Indian Journal of Agronomy **52** (1) : 49–52 (March 2007)

Efficacy of herbicides and fertilizer management on weed dynamics in wheat (*Triticum aestivum*)

I.B. PANDEY, D.K. DWIVEDI AND R.K. PANDEY

Department of Agronomy, Rajendra Agricultural University, Pusa, Bihar 848 125

Received : November 2006

ABSTRACT

A field experiment was conducted during winter (*rabi*) season of 2002-03 and 2003-04 to study the efficacy of herbicides and fertilizer management on weed dynamics of wheat (*Triticum aestivum* L. emend. Fiori & Paol.). The intensity of weeds as well as total weed count were unaffected by the method and level of fertilizer application, but side placement of fertilizer significantly reduced the total dry biomass of weeds, NPK depletion by weeds that improved the NPK uptake by the crop and produced 13.5 per cent higher grain yield than broadcast method of fertilizer application. Application of 125 per cent of the recommended dose of fertilizer (RDF) although recorded significantly higher dry biomass of weeds and NPK depletion by weeds than 75 per cent of the RDF, it increased the NPK uptake by crop and grain yield. Weed-control treatments significantly reduced the intensity of broad-leaf weeds, annual and perennial grasses, total weed count, dry biomass of weeds and NPK depletion by weeds, and increased the NPK uptake by the crop. These treatments increased the grain yield by 26.3-35.9 per cent than the weedy check. Among the weed-control treatments, sulfosulfuron proved the most effective herbicide against broad-leaf weeds and annual grasses, reducing their intensity as well as that of total weeds than the mixture of 2,4-D + isoproturon and hand-weeding but had no adverse effect on perennial grasses and sedges. However, hand-weeding significantly reduced the intensity of perennial grasses and sedges. Sulfosulfuron also recorded significanty lower total dry biomass of weeds and NPK depletion by weeds than the mixture of 2,4-D + isoproturon and showed the highest weed-control efficiency.

Key words : Wheat, Fertilizer, Weed dynamics, Sulfosulfuron, 2,4-D, Isoproturon, Weed-control efficiency

The use of optimum quantity of fertilizer and their suitable method of application are essential for improving the productivity level and finally the income (Behara, 1995). Weed infestation during the crop period causes more than 53 per cent reduction in grain yield, depending on the weed densities and type of weed flora present (Singh *et al.,* 2002). Grassy weeds emerge as a serious problem in wheat (*Triticum aestivum* L. emend. Fiori & Paol.), which pose a serious threat to its successful cultivation. Among the herbicides, isoproturon is being used since the 1980s for the control of *Phalaris minor* (Malik *et al.*, 2000). But continuous use of this herbicide for a long period has developed resistant biotypes in the wheat-growing area of the country (Walia *et al.*, 1997). To overcome this problem, various herbicides and their combinations were tested in different parts of the country. Hence it was felt necessary to screen out suitable herbicides for controlling complete weed flora of wheat in the agro-climatic condition of Bihar. Keeping these points in view, the present study was conducted.

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Rajendra Agricultural University, Pusa during winter (*rabi*) season of 2002-03 and 2003-04. The soil was clay loam, with pH 8.3, low in organic carbon (0.46%), having 290.6–23.3–152.0 kg/ha available N-P-K. The experiment was laid out in split-plot design, comprising two methods of fertilizer application (broadcast and side-dressing of basal dose of fertilizer 5 cm away from the seed) and three levels of fertilizer [75% of the recommended dose of fertilzer (RDF), i.e. 90, 45 and 30 kg/ha N, P and K respectively ($N_{90}P_{45}K_{30}$), RDF, $N_{120}P_{60}K_{40}$, and 125 per cent $N_{150}P_{75}K_{50}$ in the main plots, and four weed-control treatments [weedy check, hand-weeding (35 days after sowing), 2,4-D Na salt @ 0.4 kg/ha + isoproturon @ 0.6 kg/ha (post-emergence) and sulfosulfuron @ 25 g/ha (post-emergence)] in subplots. It was replicated thrice. Wheat 'HW 2045' was sown 22.5 in rows cm apart on 10 December 2002 and 8 December 2003. Half N and full dose of P and K as per treatment were applied in the form of

urea, diammonium phosphate and muriate of potash at the time of sowing, and the remaining half dose of N was top-dressed after first irrigation. Three uniform irrigations were applied at crown-root initation (CRI), boot and milk stages of the crop. Herbicides were dissolved in 800 litres water and applied at 35 days after sowing (DAS), using the knapsack sprayer fitted with flat-fan nozzle. Weed count and dry biomass of weeds were recorded from an area enclosed in the quardrate of 0.25 m^2 randomly selected at two places in each plot. Weed data were subjected to square-root transformation $\sqrt{X+0.5}$ before statistical analysis.

RESULTS AND DISCUSSION

Effect on weeds

The weed flora observed in the experimental plots included *Chenopodium album* L., *Convolvulus arvensis* L., *Oxalis corniculata* L., *Anagallis arvensis* L., *Melilotus indica* L., *Fumaria parviflora* Lam., *Lipia nodiflora* Mitch, *Launea pinnatifida* L., *Nicotiana plumbiginifolia* viz. *Spergula arvensis* and *Cannabis sativa* L. among broad-leaf weeds; *Phalaris minor* (L.) Retz. and *Avena fatua* L. among annual grasses; *Cynodon dactylon* (L.) Pers. among perennial grasses and *Cyperus rotundus* L. among sedges.

Side placement of fertilizer significantly reduced dry biomass of weeds over broadcast method (Table 1). In placement method the weed plants away from the fertilizer row got less opportunity to take it, leading to their lesser growth and production of lesser dry matter. The dry biomass of weeds increased with increase in the level of fertilizer. Significant increase was recorded at 125 per cent RDF compared with 75 per cent RDF. The increase in dry biomass of weeds at higher level of fertilizer resulted from greater availability of nutrients, which helped in the build-up of better vegetative growth.

The weed-control treatments significantly reduced the weed population and dry biomass of weeds than weedy check. Sulfosulfuron proved the most effective herbicide against broad-leaf weeds and annual grasses, and recorded significantly lower population of these weeds as well as the total weed population than the mixture of 2,4-D + isoproturon and hand-weeding (Table 1). The mixture of 2,4-D and isoproturon also proved superior in suppressing the population of broad-leaf weeds and annual grasses than hand-weeding. Hand-weeding (HW) reduced the population of perennial grasses and sedges significantly, but the applied herbicides proved inefficient in controlling these weeds. Sulfosulfuron being at par with HW recorded recorded significantly lower dry biomass of weeds than the mixture of 2,4-D and isoproturon. The highest weed-control efficiency was also recorded under sulfosulfuron-treated plots, followed by HW and mixture of 2,4-D and isoproturon. Higher weed population under hand-weeding might be due to regrowth and resurgence of weed population with new flushes of weeds after its removal at 35 DAS. Similarly, lower dry biomass of weeds under hand-weeding was due to slow pace of growth of the first flush of weeds, 35 DAS thereafter the emergence of new flushes of weeds could not attain full growth under the shade of crop plants. Lower weed population and dry biomass of weeds under sulfosulfuron- was due to broad spectrum control of broad-leaf weeds and annual grasses, which constitute the major proportion of weed population recorded in the experimental plots,.

Grain and straw yields

Placement of fertilizer gave 18.0 and 13.5 per cent higher grain and straw yields respectively than broadcast method (Table 2). Higher grain and straw yields under the former method was due to less weed biomass and greater availability of nutrients nearer the root, which reflected in the better growth and development of crop plant and finally the grain and straw yields. Application of 125 per cent RDF recorded significantly higher grain and straw yields than RDF and 75 per cent RDF. Similarly, RDF also gave significantly higher grain and straw yields than 75 per cent RDF. These findings are in close conformity with those of Thakur *et al.* (1999). The increase in grain and straw yields might be due to adequate amount and balanced proportion of nutrients supplied to the crop.

The weed-control treatments resulted in significantly higher grain and straw yields than the weedy check. Among the weed-control treatments, maximum increase in grain yield up to 34.87 and 34.96 per cent in the first and second year respectively was recorded under hand-weeding, followed by sulfosulfuron (32.4 and 31.72 per cent) and the mixture of 2,4-D + isoproturon (26.69 and 23.42 per cent) respectively in the first and second year over the weedy check. Yadav *et al.* (2001) also reported similar results. The higher yield under weed control treatments might be due to reduced state of crop-weed competition, as the plants have to face neither nutrient nor moisture stress due to lower weed infestation. Under weedy plot the vigorously growing weeds compete with the crop plants for nutrients, moisture, space and sunlight throughout the growing period and finally suppress the growth of crop plants.

Nutrient uptake

Placement of fertilizer significantly increased the NPK uptake by the crop in both the years (Table 2). The NPK uptake also increased substantially with increase in fertilizer level and was maximunm at 125 per cent RDF. This

Table 1. Effect of placement, fertility level and weed-control method on population, dry weight and weed-control efficiency of weeds in wheat crop

Treatment	Weed population/m² (90 DAS)										Total dry weight of weeds (g/m²)		Weed-control efficiency (%)	
	Broad-leaved		Annual grasses		Perennial grasses		Sedges		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	2002-03	2003-04
Fertilizer-application method														
Broadcast	11.30	10.96	4.93	4.68	4.69	4.49	5.22	5.03	14.38	13.87	8.50	8.22		
	(147.51)	(141.59)	(26.65)	(23.70)	(21.69)	(19.87)	(28.23)	(25.06)	(224.41)	(210.78)	(78.36)	(75.49)		
Side placement	11.11	10.40	4.59	4.49	4.18	4.09	4.95	4.93	13.69	13.11	7.76	7.36		
	(140.30)	(127.11)	(23.08)	(21.92)	(17.27)	(16.43)	(24.36)	(23.19)	(205.20)	(188.66)	(67.37)	(62.10)		
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.72	0.64		
Fertilizer level														
75% RDF	10.81	10.46	4.54	4.46	4.25	4.13	4.91	4.83	13.37	13.09	7.68	7.42		
	(132.67)	(126.21)	(22.50)	(21.63)	(17.73)	(16.73)	(24.37)	(21.77)	(197.10)	(186.35)	(66.22)	(62.86)		
RDF	11.20	10.66	4.82	4.58	4.42	4.32	5.17	4.98	14.13	13.53	8.21	7.88		
	(145.91)	(135.49)	(25.07)	(22.73)	(19.41)	(18.43)	(26.58)	(24.58)	(217.00)	(202.05)	(73.93)	(69.98)		
125% RDF	11.56	10.92	4.93	4.72	4.64	4.42	5.20	5.13	14.60	13.86	8.50	8.08		
	(153.12)	(141.34)	(27.03)	(24.07)	(21.30)	(19.28)	(27.93)	(26.04)	(229.40)	(210.75)	(78.44)	(73.55)		
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.61	0.53		
Weed-control treatment														
Weedy check	18.35	18.24	7.08	6.87	4.57	4.37	5.20	5.10	20.82	20.57	12.56	12.51		
	(337.76)	(333.64)	(49.76)	(46.81)	(20.67)	(18.83)	(27.37)	(25.85)	(435.21)	(424.13)	(158.06)	(156.73)		
Hand-weeding	10.14	9.22	4.81	4.51	3.99	3.96	4.60	4.64	12.78	12.01	6.44	6.06	3.70	76.28
	(103.47)	(85.68)	(23.10)	(20.12)	(15.64)	(15.49)	(22.03)	(21.35)	(164.08)	(144.73)	(41.46)	(37.18)		
2,4-D 0.4 kg+iso-	9.04	8.62	4.12	4.05	4.64	4.37	5.32	5.01	12.10	11.56	7.25	6.85	66.63	70.12
proturon 0.6 kg/ha	(81.31)	(73.93)	(17.63)	(16.09)	(21.18)	(18.68)	(28.06)	(24.67)	(148.11)	(133.37)	(52.47)	(46.83)		
Sulfosulfuron	7.30	6.65	3.05	2.92	4.55	4.47	5.23	4.99	10.44	9.83	6.28	5.74	75.22	78.03
(25 g/ha)	(53.08)	(44.14)	(9.06)	(8.22)	(20.44)	(19.59)	(27.70)	(24.64)	(110.20)	(96.63)	(39.45)	(34.43)		
CD (P=0.05)	0.63	0.57	0.46	0.33	0.39	0.32	0.37	0.29	1.22	1.06	0.57	0.51		

Figures shown in parentheses indicate original valueS; RDF = recommended dose fo fertilizer

Table 2. Effect of placement, fertility level and weed-control method on yield of wheat

Treatment	Yield (q/ha)				Nutrient uptake by crop (kg/ha)						Nutrient depletion by weeds (kg/ha)					
	Grain		Seed		N		P		K		N		P		K	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Fertilizer-application method																
Broadcast	31.83	33.63	44.97	47.37	75.49	79.75	17.43	19.07	80.56	83.29	16.69	15.56	8.76	8.17	15.88	14.83
Side placement	35.90	38.37	50.02	53.03	89.53	93.96	20.18	21.98	90.25	95.32	13.38	12.39	6.67	5.82	12.81	11.91
CD (P=0.05)	2.33	1.92	3.19	3.51	6.45	5.86	1.55	1.69	8.68	8.27	1.92	1.78	1.19	1.22	1.81	1.64
Fertilizer level																
75% RDF	29.19	31.35	41.39	44.31	71.26	75.88	15.84	17.76	71.32	76.96	13.30	12.37	6.80	6.14	12.73	12.02
RDF	34.90	36.75	48.42	51.21	82.02	86.71	19.28	20.33	85.98	91.15	15.35	14.28	7.96	7.11	14.60	13.57
125% RDF	37.50	39.90	52.68	55.08	95.25	97.98	21.31	22.83	95.93	99.80	16.45	15.27	8.62	7.73	15.70	14.52
CD (P=0.05)	1.81	1.54	2.74	2.96	5.89	4.93	1.26	1.40	7.09	6.91	1.56	1.40	1.02	1.11	1.48	1.31
Weed-control treatment																
Weedy check	27.62	29.38	39.62	41.85	65.93	65.39	14.77	16.67	68.25	73.65	31.52	30.41	16.96	15.09	29.51	28.88
Hand-weeding	37.12	39.65	51.04	54.78	89.22	97.93	21.15	23.11	92.64	98.21	9.03	7.97	4.64	4.09	9.09	7.74
2,4-D + isoproturon	34.32	36.26	48.91	50.51	86.78	89.17	19.26	20.53	88.44	89.72	11.06	10.21	5.51	5.13	10.63	9.79
Sulfosulfuron	36.44	38.70	50.67	53.66	88.09	94.94	20.05	21.79	91.75	95.63	8.53	7.29	4.26	3.67	8.14	7.07
CD (P=0.05)	1.54	1.13	2.55	2.77	5.24	4.58	1.20	1.32	6.17	6.02	1.06	0.94	0.69	0.75	1.09	0.91

Y_1 = 2002-03, Y_2 = 2003-04

was due to higher NPK content and greater biomass production of the crop.

The weed-control treatments significantly increased the uptake of these nutrients by crop than the weedy check. Among the weed-control treatments, hand-weeding recorded the maximum and significantly higher NPK uptake than the mixture of 2,4-D + isoproturon except N and K uptake in the first year, but was similar to sulfosulfuron. However, N and K uptake in the first year was statistically on a par among weed-control treatments except in the weedy check. Higher NPK uptake in the weed-control treatment was due to lesser weed competition and lower production of weed biomass.

The maximum reduction in NPK depletion by the weeds was registered under broadcast method of fertilizer application (Table 2). This might be due to higher production of dry biomass of weeds. Application of 125 per cent RDF recorded the maximum and significantly higher NPK depletion than 75 per cent RDF. This was due to increased weed growth, resulting in higher dry-matter accumulation and consequently nutrient depletion.

Lower NPK depletion was registered under weed control treatments than under weedy plot. Among the weed-control treatments, lowest depletion was recorded under sulfosulfuron, which was on a par with hand-weeding, and both proved superior in minimizing the nutrient loss to the mixture of 2,4-D + isoproturon. Reduction in dry biomass of weeds might be the reason for lower nutrient depletion under these treatments.

REFERENCES

Behara, A.K. 1995. Effect of seed rate, row spacing and fertilizer on wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **40**(3): 510–511.

Malik, R.K., Yadav, A., Banga, R.S. and Singh, S. 2000. Zero till, where and alternate herbicide resistant *Phalaris minor* in rice-wheat cropping system. *Indian Jouranl of Weed Science* **32**(3&4): 220–222.

Singh, G., Singh, V.P., Singh, R.K. and Saxena, A. 2002. Bio-efficacy of herbicides in zero-till wheat in rice-wheat cropping system. *Indian Journal of Weed Science* **39**: 5–8.

Thakur, S.S., Pandey, I.B. and Mishra, S.S. 1999. Effect of organic manure, fertilizer level and seed rate on yield and quality of late sown wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **44**(4) : 747–759.

Walia, U.S., Brar, L.S. and Dhaliwal, B.K. 1997. Resistance to isoproturon in *Phalaris minor* Retz. on variable soil pH. *Indian Journal of Weed Science* **34**(1&4): 116–118.

Yadav, D.P., Vaishya, R.D. and Singh, G. 2001. Response of late sown wheat to method of sowing, seed rate and weed management practices. *Annals of Agricultural Research* **22**(3): 429–431.