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Effect of chemical measures of weed control in zero-till wheat (*Triticum aestivum L*) at Gangetic alluvium of Eastern India

S. SUDHA RANI AND A.C. PRADHAN

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.

ABSTRACT

A field experiment was carried out during winter seasons of 2002–03 and 2003–04at District Seed Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal to study the effect of chemical methods of weed control in zero-till wheat. The experiment was conducted in randomized block fourteen treatments and three replications. The results of the experiment revealed that crop was severely infested with sedges and grasses as compared to broad leaf weeds. The pooled analysis showed 50 percent reduction in grain yield due to weed-crop competition. All weed control methods effectively reduced weed density and markedly suppressed dry weight of weeds. Growth parameters of wheat like tiller density, leaf area indices, crop growth rates and yield components viz. spike density, number of filled grains per spike and test weight of grain increased significantly by the application of chemicals over weedy check in comparism to others. Application of metribuzin 175 g ha^{-1} before first irrigation effectively controlled all categories of weeds in zero-till wheat resulting in 78.2 percent increase in grain production which was comparable with weed free and two manual weedings. Among the chemical control measures metribuzin 175 g ha^{-1} before first irrigation was most economical by paying highest net return (Rs. 18,598/-) and benefit- cost ratio (2 : 1).

Key words : Chemical weed control, zero tillage, wheat.

In India wheat is the second most important cereal crop after rice, grown under varied agro-climatic conditions. Delay in wheat sowing from late to very late leads to decline in grain yields from 14 – 34 percent in different agro-climatic zones of India (Jag Shoran *et al*, 2004). The main problem in sowing of wheat after harvest of kharif rice is the preparation of land at high residual moisture condition. Zero - tillage, surface seedling and minimum tillage may overcome the above problems. Weed infestation in wheat is one of the most important reasons for getting low yields which cause 16.30 percent reduction in grain yield (Mukhopadhyay, 1997). All categories of weed flora appear in wheat crop when wheat is grown in rice fallow under West Bengal conditions (Das *et al* 1989). To control all categories of weeds some broad spectrum new herbicides have to be introduced which are safe, effective and economical.

Keeping the above views in mind a field experiment was carried out to evaluate the relative efficacy of some new broad spectrum herbicides on growth and yield of wheat under zero-tillage system in rice fallow.

MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) seasons of 2002-03 and 2003-04 at Kalyani District Seed Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal on clayey loam soil. The experimental soil was neutral in reaction (pH 7.7) medium in organic carbon (0.68%) and available potassium (179 kg ha^{-1}) and low in available phosphate (20.8 Kg ha^{-1}) and 0.07 percent total nitrogen. The experiment was laid out in randomized block design with fourteen treatments having metribuzin 140 g ha^{-1} before first irrigation, metribuzin 175 g ha^{-1} before first irrigation, metribizin 210 g ha^{-1} after first irrigation, sulfosulfuron 20 g ha^{-1} before first irrigation and sulfosulfuron 25 g ha^{-1} before first irrigation, sulfosulfuron 25 g ha^{-1} after first irrigation, isoproturon 750 g ha^{-1} and 1000 g ha^{-1} before first irrigation, isoproturon 1000 g ha^{-1} after first irrigation, isoguard plus 1250 g ha^{-1} after first irrigation, one manual weeding at 20 days after sowing (DAS), two manual weedings at 20 and 35 DAS. Weed-free check (three manual weedings at 20, 30 and 50 DAS) and weedy check. The treatments were replicated thrice. Rajlakshmi (HP 1731), improved recommended variety of wheat was used in the experiment. The crop was provided with all inputs in time as per

recommendations. Plant height, tiller number per sq.m., leaf area index (LAI), crop growth rate (CGR), net assimilation rate (NAR) dry matter production were recorded. Yield components like spike density per sq.m. number of filled grains per spike, thousand grain weight, yields of grain and bhusa were recorded at harvest. Dry weight of grasses, sedges and broad leaf weeds were recorded by using 0.25 m X 0.25 m metal quadrate from two places in each plot and analysis was done after converting the original data to square root $\sqrt{x+0.5}$ transformation.

RESULTS AND DISCUSSION

Effect on growth attributes

Plant height recorded from various treatments were found non-significant (Table 1), highest density of tillers per sq.m. were obtained from weed-free plot followed by the treatments having two manual weedings and metribuzin at the lower doses (140 g and 175 g ha^{-1}) before first irrigation. Significant increase in tiller density per sq.m. was observed in all weed control treatments as compared to weedy check plot. Leaf area index (LAI) was increased from 30 to 60 days after sowing (DAS). Maximum LAI was noticed from weed-free treatment closely followed by metribuzin @ 175 g ha^{-1} before first irrigation, these two treatments were at par each other. Significant increase in LAI were noticed from all weed control treatments as compared to unweeded plot. Maximum crop growth rate (CGR) recorded from weed free plot at 30 – 60 and 60 – 90 DAS followed by metribuzin @ 175 g ha^{-1} before first irrigation, lowest values of CGR was obtained from unweeded check. Net assimilation rate (NAR) was found non-significant when recorded between 30 – 60 and 60 – 90 DAS. Maximum quantity of dry matter was produced from weed free plot closely followed by metribuzin @ 175 g ha^{-1} before first irrigation. In respect to dry matter production these two treatments were at par. Remarkable increase in dry matter production was also observed from all plots receiving manual weedings. Significant increase in dry matter production was also observed from other weed control measures in comparison with weedy check.

Effect on yield components

Maximum numbers of spikes per sq. m. were produced from weed free plot, closely followed by the treatment receiving metribuzin @ 175 g ha^{-1} before first irrigation (Table 2). These two treatments did not differ significantly. Significant increase in spike number was also obtained from the treatment having metribuzin @ 140 g ha^{-1} before first irrigation which was comparable with two manual weedings. More number of spikes were obtained from the rest of weed control treatments in comparison with unweeded plot. Weed-free plot produced maximum number of filled grains/spike closely followed by metribuzin @ 175 g ha^{-1} before first irrigation and are statistically at par. Least number of filled grains per spike was received from unweeded plot. Higher test weight of grains was recorded from weed-free plot closely followed by treatments receiving metribuzin @ 175 g ha^{-1} before first irrigation and two manual weedings. These three treatments were at par each other. Test weight of grains was remarkably increased from the treatments having metribuzin @ 140 g ha^{-1} before first irrigation and its higher dose (210 g ha^{-1}) after first irrigation and plot receiving two manual weedings.

Grain and bhusa yield

Grain yield of wheat was significantly increased from all weed control treatments as compared to weedy check plot (Table 2). Weed-free plot, plots receiving metribuzin 175 g ha^{-1} before first irrigation and two manual weedings were proved to be more effective for enhancing the grain production. Grain yield obtained from above three treatments did not show any significant difference among themselves. Improvement in grain yield at lower magnitudes was also observed from the rest of the treatments where isoproturon and sulfosulfuron were used. The results from the bhusa yield revealed that maximum bhusa yield was recorded from weed-free plot followed by the treatment receiving two manual weedings. Remarkable increase in bhusa yield was also observed from metribuzin treated plots at 140 g ha^{-1} and 175 g ha^{-1} before first irrigation and 210 g ha^{-1} after first irrigation. The lowest bhusa yield was recorded from unweeded plot.

Economics of weed control methods in zero till wheat

Maximum gross return was obtained from weed free treatment followed by two manual weedings and metribuzin treated plots. Highest net return was obtained from metribuzin 175 g ha^{-1} before first irrigation followed by metribuzin 140 g ha^{-1} before first irrigation and same chemical 210 g ha^{-1} after first irrigation with regards to benefit-cost ratio. The

Table 1 Growth attributes as influenced by chemical methods of weed control in zero-till wheat

Treatments	Plant height (cm)	Tiller density m^{-2}	Leaf area index (LAI)		Crop growth rate or CGR (g m^{-2} day^{-1})		Net assimilation rate or NAR (g m^{-2} day^{-1})		Dry matter production gm^{-2}
	90 DAS#	90 DAS	30 DAS	60 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS	90 DAS
Metribuzin 140 g b.f.i.*	82.0	375.5	1.38	2.19	10.81	3.78	2.86	6.17	801.0
Metribuzin 175 g b.f.i.	81.0	385.3	1.42	2.55	12.67	4.13	3.21	6.36	856.5
Metribuzin 210 g a.f.i.**	80.0	354.0	1.35	2.26	10.71	4.11	3.00	5.91	822.5
Sulfosulfuron 20 g b.f.i.	79.0	345.5	1.22	2.01	10.0	3.27	3.00	5.83	755.3
Sulfosulfuron 25 g b.f.i.	80.5	329.5	1.25	2.10	9.99	3.65	2.98	5.91	761.5
Sulfosulfuron 25 g a.f.i.	80.7	335.0	1.06	1.88	8.82	3.48	1.83	5.95	723.5
Isoproturon 750 g b.f.i.	79.0	345.0	1.18	1.98	9.38	3.63	2.87	6.13	745.5
Isoproturon 1000 g.b.f.i.	81.5	324.5	1.13	1.86	9.65	3.64	2.75	6.13	771.0
Isoproturon 1000 g a.f.i.	82.5	338.0	1.19	1.83	9.43	3.61	3.00	6.45	746.9
Isoguard plus 1250 g. a.f.i.	82.0	358.0	1.27	1.92	10.28	3.08	2.60	6.17	750.4
One manual weeding 20 DAS #	79.0	324.0	1.17	1.82	9.90	3.34	2.70	5.90	756.5
Two manual weeding 20 & 35 DAS	80.5	373.0	1.42	2.57	12.25	3.74	3.10	5.84	848.0
Weed free check (3 manual weedings 20, 35 & 50 DAS)	84.0	407.0	1.52	2.58	14.23	4.18	2.97	6.46	880.7
Weedy check	75.0	270.5	1.02	1.40	7.99	2.28	2.58	4.68	663.5
SEm±	**1.8**	**8.95**	**0.03**	**0.12**	**0.46**	**0.24**	**0.81**	**0.27**	**12.04**
CD at 5%	**NS**	**18.0**	**0.06**	**0.24**	**0.93**	**0.50**	**NS**	**NS**	**24.20**

* b.f.i. = before first irrigation
** a.f.i. = after first irrigation
# DAS = days after sowing

Table 2 Yield and yield components and economics of wheat as influenced by chemical methods of weed control in zero-till wheat

Treatments	Spike density m^{-2}	Number of filled grains/spike	1000 grain weight (g)	Grain yield t ha^{-1}	Bhusa yield t ha^{-1}	Gross return Rs. ha^{-1}	Net return Rs. ha^{-1}	Benefit-cost ratio
Metribuzin 140 g b.f.i.*	369.0	26.6	34.337	2.51	6.16	26240	17008	1.84
Metribuzin 175 g b.f.i.	385.5	28.5	36.171	2.74	6.40	27880	18598	2.00
Metribuzin 210 g a.f.i.**	340.5	25.2	34.780	2.46	6.31	26022	16690	1.78
Sulfosulfuron 20 g b.f.i.	340.0	24.2	32.478	2.28	4.78	23044	13962	1.53
Sulfosulfuron 25 g b.f.i.	324.0	24.4	31.021	2.07	5.18	21740	12647	1.39
Sulfosulfuron 25 g a.f.i.	307.5	21.1	30.652	1.95	4.90	20476	11383	1.25
Isoproturon 750 g b.f.i.	330.5	23.6	31.763	2.20	5.47	23102	13762	1.47
Isoproturon 1000 g.b.f.i.	314.0	22.7	32.628	2.12	4.61	21546	12103	1.28
Isoproturon 1000 g a.f.i.	329.0	24.4	30.729	2.17	4.91	22270	12827	1.35
Isoguard plus 1250 g. a.f.i.	338.0	24.3	30.758	2.12	5.56	22504	13123	1.39
One manual weeding 20 DAS #	316.0	24.1	33.383	2.12	5.14	22124	8021	0.57
Two namual weedings 20 & 35 DAS	317.0	26.7	36.558	2.70	7.18	28780	12616	0.78
Weed free check (3 manual weedings 20, 35 & 50 DAS)	399.5	30.3	38.570	3.07	8.09	32650	14623	0.81
Weedy check	268.5	17.1	29.497	1.71	4.12	18160	9386	1.6
SEm±	**7.8**	**1.11**	**1.236**	**0.142**	**0.314**			
CD at 5%	**15.8**	**2.25**	**2.534**	**0.412**	**0.630**			

* b.f.i. = before first irrigation
** a.f.i. = after first irrigation
# DAS = days after sowing

Table 3 Categorized weeds density m^{-2} as affected by chemical methods of weed control in zero-till wheat

Treatments	Grasses			Sedges			Broad leaf weeds		
	30 DAS#	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Metribuzin 140 g b.f.i.*	12.33 (152.02)	14.48 (209.67)	15.60 (243.36)	18.62 (346.70)	21.56 (468.83)	22.850 (522.12)	5.71 (32.60)	7.49. (56.10)	8.70 (75.69)
Metribuzin 175 g b.f.i.	10.55 (113.30)	13.27 (176.09)	14.37 (206.49)	17.27 (298.25)	20.09 (403.60)	22.28 (496.39)	5.14 (26.41)	6.82 (46.51)	8.35 (69.72)
Metribuzin 210 g a.f.i.**	10.21 (104.24)	14.55 (211.70)	14.57 (212.28)	19.91 (396.40)	21.07 (443.94)	22.64 (512.56)	5.64 (31.80)	7.06 (49.84)	8.57 (73.44)
Sulfosulfuron 20 g b.f.i.	12.92 (166.92)	14.99 (224.70)	16.84 (283.58)	19.93 (397.20)	22.95 (504.00)	24.49 (599.76)	5.89 (34.69)	7.56 (57.15)	9.00 (81.00)
Sulfosulfuron 25 g b.f.i.	13.20 (174.24)	15.25 (232.56)	17.01 (283.34)	20.37 (414.93)	22.90 (524.41)	24.96 (623.00)	6.35 (40.32)	7.58 (57.45)	9.20 (84.64)
Sulfosulfuron 25 g a.f.i.	13.67 (186.86)	16.03 (256.96)	17.49 (305.90)	20.79 (432.22)	23.09 (533.14)	25.35 (642.62)	6.71 (45.02)	8.05 (64.80)	9.29 (86.30)
Isoproturon 750 g b.f.i.	12.91 (166.66)	15.04 (226.20)	16.46 (270.93)	20.95 (438.90)	23.56 (555.07)	25.06 (628.00)	5.93 (35.16)	7.63 (58.21)	8.65 (74.82)
Isoproturon 1000 g b.f.i.	12.84 (164.86)	15.05 (226.50)	16.64 (276.88)	20.06 (402.40)	22.84 (521.66)	24.85 (616.03)	5.92 (35.04)	7.48 (55.95)	8.66 (74.99)
Isoproturon 1000 g a.f.i.	13.04 (170.04)	15.15 (229.52)	16.71 (279.22)	20.30 (412.09)	22.88 (523.49)	24.57 (603.68)	6.30 (39.69)	7.33 (53.72)	8.36 (69.88)
Isoguard plus 1250 g a.f.i.	12.81 (164.09)	15.22 (231.64)	15.64 (244.60)	18.11 (327.90)	20.89 (436.39)	22.63 (512.11)	5.29 (27.98)	6.52 (42.51)	8.47 (71.74)
One manual weeding 20 DAS#	11.95 (142.80)	14.82 (219.63)	16.48 (271.50)	17.25 (298.25)	21.08 (444.36)	22.40 (501.76)	6.65 (31.92)	7.48 (55.95)	8.62 (74.30)
Two manual weedings 20 & 35 DAS	11.95 (142.80)	10.79 (116.42)	12.30 (151.29)	12.98 (168.48)	13.67 (186.86)	13.15 (172.92)	7.04 (49.56)	5.97 (35.64)	7.63 (58.21)
Weed free check (3 manual weedings 20, 35 & 50 DAS	3.77 (14.21)	5.93 (35.16)	3.16 (9.98)	4.05 (16.40)	4.44 (19.71)	4.05 (16.40)	1.86 (3.45)	10.81 (3.27)	1.93 (3.72)
Weedy check	15.07 (227.10)	16.09 (258.88)	19.67 (386.90)	22.85 (522.12)	22.41 (502.20)	27.97 (782.32)	9.16 (83.90)	10.80 (116.64)	11.75 (138.06)
SEm±	**0.15**	**0.40**	**0.05**	**0.13**	**0.34**	**0.65**	**0.17**	**0.27**	**0.23**
CD at 5%	**0.30**	**0.82**	**1.01**	**0.26**	**0.68**	**1.31**	**0.34**	**0.54**	**0.46**

Figures in parenthesis indicates original values.

* b.f.i. = before first irrigation

** a.f.i. = after first irrigation

\# DAS = days after sowing

Table 4 Dry weight of categorized weeds g m^{-2} as affected by chemical methods of weed control in zero-till wheat

Treatments	Grasses			Sedges			Broad leaf weeds		
	30 DAS#	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Metribuzin 140 g b.f.i.*	5.90 (35.31)	7.73 (59.75)	9.86 (97.21)	7.44 (55.35)	10.53 (110.88)	12.84 (164.86)	2.67 (7.12)	4.88 (23.81)	7.56 (57.15)
Metribuzin 175 g b.f.i.	5.56 (31.41)	6.85 (46.92)	9.38 (87.98)	7.15 (51.12)	9.68 (93.70)	12.06 (145.44)	2.65 (7.02)	4.60 (21.16)	7.19 (51.69)
Metribuzin 210 g a.f.i.**	5.78 (33.90)	7.39 (54.61)	9.82 (96.43)	6.95 (48.30)	9.97 (99.40)	12.38 (153.26)	2.75 (7.56)	4.64 (21.52)	7.25 (52.56)
Sulfosulfuron 20 g b.f.i.	6.27 (39.81)	8.17 (66.78)	10.25 (105.66)	8.03 (64.48)	11.13 (123.87)	13.19 (173.97)	2.90 (8.41)	4.94 (24.40)	7.49 (56.10)
Sulfosulfuron 25 g b.f.i.	6.34 (40.69)	8.20 (67.24)	10.30 (106.09)	8.13 (66.09)	11.21 (125.66)	13.57 (184.14)	3.09 (9.42)	5.08 (25.80)	7.55 (57.00)
Sulfosulfuron 25 g a.f.i.	6.46 (41.73)	8.60 (73.96)	10.78 (116.20)	8.58 (73.61)	11.81 (139.47)	14.08 (198.24)	3.11 (9.67)	5.6 (26.62)	7.66 (58.67)
Isoproturon 750 g b.f.i.	6.41 (41.08)	8.60 (73.96)	10.98 (120.56)	8.46 (71.57)	11.24 (126.33)	14.04 (197.12)	2.88 (8.29)	4.92 (24.20)	7.50 (56.25)
Isoproturon 1000 g b.f.i.	6.13 (37.57)	8.12 (65.93)	10.24 (104.85)	8.02 (64.32)	10.83 (117.28)	13.14 (172.65)	2.93 (8.58)	4.84 (23.42)	7.35 (54.02)
Isoproturon 1000 g a.f.i.	6.31 (39.81)	7.80 (60.84)	10.06 (101.20)	8.14 (66.25)	11.06 (122.32)	13.48 (181.71)	3.01 (9.06)	4.84 (23.42)	7.38 (54.46)
Isoguard plus 1250 g a.f.i.	6.05 (36.60)	7.38 (54.46)	9.79 (95.84)	7.59 (57.60)	10.46 (109.41)	11.97 (143.28)	2.83 (8.00)	4.51 (20.34)	6.98 (48.72)
One manual weeding 20 DAS#	5.28 (27.87)	7.05 (49.70)	9.77 (95.45)	6.68 (44.62)	9.07 (82.26)	11.53 (132.94)	2.71 (7.34)	4.44 (19.71)	7.43 (55.20)
Two manual weedings 20 & 35 DAS	4.63 (21.43)	5.86 (34.33)	7.75 (60.06)	5.51 (30.36)	7.28 (52.99)	9.00 (81.00)	2.70 (7.29)	4.26 (18.14)	6.73 (45.29)
Weed free check (3 manual weedings 20, 35 & 50 DAS	2.13 (4.53)	2.21 (4.84)	3.42 (11.69)	2.69 (7.23)	2.80 (7.84)	3.28 (10.75)	1.13 (1.27)	1.91 (3.64)	2.14 (4.57)
Weedy check	7.02 (49.28)	9.81 (96.23)	12.86 (165.37)	9.22 (85.00)	14.71 (216.38)	17.12 (293.09)	3.84 (14.74)	6.64 (44.08)	8.94 (79.92)
SEm±	**0.17**	**0.52**	**0.45**	**0.13**	**0.53**	**0.77**	**0.09**	**0.19**	**0.10**
CD at 5%	**0.34**	**1.04**	**0.91**	**0.26**	**1.06**	**1.55**	**0.18**	**0.38**	**0.21**

Figures in parenthesis indicates original values.

* b.f.i. = before first irrigation

** a.f.i. = after first irrigation

\# DAS = days after sowing

highest value (2 : 1) was obtained from metribuzin 175 g ha^{-1} before first irrigation.

Weed flora associated with crop

The weed flora appeared in the experimental field were categorized in three groups–grasses, sedges and broad leaves. Grasses were *Cynadon dactylon, Phalaris minor, Arena fatuva, Echinochloa crusgalli* and *Echinochloa colonum*; sedge was *Cyperus rotundus* and Broad leaves were *Physalis minima, Chenopodium album, Anagallis arvensis, Circium arvense, Melilotus alba, Solanum nigrum, Viscia sativa, Rumex retroflex, Euphorbia hirta, Cannabis sativa* and *Argemone mexicana.*

Weed dynamics

The results of the experiment on weed dynamics were presented in Table 3. The results of the experiment revealed that more number and dry weight of weeds were contributed from sedges, followed by grasses and the least from broad leaved weeds in all weed control treatments. Lowest number and dry weight of weeds (sedges, grasses and broad leaf) were recorded from weed free plot at 30, 60 and 90 DAS followed by the treatment receiving two manual weedings. Considerable reduction in weed density and their dry weight were noticed from the metribuzin treated plots both at 140 g and 175 g ha^{-1} before first irrigation and 210 g ha^{-1} after first irrigation. Lower number of weeds and their dry weights were recorded from all weed control treatment as compared to unweeded plot.

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