Research Paper

ADVANCE RESEARCH JOURNAL OF
CROP
IMPROVEMENT
Volume 3 | Issue 1 | June, 2012 : 53-67

Weed dynamics in wheat as influenced by wheat establishment and weed control methods

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ABSTRACT : A field experiment was conducted at Varanasi to assess the weed dynamics and wheat yield as influenced by wheat establishment and weed control methods in wheat. The dominant weed species were *Chenopodium album* L., *Rumex dentatus* L., *Melilotus alba desr., Anagallis arvensis* in broad leaved weeds and *Phalaris minor Retz., Cynodon dactylon* (L.) Perr., in grassy weeds during both the years, respectively. Zero tillage recorded significantly lower density and dry weight of weeds and highest wheat grain yield, which was at par with sowing of wheat by rotavator drill and superior over other tillage treatments. Application of isoproturon + 2,4-D (1.0 + 0.5 kg/ha) significantly reduced the population and the dry weight of weeds, and also maximum wheat grain yield was obtained as compared to rest of herbicides except metribuzin (210 g ha^{-1}), during both the years of experiment. Establishment of wheat under zero tillage with isoproturon +2, 4-D was most effective in arresting weed population, and its growth, and also enhancing wheat grain yield.

Key Words : Herbicides, Wheat, Wheat establishment methods

How to cite this paper : Singh, A.P. and Singh, R.P. (2012). Weed dynamics in wheat as influenced by wheat establishment and weed control methods, *Adv. Res. J. Crop Improv.,* **3** (1) : 53-57.

Paper History : Received : *02.05.2012;* **Revised :** *06.06.2012;* **Accepted :** *18.06.2012*

Among agronomical methods, manipulation of sowing method has showed suppressing effect on minimizing weeds and their growth. In our country, about 40 per cent of the wheat is grown in rotation with rice (Chauhan *et al.*, 2000) and due to this cropping pattern productivity of rice and wheat system is declining, which is causing greater concern about the sustainability of rice wheat system. The major constraints for poor yield of wheat are poor crop stand, delay planting, poor soil physical conditions due to puddling of rice field and heavy infestation of weeds. To overcome these constraints, minimum tillage concept has been recognized as a major solution, particularly for reducing the weed infestation and minimizing cost of tillage operation and overall to sustain the wheat production in rice-wheat system. With the adaptation of dwarf wheat over extensive area in predominant rice-wheat cropping system of north India, weeds flourished luxuriantly owing to availability of moisture and nutrients in abundance, and posed serious problem for the growth and development of wheat. In general, major problem under high input wheat production system is interference of weeds which alone causes yield reduction to an extent of 15-40 per cent and sometimes even higher. Malik *et al.* (1989) estimated 30 per cent reduction in yield of wheat due to infestation of weeds. Weed management is a major input in wheat production, and in present context herbicides have got prime position for better management of weeds especially in minimum tillage conditions where chemical weeding has been recognized as pre-requisite. For last two decades, continuous use of isoproturon led to the selection of resistant *Phalaris minor* biotypes and also shifts in weed flora (Malik and Singh, 1993). To overcome this problem, recently introduced herbicides like metribuzin, sulfosulfuron, metsulfuron methyl, sulfonyl urea have been recommended to control grassy and broad leaf weeds in cereals like wheat and barley. Mixture of isoproturon +2,4-D, metoxuron +2,4-D and pendimethalin + oxyfluorfen have been recommended in wheat culture. Keeping these facts in view, the present investigation was undertaken.

Research Procedure

A field experiment was conducted during winter seasons of 2003 and 2004 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The soil was sandy clay loam with pH 7.5. It was moderate in fertility status being low in organic carbon content (0.46%) and available N (210.15 kg/ha) and medium in available P_2O_5 (20.65

kg/ha) and K_2O (254.86 kg/ha).The rice grown as general crop in experimental field during both the years. The experiment was laid out in split plot design with three replications. Twenty four treatment combinations comprised of four wheat establishment methods *viz.*, strip till drill, zero tillage, rotovator drill and conventional tillage assigned to main plots and six herbicidal treatments *viz.*, sulfosulfuron 25 g/ha, isoproturon 1.0 kg/ha + 2,4-D 0.5 kg/ha, pendimethalin 1.0 kg/ha, metribuzin 210 g/ha, weed free and weedy check were kept in sub plots. Wheat variety HUW-234 was sown with seed rate of 125 kg/ha by strip till drill, Pant zero till drill, rotovator drill while conventional tilled plots by opening furrow with the help of spade. The row spacing was 20 cm. in all establishment methods. Recommended dose of fertilizer (120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}) and three irrigations (CRI, before ear initiation and grain filling stage) were applied uniformly. Herbicides sulfosulfuron, isoproturon+2,4-D and metribuzin were sprayed as post-emergence at 30 day after sowing (DAS) and pendimethalin sprayed as pre-emergence just after sowing through knapsack sprayer fitted with flat fan nozzle using 500 litre water per hectare. Weed count and dry mater were recorded with a quadrate (0.5m x 0.5m) at grand growth stage (60^{th} day stage of crop growth) when there was maximum weed density and their growth. The data on weed density and dry weight were subjected to $\sqrt{x+0.5}$ transformation to normalize their distribution. The relative composition of an individual weed species was calculated by using the following formula as suggested by Shetty and Rao (1980).

$$\textbf{Relative composition of a species} = \frac{\textbf{No. of individual sp.}}{\textbf{Total number of all weeds}} \textbf{x100}$$

RESEARCH ANALYSIS AND REASONING

The results obtained from the present investigation have been discussed in the following sub heads :

Effect on weeds:

The predominant weed flora in the experimental field comprised *Rumex dentatus* L. (19.17%), *Pathenium hysterophorus* L (6.23%), *Chenopodium album* L. (16.37%), *Melilotus* spp. (7.90%), *Anagallis arvensis* L.(7.26%), *Vicia sativa* L.(1.37%), *Phalaris minor* Retz. (13.10%), *Cynodon dactylon* (L) Perr. (8.46%) and *Cyperus rotundus* L. (20.30%) (Table1). Broad leaved weeds, grasses and sedges consisted of 58.30, 21.56 and 20.30 per cent, respectively of total weed flora at 60^{th} day of crop growth. The density of broad leaved weeds, grasses and sedges and total dry weight of weeds were significantly low in zero tillage treatment as compared to strip till drill and conventional tillage, and were at par with rotavator drill in both the years (Table 1). The reduction in weed density and their dry matter under zero tillage may be attributed that weed seeds buried in subsurface layer of soil during puddling operation and they failed to come out on surface layer of soil. Similar findings were reported by Sen *et al.* (2002). Among herbicides, isoproturon + 2,4-D (1.0 + 0.5 kg/ha) recorded the lowest density of broad leaved weeds and grassy weeds and dry weight of weeds, which was at par with metribuzin 210 g/ha and significantly superior to other herbicidal treatments (Table 2). It was due to higher efficacy of isoproturon against grassy weeds and 2, 4-D against broad leaved weeds and resulted low weeds dry weight. In case of sedge, none of herbicides could show their significant superiority in arresting this group of weeds. However, all the herbicidal treatments were significantly superior over weedy check. These results had conformity with

Table 1 : Relative composition of weed flora (%) in weedy check plot (60 DAS)

Sr. No.	Weed group/Scientific name	Strip till drill			Zero tillage			Rotavator drill			Conventional tillage		
		2002-03	2003-04	Avg.	2002-03	2003-04	Avg.	2002-03	2003-04	Avg.	2002-03	2003-04	Avg.
1.	Broad leaved weeds												
	Rumex dentatus	18.51	18.72	18.61	15.67	17.08	16.38	18.10	17.90	18.00	24.05	23.31	23.68
	Chenopodium album L.	16.70	16.50	16.60	12.24	12.50	12.37	16.00	16.20	16.10	20.37	20.43	20.4
	Melilotus spp.	07.90	07.75	07.83	7.02	6.53	6.78	7.70	7.53	7.62	9.45	9.25	9.35
	Anagallis arvensis L.	07.10	07.00	07.05	6.78	7.10	6.94	6.90	6.50	6.7	8.31	8.40	8.36
	Parthenium hysterophorus L	04.55	04.40	04.48	8.05	8.00	8.03	6.50	6.40	6.45	5.83	6.10	5.97
	Vicia sativa L.	01.50	01.60	01.55	1.20	1.01	1.11	1.25	1.10	1.18	1.63	1.65	1.64
2.	Grassy weeds												
	Phalaris minor Retz.	12.50	12.42	12.46	10.3	9.57	9.94	12.07	12.17	12.12	18.80	16.9	17.85
	Cynodon dactylon (L.) Perr.	08.66	08.80	08.73	10.50	9.90	10.02	8.30	8.90	8.60	6.41	6.52	6.47
3.	Sedge												
	Cyperus rotundus L.	22.56	22.81	22.69	29.20	27.66	28.43	23.91	23.56	23.74	7.27	5.33	6.30

Table 2 : Effect of wheat establishment and weed control methods on weed density and total weed dry weight at 60th day stage of crop growth and yield of crop

Treatments	Broad leaved weeds (No./ m^2)		Grasses (No./ m^2)		Sedges (No./ m^2)		Total weed dry weight (g/m^2)		Weed control efficiency (%)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Wheat establishment methods										
Strip till drill	4.05 (18.81)	4.51 (23.58)	3.35 (12.29)	3.72 (15.3)	1.81 (3.02)	1.99 (3.81)	4.72 (29.25)	5.04 (33.29)	69.92	69.92
Zero tillage	3.71 (15.67)	4.17 (19.59)	3.10 (10.37)	3.43 (12.92)	1.84 (3.19)	2.03 (3.98)	4.56 (27.41)	4.75 (29.84)	70.63	70.82
Rotavator drill	3.87 (17.16)	4.31 (21.45)	3.21 (11.19)	3.55 (13.94)	1.82 (3.08)	2.00 (3.85)	4.64 (28.34)	4.87 (31.18)	70.44	70.30
Conventional tillage	4.24 (20.45)	4.72 (25.57)	3.46 (13.12)	3.84 (16.34)	1.78 (2.91)	1.96 (3.66)	4.85 (30.72)	5.00 (34.03)	69.88	69.13
S.E.±	0.07	0.09	0.07	0.07	0.02	0.03	0.04	0.05	-	-
C.D. (P=0.05)	0.24	0.31	0.25	0.23	NS	NS	0.14	0.20	-	-
Weed control methods										
Sulfosulfuron (25 g/ha)	4.23 (17.48)	4.71 (21.85)	3.75 (13.75)	4.20 (17.13)	2.04 (3.66)	2.22 (4.43)	4.29 (17.92)	4.61 (20.78)	81.64	80.62
Isoproturon + 2,4-D (1.0 + 0.5 kg/ha)	3.99 (15.57)	4.51 (19.47)	3.37 (10.90)	3.74 (13.58)	1.96 (3.35)	2.17 (4.20)	3.97 (15.27)	4.23 (17.41)	84.31	83.70
Pendimethalin (1.0 kg/ha)	4.59 (20.74)	5.16 (25.93)	3.91 (14.80)	4.35 (18.43)	2.04 (3.70)	2.23 (4.47)	5.26 (27.14)	5.45 (29.24)	71.62	72.75
Metribuzin (210 g/ha)	4.07 (16.22)	4.54 (20.28)	3.51 (11.88)	3.90 (14.80)	1.98 (3.43)	2.19 (4.29)	4.04 (15.81)	4.31 (18.08)	83.77	83.21
Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.70 (0.0)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	100.00	100.00
Weedy check	6.21 (38.12)	6.94 (47.66)	4.43 (19.14)	4.92 (23.83)	2.14 (4.14)	2.46 (5.51)	9.89 (97.45)	10.19 (107.01)	0.00	0.00
S.E.±	0.07	0.07	0.05	0.05	0.03	0.03	0.03	0.05	-	-
C.D. (P=0.05)	0.22	0.21	0.15	0.13	0.09	0.07	0.07	0.29	-	-

Figures in parentheses are the original values, NS=Non-significant

Table 2 a : Interaction effect of wheat establishment and weed control methods on dry weight of weeds (g^{-2}) at maximum growth stage (60 DAS)

Treatments	Wheat establishment methods							
	2002-03				2003-04			
	Strip till drill	Zero tillage	Rotavator drill	Conventional tillage	Strip till drill	Zero tillage	Rotavator drill	Conventional tillage
Weed control methods								
Sulfosulfuron (25 g/ha)	4.36 (18.50)	4.08 (16.15)	4.24 (17.52)	4.47 (19.50)	4.73 (21.87)	4.34 (18.33)	4.58 (20.52)	4.78 (22.38)
Isoproturon + 2,4-D (1.0 + 0.5 kg/ha)	3.98 (15.35)	3.81 (14.00)	3.84 (14.24)	4.18 (16.96)	4.31 (18.12)	3.96 (15.22)	4.18 (16.95)	4.45 (19.33)
Pendimethalin (1.0 kg/ha)	5.25 (27.07)	5.17 (26.25)	5.24 (27.00)	5.36 (28.22)	5.56 (30.42)	5.20 (26.56)	5.28 (27.35)	5.76 (32.63)
Metribuzin (210 g/ha)	4.06 (16.01)	3.90 (14.72)	4.00 (15.53)	4.24 (17.50)	4.39 (18.82)	4.11 (16.41)	4.21 (17.26)	4.51 (19.81)
Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Weedy check	9.95 (98.56)	9.69 (93.35)	9.81 (95.74)	10.13 (102.16)	10.53 (110.49)	10.15 (102.56)	10.27 (104.97)	10.54 (110.50)
					S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)
For comparison between weed control methods at same level of wheat establishment methods					0.05	0.14	0.05	0.15
For comparison between wheat establishment methods at same or different levels of weed control methods					0.06	0.18	0.06	0.20

Figures in parentheses are the original values, DAS – Days after sowing

Table 3 : Effect of wheat establishment methods and weed control methods on yield attributes grain and straw yield and harvest-index

Treatments	Grain yield (kg/ha)		Straw yield (kg/ha)		Harvest index (%)	
	2002-03	2003-04	2002-03	2003-04	2002-03	20003-04
Wheat establishment methods						
Strip till drill	3797.21	3657.38	5635.69	5547.53	40.30	39.69
Zero tillage	4131.75	3988.62	6132.42	5994.66	40.42	40.14
Rotavator drill	4025.95	3874.60	5860.03	5785.68	40.25	40.00
Conventional tillage	3651.28	3491.30	5572.54	5336.37	39.82	39.50
S.E.±	51.87	49.40	138.42	126.46	0.20	0.12
C.D. (P=0.05)	179.49	170.94	410.20	437.55	NS	NS
Weed control methods						
Sulfosulfuron (25 g/ha)	4085.52	3929.61	5874.10	5650.5	40.06	41.01
Isoproturon + 2,4-D (1.0 + 0.5 kg/ha)	4379.86	4218.70	6231.53	6038.72	41.31	41.18
Pendimethalin (1.0 kg/ha)	3498.70	3364.88	5439.92	5240.58	39.04	39.03
Metribuzin (210 g/ha)	4293.98	4139.30	6123.62	6015.42	41.24	41.11
Weed free	4449.59	4295.69	6325.07	6106.04	41.33	41.19
Weedy check	2701.63	2569.65	4806.78	4799.65	35.98	34.86
S.E. ±	30.43	29.39	123.80	127.29	0.11	0.03
C.D. (P=0.05)	86.95	83.99	353.78	363.75	0.24	0.09

NS=Non-significant

Table 3a : Interaction effect of wheat establishment and weed control methods on grain yield (kg/ha)

Treatments	Wheat establishment methods							
	2002-03				2003-04			
	Strip till drill	Zero tillage	Rotavator drill	Conventional tillage	Strip till drill	Zero tillage	Rotavator drill	Conventional tillage
Weed control methods								
Sulfosulfuron (25 g/ha)	4105	4345	4229	3961	3970	4212	4015	3820
Isoproturon + 2,4-D (1.0 + 0.5 kg/ha)	4337	4570	4440	4171	4164	4406	4290	4013
Pendimethalin (1.0 kg/ha)	3458	3722	3647	3167	3287	3593	3519	3059
Metribuzin (210 g/ha)	4142	4525	4416	4090	4034	4369	4262	3890
Weed free	4372	4602	4595	4230	4167	4490	4384	4140
Weedy check	2368	3025	2826	2286	2320	2859	2775	2023
					S. E.±	C.D. (P=0.05)	S. E.±	C.D. (P=0.05)
For comparison between weed control methods at same level of wheat establishment methods					60.85	174.87	58.78	168.54
For comparison between wheat establishment methods at same or different levels of weed control methods					76.01	230.32	73.36	227.21

the findings of Singh (2002) and Pandey *et al.* (1999). Highest weed control efficiency (84.31 and 83.70) was found with isoproturon+2,4-D among the herbicides.

Effect on crop :

Changing tillage practices have profound effect on grain yield. Higher grain yield of wheat was obtained under zero tillage treatment as compared to other tillage treatments (Table 3). Increase in grain yield under zero tillage can be attributed to more dry matter production, which led to effective formation of structural components, which resulted higher grain yield. The findings are in conformity with Tripathi and Chauhan (2001). In herbicides, highest grain yield was obtained with isoproturon + 2,4-D (1.0 + 0.5 kg/ha), which was at par with metribuzin 210 g/ha and significantly superior over rest of herbicides. This was due to minimum density of weeds in this treatment (Table 2), which made the crop to grow and develop in weed free environment, ultimately resulted higher yield attributes and higher grain yield. The findings are in close conformity with the findings of Virendra Sardan (2001).

Interactions:

The interaction effect of wheat establishment and weed control methods was found significant in respect to dry weight of weeds in both the years (Table 2a). Interaction effect showed that isoproturon+ 2,4-D was very effective in reducing total weeds dry weight, which was at par with metribuzin in all tillage systems during both the years. Data also showed that isoproturon +2,4-D had significant superiority over sulfosulfuron and pendimethalin in different wheat establishment methods. Among wheat establishment methods, zero tillage had recorded minimum dry weight, which was at par with rotavator drill and significantly superior to strip and conventional tillage with all the herbicidal treatments. The minimum total weed dry weight was recorded with isoproturon+ 2, 4-D under zero tillage; however, it was higher under conventional tillage with pendimethalin. It was due to poor efficacy of herbicides under conventional tillage owing to extended period of weed emergence as it provided better environment for emergence of weed in different flushes. This reasoning finds support from the observation of Buhler and Denial (1988).

The interaction effect of wheat establishment and weed control methods on grain yield of crop was found to be significant during both the years (Table 3a). A cursory view of data revealed that zero tillage was at par with rotavator till drill and significantly superior to rest of wheat establishment methods with all the herbicides in respect to grain yield during both the years. Combined application of isoproturon +2,4-D was at par with weed free, sulfosulfuron and metribuzin and significantly superior to remaining treatments with all the wheat establishment methods. This was due to fact that all the herbicidal treatments under zero tillage restricted weed growth and their population which resulted maximum crop growth, and thereby increased the more accumulation of photosynthates in reproductive parts, which ultimately enhanced the wheat grain yield. The present findings are in conformity with the findings of Bhardwaj *et al.* (2004).

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