Indian Journal of Weed Science **46**(4): 322–325, 2014

Effect of tillage and weed management practices on weed dynamics, weed seed bank and grain yield of wheat in rice-wheat system

Radhey Shyam*, Rohitashav Singh and V. K. Singh
G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand 263 145

Received: 22 October 2014; Revised: 13 November 2014

ABSTRACT

A field experiment was conducted during two consecutive *Rabi* season of 2005-06 and 2006-07 at NEB Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar on sandy loam soil to find out the effect of tillage and weed management practices on weeds, weed seed bank in soil and grain yield of wheat grown after rice. Zero till sown wheat had significantly lesser weed dry weight per unit area as compared to conventional sown wheat. *Phalaris minor, Melilotus indica* and *Chenopodium album* seed density in soil were significantly lower under zero tillage as compared to conventional tillage from 0 to 5, 5 to10 and 10 to 15 cm soil depths. Excellent suppression in weed density and dry weight and higher yield of wheat were obtained with two hand weeding under conventional tillage system. Under weedy situation, zero tillage was found better because of less weed emergence.

Key words: Conventional tillage, Isoproturon, Metsulfuron-methyl, Weed dynamics, Zero tillage

Rice-wheat is the most dominant cropping system in Indo-Gangatic Plains. Sowing of wheat in this tract is generally delayed due to the cultivation of long and medium duration rice varieties as well as time required in field preparation for wheat. Tillage practices after rice harvest also require more labour and energy which increase cost involves in field preparation. Zero and reduced tillage have an advantage of early planting, reduced cost of production as well as chances of green house gas emission (Hobbs 2002). Weed management is an important aspect in wheat production as 10 to 50% yield loss is common due to damage caused by associated weeds. For efficient and economic management of weeds in wheat, isoproturon has been found to be the most suitable herbicide for last two decades in India (Singh *et al.* 2001). The continuous use of single herbicide develops resistance in *P. minor* against this herbicide. Use of clodinafop-propargyl along with metsulfuron-methyl has been found promising against resistant *P. minor* biotype and non-grassy weeds. Therefore, the present investigation was conducted to study the influence of tillage and weed management practices on the weed dynamics and grain yield of wheat.

MATERIALS AND METHODS

A field experiment was conducted at NEB Crop Research Centre, G.B. Pant University of Agriculture & Technology, Pantnagar, during *Rabi* seasons of 2005-06 and 2006-07. The soil of experimental field was sandy loam in texture, medium in organic carbon (0.65%), low in available N (262 kg/ha), medium in available P (37.6 kg/ha) and high in K (260 kg/ha) contents with pH 7.8. The experiment was laid out in split-plot design with twelve treatments comprising three tillage methods, *viz*. zero tillage, reduced tillage and conventional tillage in main plots; and four weed management practices, *viz*. two hand weeding at 35 and 55 DAS (days after sowing), isoproturon 1.0 kg/ha, clodinafop-propargyl 60 g followed by metsulfuron-methyl 4 g/ha and weedy check, in sub-plots and was replicated thrice. Wheat variety '*PBW 343*' was sown in rows, 20 cm apart on 19 and 22 November in zero tillage and on 25 and 29 November in other tillage systems in 2005-06 and 2006-07, respectively. All the package and practices were applied to raise the crop except weed management. The fertilizer was applied at 120: 60: 40 kg N: P: K/ha and three irrigations were given at critical stages only by flooding method. Post-emergence application of isoproturon and clodinafop-propargyl was done 30 DAS while metsulfuron-methyl (MSM) was applied one week after first spray. The herbicides were applied using Maruti foot sprayer fitted with flat fan nozzle. Soil samples were collected from each plot separately before sowing and after harvesting of crop by using core sampler to determine the bulk density, organic matter and weed seed bank in soil, respectively. Data on density and dry matter of weeds were subjected to log transformation *i.e*. $\log_e (x+1)$ before statistical analysis.

***Corresponding author:** talk2radhey@india.com

RESULTS AND DISCUSSION

Soil parameters

Zero tillage, which was at par with reduced tillage recorded significantly higher bulk density of soil as compared to conventional method of sowing. Higher bulk density in zero tillage might be due to the puddling in previous rice crop and repeated movement of heavy implements that compressed the soil. However, the same soil was loosened where harrowing were done in reduced and conventional tillage. This was in confirmation with the findings of Pandey *et al.* (2005). The organic carbon in zero till soil was also found higher than others but the differences were found non-significant. Greater oxidation of organic carbon in intensively tilled soil resulted in dilution of organic carbon concentration of the top soil. However, in untilled soil, organic carbon tended to accumulates near the surface of the soil (Kumar and Yadav 2005).

Effect on weeds

The major weed flora observed in the experimental field included *Phalaris minor* (50.4%), *Melilotus indica* (18.3%), *Chenopodium album* (8.6%), *Medicago denticulata* (7.7%) and *Rumex acetocella* (7.0%). Other minor weeds, *viz. Coronopus didymus, Lathyrus aphaca, Vicia sativa, Fumaria parviflora, Polygonum plebejum,* and *Cyperus rotundus* accounted for 8.0% of total weed population.

Total weed density was not influenced significantly by different tillage practices though numerically higher values were recorded under conventional followed by reduced tillage during both the year of experimentation (Table 1). Wheat sown with zero till drill exhibited significantly lower weed dry weight per unit area than conventional method of wheat sowing, however, it was found non-significant with reduced tillage. The similar trend was also observed by Prasad *et al.* (2005) and Sinha and Singh (2005).

Among the weed management practices, two hand weeding (35 and 55 DAS) provided excellent control of all the weed species in both the years, though the differences were non- significant with clodinafop *fb* MSM. The isoproturon also reduced weed infestation significantly than weedy but did not prove as promising as clodinafop *fb* MSM. The higher weed control efficiency (WCE) was recorded under hand weeding twice which was at par with clodinafop *fb* MSM during both the years. Bharat and Kachroo (2007) also reported superiority of clodinafop + MSM over isoproturon alone in broadening the spectrum of weed control.

Effect on crop

Wheat crop sown under zero and reduced tillage conditions recorded more dry matter accumulation, number of effective tillers/m^2 and spike length than that of conventional tillage yet the differences could not reach to the level of significance (Table 2). The number of grains/spike was significantly higher under conventional tillage as compared to zero and reduced tillage. Zero tillage being at par with reduced tillage recorded higher test weight than conventional tillage during second year. All the weed management practices accumulated significantly higher crop dry matter accumulation, effective tillers, and test weight than weedy check.

Table 1. Effect of tillage and weed management practices on bulk density, organic C and weeds

Treatment	Bulk density (mg/m^3) of soil before sowing		Organic C (%) of soil before sowing		Weed density/m^2 at 90 DAS		Dry weight of weeds (g/m^2) at 90 DAS		Weed control efficiency (%) at 90 DAS	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Tillage method										
Zero tillage	1.60	1.61	0.71	0.71	1.93(33.0)	1.86(34.0)	2.04(26.0)	2.19(29.6)	72.3	71.3
Reduced tillage	1.57	1.60	0.70	0.70	2.39(36.7)	2.64(39.0)	2.24(39.4)	2.30(37.2)	72.0	71.5
Conventional tillage	1.55	1.57	0.69	0.68	2.80(63.5)	2.76(60.7)	2.34(47.2)	2.50(49.5)	72.4	71.1
LSD(P=0.05)	0.04	0.02	NS	NS	NS	NS	0.20	0.17	NS	NS
Weed management practice										
Isoproturon 1.0 kg/ha	1.57	1.57	0.70	0.71	2.45(18.7)	2.88(20.0)	2.53(12.8)	2.87(17.4)	90.7	87.1
Clodinafop 60 g *fb* metsulfuron-methyl 4 g/ha	1.58	1.59	0.72	0.72	0.74(3.1)	1.21(6.7)	0.91(1.5)	0.96 (1.6)	98.8	98.7
Weedy	1.57	1.58	0.68	0.67	4.93(152)	4.94(143)	4.88(135)	4.89(135)	0.0	0.0
Hand weeding 35 and 55 DAS	1.56	1.59	0.71	0.70	1.38(4.0)	0.64(2.2)	0.52(0.7)	0.60 (0.8)	99.4	99.4
LSD (P=0.05)	NS	NS	0.02	0.02	0.9	0.85	0.25	0.14	1.88	1.25

*Original values are given in parentheses; DAS - Days after sowing

Table 2. Effect of tillage and weed control practices on dry matter and yield attributes of wheat

Treatment	Crop dry matter (g/m^2) at 120 DAS		Effective tillers/m^2		Ear length (cm)		Grains/ear		Test weight (g)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Tillage method										
Zero tillage	361.5	371.1	155.0	154.6	8.60	8.47	40.2	39.2	40.0	41.0
Reduced tillage	348.8	363.8	150.4	152.1	8.42	8.31	41.2	42.6	37.1	37.2
Conventional tillage	321.3	342.1	142.6	141.3	8.38	7.74	46.0	47.0	36.4	34.3
LSD(P=0.05)	NS	NS	NS	NS	NS	NS	4.2	2.5	NS	4.1
Weed management practice										
Isoproturon 1.0 kg/ha	347.0	350.5	154.4	154.5	8.47	8.29	42.1	42.2	37.2	37.5
Clodinafop 60 g *fb* metsulfuron-methyl 4 g/ha	360.4	389.0	158.9	157.2	8.58	8.40	43.4	45.0	38.5	38.7
Weedy	296.4	293.9	121.6	114.4	8.14	7.59	37.4	38.3	34.5	33.7
Hand weeding 35 and 55 DAS	371.6	402.4	162.4	171.1	8.67	8.41	46.5	46.3	39.7	40.2
LSD (P=0.05)	40.1	43.7	20.6	31.1	NS	NS	2.5	3.7	2.1	3.1

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

Wheat establishment method	Weed management practices				
	Hand weeding at 35 and 55 DAS	Isoproturon 1.0 kg/ha	Clodinafop 60 g *fb* metsulfuron-methyl 4 g/ha	Weedy	Mean
Zero tillage	4.8	4.5	4.6	3.1	4.3
Reduced tillage	4.9	4.6	4.6	2.2	4.0
Conventional tillage	4.9	4.5	4.7	1.4	3.9
Mean	4.9	4.5	4.6	2.2	

LSD (P=0.05) (a) main plot: 0.24, (b) Sub plot: 0.24, (c) Main plot at constant sub plot: 0.41,
(d) Sub plot at constant main plot: 0.43

Table 4. Seed bank of weed seeds (no./100 g soil) at different soil depths (pooled data of 2 years)

Treatment	0-5 cm				5-10 cm				10-15 cm			
	P. minor	*Melilotus-indica*	*C. album*	*R. acetosella*	*P. minor*	*Melilotus-indica*	*C. album*	*R. acetosella*	*P. minor*	*Melilotus-indica*	*C. album*	*R. acetosella*
Wheat establishment method												
Zero tillage	0.5	1.4	0.3	0.7	0.9	0.8	0.2	0.4	0.1	1.2	0.3	0.1
Reduced tillage	3.9	2.1	1.1	0.4	3.3	1.5	1.0	0.1	0.4	1.3	0.4	0.1
Conventional tillage	5.1	2.4	1.4	0.4	4.1	1.8	1.3	0.1	0.5	1.8	0.3	0.0
LSD (P=0.05)	1.2	0.2	0.5	0.3	0.8	0.4	0.6	0.1	0.2	0.4	NS	NS
Weed management practice												
Isoproturon 1.0 kg/ha	0.6	1.3	0.1	0.1	1.2	1.5	0.3	0.1	0.1	1.1	0.1	0.0
Clodinafop 60 g *fb* metsulfuron - methyl 4 g/ha	0.2	0.1	0.2	0.1	0.5	0.1	0.0	0.0	0.1	0.3	0.0	0.0
Weedy	11.6	3.4	3.4	0.9	9.0	3.7	2.9	0.5	0.8	3.7	1.2	0.2
HW 35 and 55 DAS	0.3	0.4	0.2	0.1	0.3	0.1	0.2	0.1	0.3	0.3	0.1	0.0
LSD (P=0.05)	1.3	0.8	0.6	0.2	1.1	0.7	0.4	0.2	0.4	0.6	0.4	0.1

The differences were non-significant if we compare different tillage and weed management practices (Table 3). Under weedy situation, grain yield increased significantly with each successive reduction in tillage practices. Zero till system was found better as inherently weed emergence was lesser numerically. Among the weed management practices hand weeding at 35 and 55 DAS proved excellent in controlling all weed species in both the years and thereby provided lowest dry matter and highest weed control efficiency as well as number of tillers and grain yield.

Effect on weed seed bank

Variations in seed density of different weed species were higher in 0 to 5 followed by 5 to 10 and 10 to 15 cm soil depth under different tillage methods (Table 4). The total number of seeds was recorded maximum in 0 to 5 cm and minimum in 10 to 15 cm soil depth under all the tillage methods.

Seed density of different major weed species, *viz. Phalaris minor, Melilotus indica, Chenopodium album* were significantly lower under zero tillage as compared to conventional tillage at all the soil depths. The differences under reduced and conventional tillage were significant only for *Melilotus indica* at 0 to 5 cm and 5 to 10 cm and *Chenopodium album* at 5 to 10 cm soil depth. The seed density of *R. acetosella* in soil was found higher in case of zero tillage than others but the differences were significant only at 5 to 10 cm soil depth. The variation in seed density of *Melilotus indica* under zero and reduced tillage were non- significant at 10 to 15 cm soil depth. However, *Phalaris minor* seed density under reduced and conventional tillage was comparable with each other.

On the basis of two year experimentation, it was concluded that hand weeding twice at 35 and 55 DAS resulted in maximum control of weeds and provided the maximum grain yield under conventional tillage system. Whereas under weedy conditions zero till system was found better showing inherently lesser weed emergence.

REFERENCES

Bharat MN and Karchroo A. 2002. Bio-efficacy of various herbicides and their mixtures on weeds and yield of wheat *(Triticuma estivum)* under subtropical agro-ecosystem. *Indian Journal of Agronomy* **52**(1): 53-9.

Hobbs PR. 2002. Resource conserving technologies a second revolution in south Asia, pp. 67-68. In: *Proceedings of International Workshop on Herbicide Resistance Management and Zero Tillage in Rice-Wheat Cropping*, 6-9 March 2002, Hisar.

Kumar A and Yadav DS. 2005. Effect of zero and minimum tillage in conjunction with nitrogen management in wheat *(Triticum aestivum)* after rice *(Oryza sativa)*. *Indian Journal of Agronomy* **50**(1): 54-57.

Mani VS, Mala ML, Gautam KC and Bhagavandas. 1973. Weed killing chemicals in potato cultivation. *Indian Farming* **23**: 7-13.

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

Pandey IB, Sharma SL, Tiwari S and Mishra SS. 2005. Economics of tillage and weed management system for wheat *(Triticum aestivum)* after lowland rice *(Oryza sativa)*. *Indian Journal of Agronomy* **50**(1): 44-7.

Prasad S, Singh Y, Singh RP and Singh G. 2005. Effect of crop establishment, weed control method and time of nitrogen application on late sown wheat. *Indian Journal of Weed Science* **37**(1&2): 93-5.

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**: 180-81.

Sinha AK and Singh RP. 2005. Influence of cultivars under different tillage and weed management in wheat. *Indian Journal of Weed Science* **37**(3&4): 175-79.