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Response of wheat (*Triticum aestivum*) to seeding methods and weed management

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ABSTRACT

A field experiment was conducted during the winter seasons of 2000–2001 to 2001–2002, to study the response of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) to seeding methods and weed management. Criss-cross and unidirectional sowing resulted in significantly higher yield attributes, grain yield and net returns than broadcasting. Criss-cross sowing significantly reduced weed count and weed dry biomass than broadcasting. Test weight and protein content in grain were unaffected by seeding methods. Among the weed-control treatments, hand-weeding although recorded higher yield attributes, grain and straw yields but was found at par with those recorded under sulfosulfuron 33.3 g/ha and significantly higher than those recorded under isoproturon and 2,4-D. Net returns recorded among the weed-control treatments did not differ significantly. However, it was higher in isoproturon followed by sulfosulfuron, hand-weeding and 2,4-D. Weed-control treatments also recorded higher protein content weedy check.

Key words : Wheat, Unidirectional sowing, Broadcasting, Criss-cross sowing, Herbicides, Yield

Uniform and optimum distribution of plants per unit area is one of the factors responsible for increasing wheat yield. *Phalaris minor* Retz. and *Avena ludoviciana* Durieu emerged as serious weeds of wheat crop in rice–wheat cropping system. Because of their morphological similarities with the crop, they are not easily identified by the farmers and defy all manual mechanical attempts to control them. Among the existing herbicides, isoproturon has been intensively used for controlling these weeds since last 15 years (Gupta *et al.,* 1990). Due to continuous use of isoproturon, *Phalaris minor* has developed resistance to this herbicide (Walia *et al.* 1997). To overcome to this problem, a judicious combination of seeding method and weed management may act synergistically to control weeds and ultimately boost up the crop yield. Keeping this in view, the present experiment was conducted at research farm of Rajendra Agricultural, Pusa, Samastipur, Bihar.

MATERIALS AND METHODS

The field experiment was conducted at research farm of Rajendra Agricultural University, Pusa (Samastipur), during winter seasons of 2000–2001 and 2001–2002. The soil was clay loam in texture and calcareous in nature, low in organic carbon (0.36%), available nitrogen (217.84 kg/ha), phosphorus (21.8 kg/ha) and potassium (103.5 kg/ha), with pH 8.7. The experiment was laid out in split-plot design, comprising 3 seeding methods [Criss-cross sowing (20 cm × 20 cm), unidirectional sowing (20 cm) and broadcasting] in main plots and 5 weed-control treatments [weedy check, hand-weeding (30 days after sowing), isoproturon @ 750 g/ha (pre-emergence), sulfosulfuron @ 33.3 g/ha (post-emergence) and 2,4-D Na-salt @ 800 g/ha (post-emergence) in sub-plots and was replicated thrice. Wheat variety 'HD 2733' was sown on 9 and 14 December in 2000 and 2001 respectively. The recommended dose of fertilizers, i.e. 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha, was applied to the crop. Full dose of P and K and half dose of N were applied basal and remaining N in 2 equal splits, i.e. 30 kg at tillering and 30 kg at boot stage. The crop received 3 uniform irrigations. Weed count and weed dry biomass were recorded 90 days after sowing from an area enclosed in a quadrate of 0.25 m² randomly selected at 2 places in each plot. Weed data were subjected to square root transformation ($\sqrt{x+0.5}$) before statistical analysis. Pre-emergence application of isoproturon was done 2 days after sowing. However, the post-emergence application of sulfosulfuron and 2,4-D was done 30 days after sowing, using the knap-sack sprayer fitted with flat-fan nozzle.

RESULTS AND DISCUSSION

The major weed flora observed in the experimental plots included *Chenopodium album* L., *Fumaria parviflora* Lam., *Oxalis corniculata* L., *Convolvulus arvensis* L., *Anagallis arvensis* L., *Lipia nudiflora* Mitch, *Melilotus indica* L., *Launea pinnatifida* L., *Cannabis sa-*

tiva L., *Nicotiana plumbginifolia* Viz. and *Spergula arvensis* L. among broad-leaf weeds; and *Phalaris minor* (L.) Retz., *Avena fatua* L., *Cynodon dactylon* (L.) Pers. and *Cyperus rotundus* L. among the narrow-leaf weeds throughout the crop season.

Weed

Criss-cross sowing significantly reduced the weed count and weed dry biomass compared to broadcasting. Unidirectional sowing also recorded lower weed count and weed dry biomass than broadcasting, though differences were not significant (Table 1). The reduction in weed count and weed dry biomass in criss-cross sowing may be attributed to competition created by the canopy of more number of crop plants in an unit area having a suppressive effect on associated weeds. These results confirm the findings of Jhadhao and Nalamwar (1993). Weed-control treatments significantly lowered the weed count and weed dry biomass than weedy check. Among the weed-control treatments, sulfosulfuron recorded significantly lower weed count than rest of the herbicides and hand-weeding. Isoproturon also recorded significantly lower weed count than hand-weeding but was at par with 2,4-D. However, weed dry biomass recorded in sulfosulfuron and hand-weeding was at par and both recorded significantly lower value than isoproturon and 2,4-D. Isoproturon at 750 g/ha also significantly lowered weed dry biomass than 2,4-D. Malik *et al.* (2000) also reported the similar result. Lower weed count and weed dry biomass in sulfosulfuron-treated plot was due to broad-spectrum activity of herbicide particularly on established plants of both narrow and broad-leaf weeds. Similarly, lower weed dry biomass under hand-weeding was due to slow pace of growth of first flush of weeds 30 days after sowing and thereafter emergence of new flushes of weeds could not attain full growth under shade of crop plant.

Yield attributes

Criss-cross sowing recorded maximum tillers/m^2 (351–360), ear length (8.80–9.11 cm), grains/ear (41.63–43.06) and leaf-area index (3.50–3.57), being significantly higher than broadcasting and except ear length with unidirectional sowing (Table 1). Similarly, unidirectional sowing also recorded significantly higher value of these yield indices than broadcasting. Weed-control treatments recorded significantly higher values of yield indices, i.e. tillers/m^2, ear length, grains/ear and leaf-area index, than weedy check. Maximum value of these indices were recorded under hand-weeding which was found to be at par with sulfosulfuron at 33.3 g/ha but significantly higher than isoproturon at 750 g/ha and 2,4-D.

Grain and straw yields

Seeding method influenced the grain and straw yields significantly (Table 2). Criss-cross sowing although, resulted maximum grain and straw yields but was at par with unidirectional sowing and both significantly outyielded broadcasting except the straw yield in the second year. The straw yield recorded under unidirectional sowing and broadcasting in second year was at par. Gogoi and Kalita (1995) also reported the similar results. Higher yield under criss-cross and unidirectional sowing was owing to optimum number of plants per unit land area, which reduced weed infestation and provided conducive environment for proper growth and development of crop plant and yield attributes to the desirable extent. On the contrary, improper depth and uneven distribution of seeds in broadcasting caused significant reduction in plant population per unit area, which provided sufficient space to grow weed resulted poor yield attributes and grain yield. Weed-control treatment resulted significantly higher grain and straw yields than weedy check. Hand-weeding recorded significantly higher grain and straw yields than isoproturon and 2,4-D, but was found to be at par with sulfosulfuron. Among the herbicides, sulfosulfuron significantly outyielded the 2,4-D, but was found at par with isoproturon except for straw yield in second year. The results confirm with the findings of Singh and Ghosh (1992) and Sharma *et al.* (1999). Due to poor resurgence frequency and growth of weeds in weed-control treatments, weeds were unable to compete with the crop plants for different growth factors, which consequently resulted in the better expression of yield components and thus gave higher grain yield. Less effective control of weeds particularly narrow-leaf weeds in 2,4-D-treated plot resulted in lower grain yield. Hand-weeding also recorded significantly higher harvest index than 2,4-D but was found to be at par with sulfosulfuron and isoproturon.

Protein

Protein content in grain was unaffected by seeding methods. Weed-control treatment recorded significantly higher protein content in grain (11.60 to 11.66 and 11.57 to 11.64) than weedy check (11.36 to 11.41). The highest protein content was recorded under weed-free environment, which might be due to increased uptake of nitrogen by the crop plant, which was ultimately converted into higher amounts of amino acid.

Economics

Criss-cross sowing recorded significantly higher net returns than unidirectional sowing and broadcasting (Table 2). Likewise, unidirectional sowing also recorded

Table 1. Effect of seeding methods and weed management on yield attributes of wheat and weed dynamics

Treatment	Effective tillers/m^2		Leaf-area index (60 DAS)		Length of ear (cm)		Grains/ ear		Weeds/m^2 (90 DAS)		Weed dry weight (g/m^2) 90 DAS	
	2000–2001	2001–2002	2000–2001	2001–2002	2000–2001	2001–2002	2000–2001	2001–2002	2000–2001	2001–2002	2000–2001	2001–2002
Seeding method												
Broadcasting	327.10	321.33	3.14	3.06	8.68	8.54	35.96	34.46	13.99 (209.09)	14.25 (220.49)	8.05 (69.62)	8.34 (74.10)
Unidirectional sowing	347.27	339.40	3.38	3.27	8.87	8.70	40.67	39.06	13.06 (184.94)	13.60 (198.26)	7.43 (60.69)	7.82 (66.06)
Criss-cross sowing	360.96	351.93	3.57	3.50	9.01	8.80	43.06	41.46	12.45 (170.29)	13.25 (186.21)	7.04 (55.24)	7.49 (61.25)
CD (P=0.05)	10.81	9.22	0.09	0.06	0.21	0.18	1.12	0.83	1.08	0.94	0.92	0.82
Weed control method												
Weedy check	316.50	310.44	3.17	3.12	7.63	7.30	31.16	29.22	20.50 (420.11)	20.74 (431.97)	12.09 (145.86)	12.28 (150.50)
Hand-weeding (30 DAS)	365.81	356.44	3.50	3.41	9.34	9.21	43.92	42.28	12.60 (158.73)	13.32 (177.61)	5.74 (32.73)	6.23 (38.67)
Isoproturon 750 g/ha	348.68	338.00	3.38	3.27	9.13	8.96	41.83	40.11	11.24 (126.47)	11.94 (142.72)	6.67 (44.24)	7.11 (50.39)
Sulfosulfuron 33.3 g/ha	360.67	349.77	3.47	3.37	9.26	9.10	43.33	41.65	9.40 (88.79)	10.27 (105.70)	5.56 (30.73)	6.07 (36.62)
2,4-D 800 g/ha	339.98	332.78	3.29	3.22	8.91	8.83	39.25	37.98	12.10 (146.43)	12.25 (150.09)	7.48 (55.69)	7.73 (59.50)
CD (P=0.05)	8.36	7.80	0.06	0.04	0.16	0.14	0.98	0.79	0.91	1.12	0.59	0.51

DAS, Days after sowing

Figures in parentheses indicate original value

Table 2. Effect of seeding methods and weed management on grain and straw yields, protein content in grain and net returns in wheat

Teratment	Grain yield (q/ha)		Straw yield (q/ha)		Harvest index (%)		Protein content in grain (%)		Net return (Rs/ha)	
	2000–2001	2001–2002	2000–2001	2001–2002	2000–2001	2001–2002	2000–2001	2001–2002	2000–2001	2001–2002
Seedling method										
Broadcasting	32.00	29.62	46.81	44.19	40.51	40.13	11.57	11.53	14,462.78	12,594.08
Unidirectional sowing	35.71	33.19	51.67	48.26	40.87	40.74	11.58	11.55	17,329.72	15,288.15
Criss-cross sowing	38.38	35.54	54.80	51.04	41.15	41.04	11.60	11.56	19,206.26	16,915.56
CD (P=0.05)	3.27	2.38	3.79	4.25	0.55	0.61	NS	NS	1,597.43	14,55.560
Weed-control method										
Weedy check	29.06	26.90	44.34	41.44	39.61	39.36	11.41	11.36	13,276.72	11,521.05
Hand-weeding (30 DAS)	38.72	36.11	54.83	51.65	41.37	41.15	11.66	11.64	18,169.49	16,094.68
Isoproturon 750 g/ha	36.41	33.35	52.21	48.07	41.08	40.96	11.63	11.60	18,412.39	15,926.99
Sulfosulfuron 33.3 g/ha	38.10	35.26	54.15	50.78	41.28	40.98	11.62	11.58	18,126.65	15,872.24
2,4-D 800 g/ha	34.52	32.31	49.95	47.20	40.86	40.64	11.60	11.57	17,012.69	15,248.03
CD (P=0.05)	2.48	2.02	2.32	2.51	0.34	0.38	0.08	0.05	1,431.81	1,319.26

DAS, Days after sowing

significantly higher net returns than broadcasting. Weed-control treatments recorded significantly higher net return and than weedy check.

Net returns found in all the weed-control treatments were at par and significantly higher than weedy check. However, isoproturon at 750 g/ha recorded the maximum net returns followed by sulfosulfuron, hand-weeding and 2,4-D in both the years. Though the grain yield was higher under hand-weeding and sulfosulfuron but net returns were higher under isoproturon. This was might be due to higher cost investment in hand-weeding and sulfosulfuron caused such difference.

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