2.2 (8.6)	2.6 (12.6)	
Isoproturon 750 g/ha 1-2 DBFI	2.6 (13.1)	1.9 (5.5)	2.5 (11.5)	3.0 (19.7)	3.0 (18.5)	3.0 (19.8)	1.7 (4.4)	2.7 (13.6)	71	80	3.7 (40.7)	3.8 (43.4)	
Isoproturon 1000 g/g/ha 1-2 DBFI	1.8 (4.9)	1.4 (2.9)	2.1 (7.4)	2.8 (14.9)	2.6 (12.4)	2.8 (15.9)	1.5 (3.4)	2.2 (8.3)	83	86	3.2 (23.9)	3.4 (30.1)	
Isoproturon 750 g/ha 1-2 DAFI	1.7 (4.6)	1.4 (2.9)	1.7 (4.4)	2.1 (7.4)	2.0 (6.7)	2.7 (14.6)	1.2 (2.4)	2.2 (7.6)	88	87	2.9 (16.3)	3.3 (27.2)	
Isoguard plus 1000 +2,4-D 500 g/ha 1-2 DAFI	2.5 (12.2)	1.7 (4.8)	0.0 (0.0)	0.0 (0.0)	0.6 (1.3)	0.6 (1.1)	1.8 (4.3)	2.2 (7.6)	88	94	2.9 (16.7)	2.7 (14.7)	
Manual weeding at 30 DAS	2.4 (10.5)	2.6 (12.5)	1.8 (5.2)	2.6 (12.5)	3.2 (22.3)	3.2 (24.6)	2.2 (8.3)	3.6 (34.0)	60	57	4.1 (56.6)	4.5 (93.9)	
Manual weeding at 30 and 45 DAS	2.0 (6.4)	2.2 (8.4)	0.9 (1.5)	1.8 (5.1)	1.2 (2.4)	2.0 (6.1)	0.8 (1.2)	2.0 (6.3)	90	87	2.6 (12.9)	3.3 (26.9)	
Unweeded (check)	2.9 (16.9)	2.8 (15.4)	3.2 (23.5)	3.3 (27.5)	3.8 (45.4)	4.0 (52.1)	2.6 (12.9)	4.3 (76.1)	0	0	5.0 (143.1)	5.4 (219.1)	
CT + manual weeding at 30 and 45 DAS	1.2 (2.5)	2.5 (11.5)	0.4 (0.6)	1.0 (1.7)	1.2 (2.4)	1.3 (2.5)	0.0 (0.0)	1.8 (5.3)	95	93	2.2 (7.6)	2.8 (15.5)	
CT + unweeded (check)	2.4 (27.5)	3.9 (50.5)	3.6 (34.0)	3.7 (37.6)	3.9 (50.8)	4.1 (60.3)	1.4 (3.1)	1.3 (2.1)	0	0	5.1 (163.0)	5.0 (209.5)	
LSD (P= 0.05)	0.2	0.2	0.3	0.2	0.3	0.3	0.1	0.2	0.2	0.2	0.2	0.1	

CT - Conventional tillage, DBFI- Days before first irrigation, DAFI - Days after first irrigation, Figures in paranthesis are original value.

Table 2. Effect of different treatments on yield attributing characters, grain yield and economics (net return Rs/ha, average of two years) during 2003-04 and 2004-05

Treatment	Number of spikes		Spike length (cm)		Number of grain spike		1000-grain weight (g)		Grain yield (kg/ha)		Net return average of two years (Rs/ha)
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	
	Metribuzin 140 g/ha 1-2 DBFI	363.5	337.0	10.0	10.3	44.8	45.5	39.5	34.3	3832	
Metribuzin 175 g/ha 1-2 DBFI	372.5	323.0	10.0	10.4	44.5	45.5	39.1	35.0	4087	3733	14332
Metribuzin 210 g/ha 1-2 DBFI	365.5	303.2	9.7	10.2	43.7	44.5	39.9	35.0	3851	3610	13539
Sulfosulfuron 20 g/ha 1-2 DBFI	379.0	340.2	9.8	9.2	44.4	43.8	39.2	34.6	40.04	3517	12360
Sulfosulfuron 25 g/ha 1-2 DBFI	380.0	338.5	10.0	10.3	44.7	44.4	39.1	34.2	4286	3724	13986
Sulfosulfuron 25 g/ha 1-2 DAFI	386.5	341.5	9.9	9.9	43.9	45.3	39.5	35.1	4431	3924	15240
Isoproturon 750 g/ha 1-2 DBFI	373.1	331.0	9.7	9.0	43.7	45.1	39.3	34.0	3801	3505	12054
Isoproturon 1000 g/ha 1-2 DBFI	382.5	331.5	9.9	9.8	44.2	44.3	39.6	34.6	3986	3824	14141
Isoproturon 750 g/ha 1-2 DAFI	384.5	336.5	9.8	10.4	42.9	47.2	39.6	35.1	4185	3868	14964
Isogaard plus 1000 + 2, 4 500 g/ha 1-2 DAFI	382.5	331.5	9.7	9.6	44.2	46.3	40.3	35.1	4175	3898	14941
Manual weeding at 30 DAS	314.5	319.0	9.6	10.2	43.0	45.5	39.3	35.0	3347	3110	9113
Manual weeding at 30 and 45 DAS	389.5	332.0	9.8	9.7	45.1	45.8	39.6	35.2	4135	3859	10429
Unweeded (check)	277.0	264.5	8.8	9.7	41.0	45.3	39.7	34.9	3160	3130	9504
CT + manual weeding at 30 and 45 DAS	403.0	352.0	9.9	10.0	45.3	45.5	40.2	35.1	4585	4019	12858
CT + unweeded (check)	292.0	230.0	9.8	9.9	41.6	44.8	38.8	34.7	3013	2707	5915
LSD (P = 0.05)	11.50	6.9	0.4	NS	2.70	NS	NS	NS	293	339	

CT- Conventional tillage, DBFI- Days before first irrigation, DAFI- Days after first irrigation

Table 3. N, P, K uptake by crop and weeds (g/m³) at harvest during 2003-04 and 2004-05 as influenced by treatments

Treatment	Crop						Weeds					
	N		P		K		N		P		K	
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Metribuzin 140 g/ha 1-2 DBFI	121.15	114.15	23.92	21.95	149.6	138.1	15.46	19.10	4.50	4.73	14.84	15.50
Metribuzin 175 g/ha 1-2 DBFI	115.45	115.14	24.35	22.45	152.4	140.2	12.40	14.80	3.61	3.62	11.72	11.90
Metribuzin 210 g/ha 1-2 DBFI	116.90	116.40	24.10	22.30	156.1	139.3	5.80	6.10	2.10	1.50	5.10	4.10
Sulfosulfuron 20 g/ha 1-2 DBFI	112.35	115.20	23.44	22.07	148.4	135.1	8.71	9.11	2.10	2.05	6.91	6.60
Sulfosulfuron 25 g/ha 1-2 DBFI	112.57	118.17	24.35	22.45	150.4	139.1	5.73	5.50	1.40	1.40	4.70	4.60
Sulfosulfuron 25 g/ha 1-2 DAFI	121.67	124.07	24.95	23.30	158.6	144.1	3.11	3.51	0.86	0.91	1.21	0.98
Isoproturon 750 g/ha 1-2 DBFI	114.97	121.12	22.57	22.20	148.6	136.1	14.81	14.45	3.92	3.50	12.87	11.40
Isoproturon 1000 g/ha 1-2 DBFI	117.10	119.05	23.90	22.77	150.4	139.1	9.93	9.81	2.50	2.30	8.25	7.40
Isoproturon 750 g/ha 1-2 DAFI	110.15	117.42	24.15	22.97	154.5	143.6	6.90	7.12	1.53	1.20	5.01	3.80
Isogard plus 1000 + 2,4-D 500 g/ha 1-2 DAFI	117.72	116.42	23.97	21.87	157.3	144.6	4.52	4.73	0.81	0.70	2.72	2.40
Manual weeding at 30 DAS	97.67	102.45	20.27	19.42	118.1	114.1	24.71	38.71	14.30	14.70	38.93	48.24
Manual weeding at 30 and 45 DAS	119.35	118.89	24.20	22.75	151.4	142.5	16.33	21.43	4.71	4.40	15.61	14.40
Unweeded (check)	92.60	92.58	15.97	16.00	105.2	99.5	56.02	66.10	34.70	33.9	84.70	77.60
CT + manual weeding at 30 and 45 DAS	125.30	120.67	24.60	23.41	159.6	145.1	8.32	13.21	2.23	1.10	7.33	3.70
CT + unweeded (check)	84.62	72.97	16.30	16.00	91.2	90.3	68.00	72.10	38.60	38.60	89.61	85.70
LSD(P=0.05)	8.35	14.68	1.43	1.26	15.3	10.1	3.9	2.13	0.61	0.57	2.90	2.06

CT- Conventional tillage, DBFI - Days before first irrigation, DAFI - Days after first irrigation

more in zero tillage wheat. Zero tillage fetched even higher net return when herbicides replaced manual weeding. Herbicides were more effective in zero tillage when applied after first irrigation.

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