Journal of crop and weed **2**(1) : 52-59 (2005)

Effect of weed management on wheat (*Triticum aestivum* L.) under different tillage systems after *kharif* rice

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ABSTRACT

To study the efficacy of weed management (Metribuzin 175 g ha^{-1} and isoguard plus 1250 g ha^{-1} as post-emergence at 4 weeks of sowing, one hoeing at 4 weeks of sowing along with weed free and weedy checks) on wheat under different tillage systems (zero, minimum and conventional) a field experiment was carried out at District Seed Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Begnal during winter seasons of 2001-2002 and 2002 - 2003 in split plot design with three tillage systems in main-plots and five weed control measures in sub-plots. The treatments were replicated thrice. The pooled analysis of the experiment revealed that growth parameters like plant height, tiller density and dry matter production at harvest, leaf area indices upto 11 weeks of sowing, crop growth rates from 7 to 9, 9 to 11 and 11 to 13 weeks after sowing improved significantly among three tillage systems and between five weed control treatments. Yield components viz. number of spikes per square metre, number of grains per spike and test weight of grains increased significantly within tillage systems and between weed control measures. Grain yield of wheat differed significantly among the tillage systems. 41.2 and 53.2 per cent increase in grain yields were obtained from minimum and conventional tillage respectively over zero tillage. Significant increase in grain yields were observed from all weed control measures over weedy check. 56.9, 48.1, 37.4 and 22.4 per cent increase in grain were recorded from weed free check, isoguard plus, metribuzin and one hoeing, in sequence over weedy check. Significant difference in weed density and dry weight of weeds were observed between tillage systems at early stages of crop growth. However, the lowest values were recorded from conventional tillage followed by minimum tillage. Among three categorised weeds (grasses, sedges and broad leaves), appearance of broad leaves under zero tillage was quite low. Density and dry weight of weeds were significantly reduced due to all weed control measures. However, metribuzin 175 g ha^{-1} was proved to be the best herbicidal treatment closely followed by isoguard plus 1250 g ha^{-1} for controlling all categorised weeds. Among these two treatments, isoguard plus was much more profitable in terms of net return and benefit-cost ratio under three tillage systems.

Key words : Weed management, tillage system, wheat

To meet the need of the steadily rising demographic pressure and to increase the total food grain production, cultivation of wheat after transplanted *kharif* rice is gaining importance in India, especially in eastern and north eastern regions of the country which covers about 10 million hectares under this cropping system (Singh *et al,* 1986). Under such conditions a primery deep tillage after harvesting of *kharif* rice followed by some secondary tillage operations for seed bed preparation of wheat is the common practice. This practice takes about 2 - 3 weeks to make the field ready for wheat sowing which is not feasible before first fortnight of December under medium land situation and second fortnight of December under medium low land conditions. Thus the productivity of wheat is reduced drastically due to curtailment of winter spell for delayed sowing. Recently, reduced tillage and zero tillage have been advocated by a number of wheat agronomists for these areas to minimise the duration of land preparation for wheat sowing in rice fallow at optimum residual moisture conditions. Weed infestation is one of the most important reasons of low yield of wheat causing 16 - 30% reduction in yield (Mukhopadhyay, 1992). Mixed weed flora appear in wheat field when wheat is cultivated in rice fallow under West Bengal situations (Das *et al,* 1997). Hand pulling method of weed control inspite of being very expensive, is still used by the farmers. A very few wheat farmers of eastern and north eastern India use the herbicide 2, 4-D which can control only broad-leaved weeds. To control mixed weed flora in wheat crop some broad spectrum new herbicides have been introduced. These herbicides are have been reported to control mixed weed flora in wheat field very effectively and economically.

Keeping the above views in mind a field experiment was carried out to evaluate the relative efficacy of weed control methods on growth and yield of wheat under conventional, minimum and zero tillage systems after *kharif* rice.

MATERIALS AND METHODS

A field experiment was carried out during winter (*rabi*) seasons of 2001-02 and 2002-03 at District Seed Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal situated at 22^0 56' N latitude, 88^0 32' E longitude at an elevation of 9.75 metres above the mean sea level (MSL). The topography of land is medium low with clayey loam soil having pH - 7.7, 0.65% organic carbon and moderate soil fertility (total nitrogen - 0.064%, available P_2O_5 – 20.1 kg ha^{-1} and available K_2O - 176 kg ha^{-1}) .

The experiment was laid out in split plot design having three tillage systems (zero, reduced and conventional) in main-plots and five weed control methods [metribuzin 175 g a.i. ha^{-1} as post emergence, isoguard plus i.e. isoproturon 750 g a.i. ha^{-1} + 2, 4-D 500 g. a.i. ha^{-1} as post-emergence, one hoeing at 28 days after sowing (DAS), weed free check (3 hand pulling at 20,35 and 50 DAS) and weedy check] in sub-plots and the treatments were replicated thrice. Wheat variety HP-1731(Rajlaxmi) was sown on 9th December, 2001 and 29th November, 2002 and harvested on 24th March 2002 and 19th March 2003 respectively. The crop was provided with all the inputs as per recommendation for this agro-climatic situation. The growth parameters at different stages of growth, yield components grain and bhusa yields of the crop were recorded. Population and dry weights of grasses, broad leaves and sedges were recorded at 40 and 80 DAS by using 0.5mX0.5m metal quadrat at two places from each plot and analysed after converting the original data to square root (□ x+0.5) transformation.

RESULTS AND DISCUSSION

Growth attributes

Plant height and tiller density per square metre recorded from conventional and reduced tillage were at par each other but significantly higher than those recorded from zero tillage. Maximum values of above two parameters were recorded from weed free check plot followed by those received from isoguard plus and metribuzin. Maximum LAI value was recorded from conventional tillage as compared to minimum tillage and zero tillage at 7, 9 and 11 weeks after sowing (WAS). No significant difference in LAI was found at 13 WAS. At all the growth stages (7,9,11 and 13 WAS) the highest LAI was recorded from weed free check plot followed by metribuzin and isoguard plus treated plots. Crop dry matter obtained from conventional tillage was at par with minimum tillage but it was significantly higher than that of zero tillage. Maximum crop dry matter was accumulated from weed free check plot followed by the plots receiving isoguard plus and metribuzin. Maximum values of crop growth (CGR) were obtained from conventional tillage followed by minimum tillage during the period between 7 - 9 and 11-13 weeks. Where as, the maximum values of CGR were received from the minimum tillage from the periods between 9 – 11 and 13 – 15 weeks which were at par with conventional tillage. The highest values of CGR were recorded from the period between 7-9 weeks and then decreased afterwards. However, the values of CGR recorded during 13 - 15 WAS under all the tillage systems did not differ significantly. The maximum values of CGR under weed control methods was recorded from the period between 7-9 WAS and then gradually declined excepting from one hoeing and weedy check. Among the weed control methods, weed free plot recorded highest value of CGR followed by isoguard plus and metribuzin treated plots.

Yield components

Conventional tillage system recorded maximum number of spikes per square metre, grains per spike and test weight of grain in comparison with minimum and zero tillage (Table 2). Maximum spikes per square metre was also produced from weed free check plots followed by plots treated with isoguard plus and metribuzin. However, spike production from those two chemical treatments were at par each other. Number of grains per spike were maximum in conventional tillage which was significantly higher than minimum and zero tillage systems. Maximum number of grains per spike was produced from weed free plot which was at par with those obtained from plots receiving metribuzin and isoguard plus. Effect of tillage on test weight of grain was similar to number of spikes per square metre. Among the weed control methods the highest value of test weight of grain was recorded from the weed free plot followed by the plots receiving metribuzin and isoguard plus; however, the values obtained from those two chemical treatments did not differ significantly.

Grain yield and harvest index

The highest grain yield was received from the pooled data conventional tilled-plots followed by minimum and zero-tilled plots during both the years of experimentation (Table 2). Two years pooled data showed that 53.2 and 41.2 per cent reduction in grain yield were obtained from zero tillage as compared to conventional and minimum tillage systems, respectively. Maximum grain yield was recorded from weed free treatment followed by the plots receiving isoguard plus and metribuzin during both the years of experimentation and also from their pooled analysis. From the first year of experimentation and pooled data the significant differences in grain yields were found from two chemical treatments with weed free chec where as in the second year grain yields obtained fron those three treatments were at par each other. 56.9 48.1, 37.4 and 22.4 per cent increase in grain yiel were recorded from weed free check, isoguard plus, metribuzin and one hoeing, over weedy check.

Maximum value of harvest index was obtained from conventional tillage followed by minimum tillage. Highest value of harvest index was recorded from metribuzin treatment followed by isoguard plus treatment and the lowest from weedy check plot (Table 3).

Weed spectrum

Different categories of weed flora appeared in the field during two years of experiment are presented below:

Grasses	Broad leaves
Cynodon dactylon Pers.	*Physalis minima* L.
Avena fatua Dur.	*Chenopodium album* L.
Phalaris minor Retz.	*Anagallis arvensis* L.
Echinochloa colonum (L.) Link	*Circium arvense* L.
Echinochloa crusgalli (L.) Beauv.	*Fumaria parviflora* L.
Sedges	*Melilotus alba* Debr.
Cyperus rotundus L.	

Weed dynamics

The results of the experiment on weed density depicted in table 3 revealed that no significant effect of tillage systems was observed on the population of sedges and broad-leaved weeds. But the density of grasses was significantly influenced by tillage systems at 40 DAS which was reflected on total weed density. Among weed control treatments weed free check recorded lowest weed density followed by metribuzin treated plots both at 40 and 80 DAS.

Dry weight of weeds varied considerably under different tillage systems and weed control methods (Table 4). Minimum dry weight of weeds were received from the weed free plot followed by the plots receiving metribuzin and isoguard plus at all growth stages of the crop. Regarding reduction in dry weight of individual category of weeds metribuzin showed its superiority on grasses as compared to isoguard plus but the chemical failed to control sedges.

Production economics

The production economics of the experiment was presented in table 5. The cost of cultivation varied from Rs. 7837 ha^{-1} to Rs. 12235 ha^{-1} due to different tillage systems and weed control methods. Gross returns of Rs. 21310, 29889 and 31670 were obtained from weed free plots under zero, minimum and conventional tillage, closely followed by Rs. 19529, 28387, and 29546 from isoguard plus and Rs. 17834, 25240 and 28207 from metribuzin under zero, minimum and conventional tillage systems, respectively. Net returns of Rs. 11290, 19212 and 19300 were obtained from isoguard plus under zero, minimum and conventional tillage system followed by Rs. 11081 and 18724 from weed free plots under zero and minimum tillage systems. Maximum benefit-cost ratio (2.09 and 1.88) were obtained from isoguard plus under minimum and conventional tillage systems (1.72) from and metribuzin under minimum and conventional tillage systems.

Table 1 Growth parameters of wheat as influenced by tillage systems and weed control methods

Treatments	Plant height (cm)	Tiller density	Leaf area index(LAI)				Dry Matter (g/ha^{-1})	crop growth rate (g m^{-2} day^{-1})			
	At harvest	At harvest	7 WAS^{+}	9 WAS	11 WAS	13 WAS	At harvest	7-9 WAS	9-11 WAS	11-13 WAS	13-15 WAS
Tillage systems:											
Zero tillage	73.27	208.08	1.75	1.92	0.94	0.66	69.24	9.00	6.64	6.06	1.81
Minimum tillage	82.25	277.84	3.43	3.71	1.63	0.69	99.99	10.12	10.07	7.60	2.54
Conventional tillage	83.02	286.18	3.82	4.12	1.66	0.68	103.94	13.17	9.52	8.87	2.20
SEm(±)	0.88	4.01	0.11	0.11	0.02	0.01	3.16	0.36	0.55	0.22	0.28
CD (at 5%)	2.89	13.07	0.36	0.35	0.08	NS^{0}	10.30	1.17	1.80	0.72	NS
Weed control methods:											
Metribuzin 175 g ha^{-1}	80.18	264.88	3.14	3.46	1.38	0.70	87.42	10.35	10.13	7.09	1.75
Isoguard plus 1250 g ha^{-1}	79.60	271.35	3.03	3.22	1.38	0.67	99.04	13.03	9.74	7.13	2.48
One hoeing at 28 DAS*	77.91	234.64	2.56	2.77	1.38	0.67	81.51	7.64	6.73	8.48	2.12
Weed Free Check (3hw^)	82.16	283.64	3.54	3.91	1.65	0.72	114.33	16.05	9.93	7.56	2.58
Weedy Check	77.71	232.33	2.73	2.89	1.26	0.63	72.98	6.76	7.19	7.28	2.00
SEm(±)	0.50	3.55	0.12	0.09	0.02	0.01	2.18	0.33	0.36	0.31	0.43
CD (at 5%)	1.42	10.09	0.35	0.28	0.06	0.04	6.21	0.95	1.01	0.87	NS

* DAS = days after sowing, $^{+}$ WAS = weeks after sowing, NS^{0} = non-significant, hw^ = hand weeding

Table 2 Yield components, grain yield and harvest index of wheat as influenced by tillage systems and weed control methods.

Treatments	Yield Components			Yield (t ha^{-1})			Harvest Index (%)
	Number of spikes per m^{-2}	Grains per spike	Test wt. (g)	2001-02	2002-03	Pooled	
Tillage systems:							
Zero tillage	208.08	30.73	36.57	1.47	2.73	2.10	29.10
Minimum tillage	277.84	35.17	36.76	2.14	3.80	2.97	30.17
Conventional tillage	286.18	38.35	37.23	2.63	3.81	3.22	30.59
SEm(±)	4.01	0.27	0.10	0.08	0.22	0.12	-
CD (at 5%)	13.07	0.88	0.32	0.31	0.85	0.38	-
Weed control methods:							
Metribuzin 175 g ha^{-1}	264.88	37.37	37.45	2.13	3.58	2.86	31.53
Isoguard plus 1250 g ha^{-1}	271.35	37.26	37.36	2.38	3.78	3.08	30.76
One hoeing at 28 DAS*	234.64	32.32	35.95	1.74	3.34	2.54	30.26
Weed Free Check (3 hw^)	283.64	37.64	38.52	2.67	3.85	3.26	29.45
Weedy Check	232.33	29.15	34.98	1.47	2.68	2.08	27.93
SEm(±)	3.55	0.39	0.22	0.05	0.17	0.09	-
CD (at 5%)	10.09	1.13	0.63	0.15	0.49	0.25	-

* DAS = days after sowing, hw^ = hand weeding

Table 3 Weed density (number m^{-2}) as affected by tillage systems and weed control methods

Treatments	Weed population (no. m^{-2})							
	Total		Grasses		Sedges		Broad leaves	
	40 DAS*	80 DAS	40 DAS	80 DAS	40 DAS	80 DAS	40 DAS	80 DAS
Tillage systems:								
Zero tillage	24.13 (600.75)	38.51 (1537.90)	15.09 (250.80)	22.83 (558.07)	16.62 (282.45)	21.07 (460.15)	7.82 (67.50)	22.24 (519.68)
Minimum tillage	21.58 (503.84)	37.07 (1407.80)	7.97 (85.91)	20.46 (444.62)	15.64 (249.57)	20.69 (441.05)	10.68 (168.36)	22.40 (522.13)
Conventional tillage	20.90 (455.84)	37.18 (1439.47)	8.61 (83.21)	19.82 (415.55)	16.01 (262.36)	20.73 (444.82)	9.13 (110.27)	23.45 (582.43)
SEm (±)	0.26	0.88	0.42	0.98	0.32	0.50	0.37	0.52
CD (at 5%)	0.86	NS^0	1.36	NS	NS	NS	NS	NS
Weed control methods:								
Metribuzin 175 g ha^{-1}	19.48 (390.54)	37.54 (1417.84)	9.95 (119.80)	20.76 (446.28)	15.08 (231.46)	22.75 (519.56)	5.73 (39.29)	21.14 (452.00)
Isoguard plus 1250 g ha^{-1}	21.99 (496.49)	37.80 (1434.39)	11.35 (159.48)	22.62 (527.10)	16.40 (273.04)	21.18 (450.99)	7.06 (63.96)	21.19 (456.30)
One hoeing at 28 DAS*	23.36 (562.62)	40.67 (1661.24)	10.59 (143.70)	24.11 (591.65)	15.60 (246.86)	21.47 (469.06)	11.79 (172.07)	24.21 (600.54)
Weed Free Check (3 hw^)	17.31 (305.70)	26.32 (704.85)	6.27 (50.91)	12.89 (171.11)	14.36 (209.06)	15.06 (232.01)	6.61 (45.73)	17.13 (301.74)
Weedy Check	28.87 (845.36)	45.62 (2090.29)	14.64 (225.99)	24.77 (627.59)	19.00 (363.55)	23.70 (571.76)	14.87 (255.82)	29.83 (896.50)
SEm(±)	0.65	0.94	0.77	0.65	0.45	0.53	0.75	0.58
CD (at 5%)	1.85	NS	2.18	1.84	1.29	1.51	2.15	1.66

Figure in the parenthesis are original values; square root transformation was used for statistical analysis.
* DAS = days after sowing, $^+$ WAS = weeks after sowing, NS^0 = non-significant, hw^ = hand weeding

Table 4 Dry wt (gm^{-2}) of weed as affected by tillage systems and weed control methods

Treatments	Dry wt of weeds ($g\ m^{-2}$)							
	Total		Grasses		Sedges		Broad leaves	
	40 DAS*	80 DAS	40 DAS	80 DAS	40 DAS	80 DAS	40 DAS	80 DAS
Tillage systems:								
Zero tillage	8.68 (81.95)	20.09 (423.23)	5.16 (32.19)	14.40 (222.71)	5.12 (27.63)	7.26 (56.27)	4.52 (22.13)	11.51 (144.26)
Minimum tillage	6.46 (45.26)	19.30 (393.24)	2.16 (10.22)	12.60 (174.63)	5.01 (25.98)	7.56 (62.81)	2.69 (9.06)	11.99 (155.79)
Conventional tillage	6.19 (41.30)	19.10 (384.47)	2.77 (9.14)	12.27 (166.60)	4.73 (23.7)	7.19 (53.57)	2.68 (8.39)	12.35 (164.29)
SEm (±)	0.44	0.38	0.22	0.34	0.27	0.27	0.17	0.23
CD (at 5%)	1.43	NS^0	0.72	1.09	NS	NS	0.56	NS
Weed control methods:								
Metribuzin 175 g ha^{-1}	6.34 (41.72)	16.81 (284.22)	2.70 (8.83)	10.32 (109.89)	4.94 (25.03)	8.29 (69.96)	2.48 (7.86)	10.15 (104.37)
Isoguard plus 1250 g ha^{-1}	6.94 (50.28)	17.9 (323.44)	3.82 (17.79)	12.83 (169.74)	5.11 (26.84)	6.69 (46.72)	2.10 (5.65)	10.17 (106.98)
One hoeing at 28 DAS*	7.57 (61.30)	21.51 (463.66)	3.37 (14.73)	14.41 (217.30)	5.06 (26.58)	7.68 (61.85)	4.28 (19.99)	13.26 (184.50)
Weed Free Check (3 hw^)	4.63 (22.28)	14.50 (212.44)	1.51 (2.15)	8.93 (80.63)	3.53 (12.79)	6.43 (46.48)	2.66 (7.34)	9.16 (85.33)
Weedy Check	10.09 (105.27)	26.75 (717.81)	6.18 (42.43)	18.97 (362.35)	6.14 (37.73)	7.60 (62.73)	4.96 (2 5.11)	17.00 (292.72)
SEm(±)	0.25	0.29	0.25	0.42	0.18	0.38	0.21	0.42
CD (at 5%)	0.71	0.85	0.71	1.21	0.51	1.09	0.59	1.18

Figure in the parenthecis are original values; square root transformation was used for statistical analysis.
*DAS = days after sowing., hw^ = hand weeding, NS^0 = non-significant

Table 5 Production Economics of wheat under tillage systems and weed control methods

Treatments	Yield (qha^{-1})		Cost of cultivation (Rs.)	Gross return ($Rs.ha^{-1}$)	Net return ($Rs.\ ha^{-1}$)	Benefit-cost ratio
	Grain	Bhusa				
Zero tillage:						
Metribuzin	21.41	48.28	8352	17883	9531	1.14
Isoguard plus	23.26	54.11	8239	19528	11289	1.37
One hoeing	20.12	50.94	8502	17140	8638	1.02
Weed free check	24.50	69.33	10229	21309	11080	1.08
Weedy check	15.82	45.78	7837	13820	5983	0.76
Minimum tillage:						
Metribuzin	30.19	68.45	9288	25240	15951	1.72
Isoguard plus	33.90	77.62	9175	28387	19211	2.09
One hoeing	26.68	64.54	9438	22548	13109	1.39
Weed free check	35.68	81.89	11165	29889	18723	1.68
Weedy check	22.00	59.64	8774	18978	10204	1.16
Conventional tillage:						
Metribuzin	34.10	72.29	10358	28207	17848	1.72
Isoguard plus	35.20	81.76	10245	29545	19300	1.88
One hoeing	29.53	65.86	10508	24622	14114	1.34
Weed free check	37.63	88.82	12235	31670	19434	1.59
Weedy check	24.54	64.50	9844	21048	11204	1.14

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