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Efficacy of tillage and weed management practices on weed infestation and yield of wheat

Dhiman Sen, Rohitashav Singh and Radhey Shyam
G.B. Pant University of Agriculture & Technology Pantnagar, U.S. Nagar (Uttarakhand)
E-mail: rohitash_1961@rediffmail.com

ABSTRACT

Effect of tillage methods and weed management practices on weed infestation and yield of wheat was studied during 2002-2003 and 2003-2004. Density and dry weight of total weeds recorded lower under zero till and bed planting system as compared to conventional tillage for initial year. In second year, it was again recorded lowest under zero tillage, but increasing trend was observed under bed planting situation. Number of spikes as well as grain yield was not influenced by tillage methods during first year, but was found maximum under zero till situation in the next year. Excellent suppression of weeds and thereby higher yields were obtained under two hand weeding under conventional system. Under weedy situation, zero till system was found better because of lesser weed emergence.

Key words: Conventional tillage, Zero tillage, Strip till drill, FIRBS, Isoproturon, Clodinafop-propargyl

Recently resource conserving technologies like zero tillage, bed planting and strip till drill (rotary tillage) are being promoted for wheat cultivation in the rice-wheat areas of the Indo-Gangetic zone (Hobbs 2002). Economic management of water (Sayre 2000), fertilizer, weeds and seed are the advantages in bed planting system (Yadav *et al.* 2002), where as, zero tillage and strip till drill have the advantages of earlier planting, reduced cost of production as well as less chances of green house gas emission (Hobbs 2002). Weed management is an important aspect in wheat production as 10-50% yield loss is common due to damage caused by different associated weeds (Mukhopadhyay and Bera 1980). For efficient and economic management of weeds in wheat, isoproturon has been found the most suitable herbicide for more than last two decades in India (Singh *et al.* 2001). In north western part of India, *P. minor* biotypes have already developed resistance against isoproturon (Malik and Singh 1995), which has created a major problem in weed management. Use of clodinafop-propargyl is one of the herbicides which has been found promising against grassy weeds, particularly for resistant *P. minor* biotype (Brar *et al.* 2003). Considering the above facts in view, present investigation was undertaken to study that how different tillage methods and weed management practices influence the pattern of weed infestation and grain yield of wheat.

MATERIALS AND METHODS

A field experiment was conducted during winter seasons of 2002-2003 and 2003-2004 at crop research centre of G.B. Pant University of Agriculture and Technology, Pantnagar. Soil of the experimental field was silty clay loam in texture, medium in organic carbon (0.73%), available phosphorus (19.0 kg/ha) and available potassium (214 kg/ha). For the several years, rice-wheat cropping system is being practiced on the experimental field.

Sixteen treatments comprised of four tillage methods *viz.,* conventional tillage, zero tillage, strip till drill and furrow irrigated raised bed planting system (FIRBS) in the main plot and four weed management practices *viz.,* two hand weeding (at 30 and 50 days after sowing), isoproturon at 1.0 kg/ha (30 days after sowing), clodinafop-propargyl at 0.06 kg/ha (30 days after sowing) and weedy check in the sub plot were laid out in a split plot design with four replications. Conventional system was followed for rice in rainy season of 2003, after conventional, zero and strip till drill systems of wheat, however, it was raised on permanent beds after bed planted wheat.

For conventional method, seven operations were done namely, deep ploughing, roller, three harrowing followed by leveling and finally sowing. In case of bed planting for first year of the experiment, till land preparation, operations were similar to conventional method and at last, sowing was done with the help of bed planter. However, in second year, permanent bed (for wheat-rice-wheat) system was followed. Under zero tillage, zero till ferti seed drill was used for sowing. In strip till drilling, pulverization of soil, opening of furrows and sowing operations were done in a single drive with strip till drill. In each plot, 18 crop rows were raised and to accommodate 18 rows, under conventional, zero till and strip till drill 6.0 x 3.6 m plot size was kept. However, under bed planting system it was 6.0 x 4.2 m to

accommodate same number of rows as under FIRBS, land area requirement was more compared to rest of the tillage methods and therefore, fertilizer as well as seed rate was calibrated accordingly. In conventional tillage, zero tillage and strip till drill, experimental crop was fertilized with 120 kg N, 60 kg P and 40 kg K per hectare where as under bed planting system 90, 40 and 30 kg/hectare N, P and K were applied. Wheat variety *PBW 343* was sown on 3 December in 2002 and 27 November in 2003 in rows, 20 cm apart, at the rate of 100 kg seed/hectare for conventional, zero till and strip till drill system, where as, in bed planting system, three rows were raised in a single bed having a width of 70 cm, at the rate of 75 kg seed/hectare. Herbicides were applied in aqueous medium using 600 litre of water per hectare. Weed control efficiency was calculated in relation to total weed dry matter by using the standard method.

Weed crop competition index (WCCI) was calculated by using the following formula and expressed in per cent.

$$\text{Weed crop competition index} = \frac{(a - b)}{q}$$

a = Grain yield in hand weeded plot
b = Grain yield in treated plot
q = Grain yield in hand weeded plot

The data on weed population, dry matter and weed control efficiency were analyzed after applying $\log_e (X+1)$ transformation.

RESULTS AND DISCUSSION

Major weed flora

In the experimental field, *Phalaris minor, Chenopodium album* and *Melilotus* spp. were the major weeds during both the years contributing 35.5, 18.7; 17.8, 50.2, 4.2 and 18.3% of the total weed population in consecutive years. However, *Medicago denticulata* (7.5%) and *Rumex acetosella* (3.8%) were emerged out as major weeds in the second year of the experiment. *P. minor* was the most dominant weed in the experimental field in both the years, which might be due to continuous growing of rice-wheat on the experimental field. Other weeds (30.4% and 16% in consecutive years) were *Anagalis arvensis, Coronopus didymus, Cyperus rotundus, Fumeria parviflora, Cynodon dactylon, Lathyrus aphaca, Vicia sativa* and *Vicia hirsuta* in both the years and *Polygonum plebejum* in the second year.

Effect of tillage methods on weed population

Density of *P. minor, C. album* and *Melilotus* spp. during both the years and *M. denticulata* and *Rumex acetosella* for the second year were recorded maximum under conventional tillage system which was at par with strip till drill system and significantly higher than zero till and bed planting system except density of *M. denticulata* in bed planted condition (for second year) which was at par with conventional system. In the first year of the experiment, total weed density did not influence significantly, though numerically higher values were recorded under conventional and strip till drill situations which reflected significantly higher total weed dry matter under these systems than zero tillage and FIRBS. In the second year of the experiment, significantly higher density and dry weight of total weeds were observed under conventional tillage than other tillage methods followed by strip till drill which also recorded higher density and dry matter than zero and FIRB systems (Table 1). Significantly higher weed dry weight under conventional tillage than zero tillage was also reported by Malik *et al.* (2000). Better tilth and exposer of the weed seeds to upper soil may be responsible for higher weed infestation under conventional tillage than zero tillage (Singh *et al.* 2001) and intermediate tilth in strip till drill may be responsible for intermediate results regarding weed density and dry matter production. Under permanent bed, more amounts of undisturbed seeds might be concentrated at the top soil layer which ultimately gave significantly higher density and dry weight of total weed in the second year under bed planting system than zero till situation.

Weed control efficiency (WCE) did not differ significantly owing to tillage methods in the first year, though significantly higher WCE was calculated under strip till drill and conventional systems as compared to zero tillage and FIRBS in the second year of experiment.

Effect of tillage methods on crop

During 2002-03, number of spikes and grain yield was not influenced by tillage methods, though numerically they were recorded maximum under conventional tillage and lowest under bed planted system. In second year, maximum number of spikes as well as grain yield was noticed under zero tillage which was at par with strip till drill and conventional tillage but significantly higher than FIRBS. These findings are corroborate with the finding of (Mahey *et al.* 2002). Probably better tilth produced higher grain yield under conventional system in the first year, but comparatively heavy weed infestation in the second year suppressed the effect of better tilth under this system. Under FIRBS, for accommodation of same number of rows, land area requirement was higher in the experimental field as compared to rest of the tillage methods and that ultimately attributed lesser number of spikes and grain yield, when calculated as per unit area basis. More over, greater weed infestation and poor soil tilth under permanent beds intensified the reduction in spike number and yield during second year (Table 2).

Table 1. Effect of different treatments on major and total weed density in wheat at 60 days after sowing

Treatment	*P. minor*		*C. album*		*Melilotus* sp.		*M. denticulata*		*R. acetosella*		Total	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
A. Establishment methods												
Conventional tillage	1.2 (24)	2.1 (58)	1.8 (19)	0.9 (7)	2.0 (29)	1.9 (35)	-	1.6 (11)	-	1.2 (8)	3.0 (106)	3.5 (142)
Zero tillage	0.9 (8)	1.2 (9)	1.2 (8)	0.2 (2)	1.2 (7)	1.1 (9)	-	1.1 (5)	-	0.6 (2)	2.3 (38)	2.6 (41)
Strip till drill	1.2 (20)	1.9 (37)	1.7 (16)	0.8 (6)	1.8 (19)	1.6 (22)	-	1.3 (9)	-	1.1 (5)	3.0 (86)	3.2 (98)
Bed planting	0.7 (4)	1.4 (15)	1.2 (9)	0.2 (3)	1.2 (7)	1.2 (12)	-	1.5 (8)	-	0.6 (3)	2.5 (38)	2.9 (62)
LSD (P=0.05)	0.3	0.3	0.5	0.5	0.3	0.45	-	0.5	-	0.6	NS	0.20
B. Weed management practices												
Two hand weedings at 30 and 50 DAS	0.2 (1)	0.0 (0)	0.0 (0)	0.1 (0)	0.0 (0)	0.1 (0)	-	0.1 (0)	-	0.0(0)	0.3 (1)	0.1 (0)
Isoproturon 1.0 kg/ha at 30 DAS	0.1 (0)	2.2 (12)	0.0 (0)	0.1 (0)	0.0 (0)	0.0 (0)	-	1.4 (7)	-	0.1 (0)	1.0 (5)	3.1 (26)
Clodinafop 0.06 kg/ha at 30 DAS	0.0 (0)	0.0 (0)	2.5 (21)	1.7 (9)	3.2 (34)	3.3 (37)	-	2.3 (11)	-	1.9 (9)	4.5 (102)	4.5 (104)
Weedy	3.7 (55)	4.4 (107)	3.2 (29)	1.9 (9)	3.0 (26)	3.5 (39)	-	2.6 (16)	-	1.5 (8)	4.9 (161)	5.2 (213)
LSD (P=0.05)	0.3	0.3	0.4	0.6	0.5	0.4	-	0.6	-	0.6	0.5	0.2

Original values are in parentheses

Table 2. Effect of different treatments on total weed dry weight (at 60 days after sowing), weed control efficiency, weed index and number of spikes

Treatment	Total weed dry weight (g/m^2)		Weed control efficiency (%)		Weed index (%)		Number of spikes /m^2	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
A. Establishment methods								
Conventional tillage	2.0 (26.7)	2.6 (51.9)	3.1 (50.3)	3.2 (67.1)	17.1	21.9	322	320
Zero tillage	1.5 (9.3)	1.7 (11.1)	3.1 (54.9)	3.1 (60.2)	10.4	11.5	317	330
Strip till drill	2.0 (21.8)	2.2 (34.9)	3.1 (52.4)	3.2 (67.8)	13.4	17.3	319	327
Bed planting	1.4 (6.6)	1.9 (14.4)	3.1 (52.6)	3.1 (59.3)	8.1	13.3	311	316
LSD (P=0.05)	0.5	0.2	NS	0.1	5.8	4.7	NS	8
B. Weed management practices								
Two hand weedings at 30 and 50 DAS	0.2 (0.5)	0.1 (0.0)	4.6 (95.6)	4.6 (100.0)	0.0	0.0	338	354
Isoproturon @ 1.0 kg/ha at 30 DAS	0.7 (1.9)	1.8 (6.3)	4.4 (81.9)	4.5 (89.5)	4.9	6.5	334	346
Clodinafop @ 0.06 kg/ha at 30 DAS	2.4 (11.4)	3.0 (23.3)	3.4 (32.7)	4.2 (64.9)	13.8	16.3	315	327
Weedy	3.6 (50.7)	4.2 (82.6)	0.0 (0.0)	0.0 (0.0)	30.4	41.4	282	266
LSD (P=0.05)	0.4	0.2	0.2	0.1	3.4	3.9	7	11

Original values are in parentheses

Weed index (WI) was estimated maximum under conventional system which was at par with strip till drill. In 2002-03, WI was recorded lowest under FIRBS, but in the next year it was recorded lowest under zero tillage followed by FIRBS (Table 2).

Effect of weed management practices on weed and crop

Among the weed management, two hand weeding (at 30 and 50 days after sowing) provided excellent control of all weed species in both the years and there by produced lowest dry matter, highest weed control efficiency as well as number of spikes and grain yield. Poor wheat grain yield due to uncontrolled weeds has also been reported from various locations (Gill and Walia 1989, Singh and Bhan 1997). Uncontrolled weeds in weedy plots recorded significantly higher individual as well as total weed density and total weed dry weight which resulted into highest weed crop competition, lowest spikes number as well as grain yield for both the years. Clodinafop was found effective against *P. minor*, but failed to control broad-leaved weeds and that ultimately made it less effective than isoproturon to minimize weed infestation problem in wheat. Good control of *P. minor* by clodinafop at 0.06 kg/ha and no effect on non-grassy weeds has also been reported by Singh *et al.* (2002). Greater weed infestation under clodinafop treated plots shown lesser weed control efficiency leads to lesser there by poor, number of spikes, grain yield and significantly higher weed crop competition index than isoproturon. Similar findings have also been reported by Sharma and Thakur, (2002).

Interaction effect of establishment methods and weed management practices on grain yield

All the wheat establishment method produced non comparable grain yield during both the years except bed planting in the year 2003-04, which was significantly lower than others. Among weed management practice, hand weeding twice at 30 and 50 DAS produced highest grain yield while weedy recorded lowest. Isoproturon at 1.0 kg/ha also produced significantly higher yield than clodinafop 0.06 kg/ha during both the years.

During first year of the experiment, in two hand weeding as well as isoproturon treated plots, maximum yield was observed under conventional system, however, in clodinafop treatment it was recorded maximum under strip till drill condition and in weedy plot it was found under FIRBS. In next season, the highest yield was found under conventional tillage only in case of two hand weedings while in isoproturon as well as clodinafop treatment, the highest yield was obtained under strip till drill, where as that was recorded maximum under zero till system when field was kept weedy (Table 3). Basically maximum control of weeds provided the maximum grain yield under conventional system, where as under weedy situation, zero till system was found better, as inherently weed emergence was lesser. In second year, higher weed infestation and lesser tilth under permanent bed reduced yield under weedy plot.

REFERENCES

Brar LS, Mahajan G, Boperai BS and Sardana V. 2003. Control of little seed canary grass (*Phalaris minor* Retz.) and productivity of wheat varieties under different row spacing and doses of clodinafop. In: *Biennial Conference of Indian Society of Weed Science,* March 12-14, G.B.P.U.A.&T., Pantnagar : 14.

Gill HS and Walia US. 1989. Studies on control of wild oat (*Avena ludoviciana* Dur.) in irrigated wheat (*T. aestivum* L.) with substituted urea herbicides. *Indian Journal of Weed Science* **20**: 1-4.

Table 3. Interaction effect of different treatments on wheat grain yield (kg/ha)

Treatment		Year	A. Establishment methods				
			Conventional tillage	Zero tillage	Strip till drill	Bed planting	Mean
B. Weed management practices	Two hand weedings at 30 and 50 DAS	2002-03	4484	4060	4254	3956	4188
		2003-04	4534	4167	4420	3872	4248
	Isoproturon 1.0 kg/ha at 30 DAS	2002-03	4200	3940	4031	3731	3976
		2003-04	4176	3884	4188	3619	3967
	Clodinafop 0.0 6 kg/ha at 30 DAS	2002-03	3601	3543	3690	3473	3577
		2003_04	3561	3607	3675	3332	3544
	Weedy	2002-03	2555	3011	2728	3188	2870
		2003-04	1860	3075	2324	2571	2458
	Mean	2002-03	3710	3638	3676	3587	-
		2003-04	3533	3683	3652	3349	-

For 2002-03 CD (*P* = 0.05) values: (a) Main plot: NS (b) Sub plot: 153 (c) Main plot at constant sub plot : 305 (d) Sub plot at constant main plot: 349
For 2003-04 CD (*P* = 0.05) values: (a) Main plot: 184 (b) Sub plot: 183 (c) Main plot at constant sub plot : 367 (d) Sub plot at constant main plot: 367

Hobbs PR. 2002. Resource conserving technologies a second revolution in South Asia. In: *Proceedings of International Workshop on Herbicide Resistance Management and Zero Tillage in Rice-Wheat Cropping System.* March 4-6,Hisar, : 67-69.

Mahey RK, Singh O, Singh A, Brar SS, Virte AS and Singh J. 2002. Effect of first, subsequent irrigation(s) and tillage on grain yield, nutrient uptake, rooting density of wheat, soil moisture content, consumptive use and water use efficiency. *Research on Crops* **3:** 1-3.

Malik RK and Singh S. 1995. Little seed canary grass (*Phalaris minor* Retz.) resistance to isoproturon in India. *Weed Technology* **9:** 419-5.

Malik RK and Singh S.1993. Evolving strategies for herbicide use in wheat: resistance and integrated weed management. In: *Proceedings of the ISWS. International Symposium on Integrated Weed Management for Sustainable Agriculture*, 18-20 November, 1993, Hisar, India : 225-8.

Malik RK, Yadav A, Banga RS, and Singh S. 2000. Zero tillage sowing and alternative herbicides against resistant *P. minor* in rice- wheat cropping system. *Indian Journal of Weed Science* **33**(1&2) : 19-25.

Mukhopadhyay SK and Bera PS. 1980. Effectiveness of basalin, tribunal, isoproturon and cultural methods in controlling weeds in wheat crop. *Pesticides,* **14:** 21-3.

Sayre KD. 2000. Saving water and increasing sustainability with bed planting. *In: Outlook*. Int. Maize and Wheat Improvement Centre, CIMMYT, Mexico Vol 1&2.

Sharma V and Thakur DR. 2002. Integrated weed management in wheat under sub-humid agroclimate of Himachal Pradesh. *Indian Journal of Weed Science* **34:** 20-3.

Singh BB, Singh R, Singh G, Tripathi SS and Singh VK. 2001. Effect of metribuzine on weed control and grain yield of wheat. *Indian Journal of Weed Science* **33:** 180-181.

Singh G, Singh Y, Singh VP, Singh RK and Saxena A. 2002. Bio-efficacy of herbicides in zero till wheat cropping system. *Indian Journal of Weed Science* **34:** 5-8.

Singh RG, Singh VP, Singh G and Yadav SK. 2001. Weed management studies in zero till rice wheat cropping system. *Indian Journal of Weed Science* **33:** 95-99.

Singh S and Bhan VM. 1997. Effect of tralkoxydim and its combination with 2,4-D on control of weeds in wheat. *Indian Journal of Weed Science* **29:** 1-3.

Yadav A, Malik RK, Chauhan BS, Kumar V, Banga RS, Singh S, Yadav JS, Punia SS, Rathee SS and Sayre KD. 2002. Feasibility of raising wheat on furrow irrigated raised beds in South-Western Haryana. In: *Proceedings of International Workshop on Herbicide Resistance Management and Zero Tillage in Rice-Wheat Cropping System.* March 4-6,Hisar : 201-206.