Indian Journal of Agronomy **52** (3) : 235–238 (September 2007)

Effect of planting pattern and weed-control methods on weed growth and performance of wheat (*Triticum aestivum*)

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Received: August 2007

ABSTRACT

A field experiment was conducted during 2000-01 and 2001-02 at Pusa, Bihar to study weed growth, nutrient removal, weed-control efficiency and yield, and nutrient uptake by wheat (*Triticum aestivum* L. emend. Fiori & Paol.) as influenced by planting pattern [criss-cross (20 cm × 20 cm), normal line sowing (20 cm) and broadcast] as well as weed-control treatment [weedy check, hand-weeding (30 days after sowing), isoproturon @ 0.75 kg/ha (pre-emergence), sulfosulfuron @ 33.3 g/ha (post-emergence) and 2,4-D Na salt @ 0.80 kg/ha (post-emergence)]. Criss-cross sowing significantly reduced the weed biomass and hence lowered the nutrient depletion by weeds, ultimately resulting in higher nutrient uptake and yield of wheat crop. Normal line sowing and broadcasting methods recorded 7.29 and 19.93% less grain yield than criss-cross sowing. Amongst the weed-control treatments, post-emergence application of sulfosulfuron was found on a par with hand weeding treatment for controlling weeds and producing grain yield of wheat. The different weed-control measures led to 119.5-139.0, 123.2-141.3 and 120.4-138.5% increase in N, P and K uptake by wheat respectively, and 59.9-74.6, 60.2-75.0 and 60.0-75.5% reduction in the depletion by weeds over the weedy check.

Key words: Grain yield, Nutrient depletion, Nutrient uptake, Weed biomass, Weed-control efficiency, Wheat

Weeds compete with crop plants for nutrients and other growth factors. The close proximity of weeds and their number causes sub-optimal absorption of growth factors, leading to reduction in growth and yield of crop (Reddy and Reddy, 1997). Reduction in yield of wheat due to weeds varies from 7 to 50% depending upon weed density and type of weed flora present (Kurchania *et al.*, 2000). Effective weed-control measures increase the uptake of nutrients by the crop and decrease their removal by weeds (Pandey *et al.*, 2001). Identification of effective sowing technique for uniform and optimum distribution of crop plants even with the same seed rate and judicious weed management may act synergistically to minimize the weed-crop competition in time. Keeping these facts in view, the present experiment was carried out to assess the nutrients removal by weeds in wheat under different planting patterns and weed-control treatments.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm of Rajendra Agricultura University, Pusa (Bihar) during winter seasons of 2000-01 and 2001-02 in clay-loam calcareous soil (pH 8.7), low in organic C (0.36%) and available N (217.8 kg/ha), P (21.8 kg/ha) and K (103.5 kg/ha). The experiment was laid out in split-plot design, comprising three sowing tecniques, viz. broadcasting, normal line sowing (20 cm) and criss-cross sowing (20 cm × 20 cm) in the main plots, and five weed-control treatments, viz. weedy check, hand-weeding 30 days after sowing (DAS), isoproturon 0.75 kg/ha at pre-emergence, sulfosulfuron 33.3 g/ha at post-emergence and 2,4-D Na salt 0.80 kg/ha at post-emergence (30 DAS) in subplots; replicated thrice. Wheat variety 'HD 2733' was sown on 9 December 2000 and 14 December 2001. The recommended dose of fertilizer nutrients, i.e. 120 kg N + 26.2 kg P + 33.3 kg K /ha, was applied to the crop. Full dose of P and K and half that of N were applied at the time of sowing and the remaining N was applied in two equal splits at tillering and boot stages. The crop received three uniform irrigations. The number and dry biomass of weeds were recorded with quardrates measuring 0.25 m^2 randomly at 2 places in each plot. The data on weeds were subjected to square-root transformation before statistical analysis. Herbicides were applied with the help of knap-sack sprayer fitted with flat-fan nozzle, using spray volume of 500 litres water/ha under moist field condition.

Weed-control effieincy (WCE) was worked out by

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considering dry-matter production of weeds.

Nitrogen, phosphorus and potassium contents in crop plants and weed materials were determined by micro-Kjeldahl, vanadomolybdate yellow-colour and flame-photometer methods respectively. The percentage content was then multiplied by the total biomass produced for estimation of nutrient uptake (kg/ha).

Predominant weeds in the experimental plots included *Chenopodium album* L., *Fumaria parvifolora* L., *Oxalis corniculata* L., *Convolvulus arvensis* L., *Nicotiana plumbaginifolia* L., *Spergula arvensis* L., *Phalaris minor* (L.) Retz., *Avena fatua* L., *Cynodon dactylon* (L.) Pers. and *Cyperus rotundus* L.

RESULTS AND DISCUSSION

Effect of weeds

The relative proportion of different weeds in the unweeded plots was: *Chenopodium* sp. (40%), nutgrass (22%), dubgrass (8%), *Phalaris* sp. (12%), and other grasses (18%).

Criss-cross sowing significantly reduced the weed density and weed biomass, and increased the weed-control efficiency compared with broadcast method of wheat sowing, which was found on a par with line sowing during 2000-01 (Table 1). During the next year although criss-cross sowing was found effective and recorded lower weed density than both the methods of sowing, the difference was non-significant. The reduction in density and biomass of weeds in criss-cross sowing may be attributed to greater competition created by this planting pattern, which reduced the weed intensity. However, the higher weed density and weed biomass under broadcast method of sowing may be due to lesser and uneven distribution of crop plants and hence greater availability of space, light and air for the weeds to grow. The results confirm the findings of Gogoi and Kalita (1995).

Application of sulfosulfuron @ 33.3 g/ha recorded significantly lower weed

Table 1. Effect of sowing technique and weed management on weed growth and nutrient depletion by weeds at harvest

Treatment	No. of weeds/m²		Dry weight of weeds (g/m²)		Weed-control efficiency (%)		Nutrient removal (kg/ha)					
							N		P		K	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Planting pattern												
Broadcast	12.93 (179.22)	13.19 (188.35)	8.54 (77.56)	8.75 (82.58)	65.76	64.53	15.88	16.74	8.87	9.07	15.52	15.75
Normal line sowing	12.21 (159.91)	12.61 (171.30)	7.91 (67.99)	8.35 (73.57)	70.41	69.00	13.97	14.84	7.82	8.15	13.66	114.03
Criss-cross sowing	11.49 (145.52)	12.18 (158.19)	7.59 (62.88)	7.98 (68.58)	71.95	69.37	12.99	13.67	7.24	7.53	12.67	13.11
SEm±	0.26	0.31	0.22	0.20	1.33	1.20	0.42	0.38	0.23	0.21	0.40	0.38
CD (P=0.05)	0.77	NS	0.69	0.57	3.98	4.74	1.26	1.61	0.68	0.82	1.19	1.47
Weed-control treatment												
Weedy check	19.02 (361.71)	19.26 (372.61)	12.51 (156.2)	12.80 (163.63)			31.26	32.38	17.74	17.83	30.94	31.08
Hand-weeding at 30 DAS	11.95 (142.83)	12.55 (157.57)	6.31 (39.57)	6.68 (44.28)	74.32	72.84	8.66	9.15	4.65	4.96	8.18	8.55
Isoproturon 0.75 kg/ha (pre-eme)	10.12 (102.54)	10.64 (113.64)	7.35 (53.77)	7.77 (60.08)	65.60	63.21	11.17	12.20	6.21	6.67	10.95	11.54
Sulfosulfuron 33.3 g/ha (post-eme)	8.57 (73.67)	9.39 (88.03)	6.08 (36.77)	6.42 (40.77)	76.40	74.96	7.55	8.52	4.27	4.63	7.40	7.80
2-4-D Na salt 0.8 kg/ha (post-eme)	11.38 (126.98)	11.44 (131.22)	7.83 (61.06)	8.14 (65.78)	60.89	59.52	12.46	13.16	7.00	7.16	12.26	12.50
SEm±	0.22	0.34	0.25	0.16	1.70	2.15	0.46	0.73	0.26	0.34	0.45	0.67
CD (P=0.05)	0.65	1.02	0.76	0.46	5.17	6.37	1.38	2.20	0.77	1.02	1.34	1.96

Figures in parentheses indicate original values

biomass with higher weed-control efficiency, and this treatment was found to be on a par with hand-weeding and superior to isoproturon and treaments. The number of weeds/m^2 (weed density) was significantly lower with sulfosulfuron treatment than with others. Hand-weeding recorded significantly higher weed density than sulfosulfuron and isoproturon. This might be due to resurgence of weeds in the plots treated with isoproturon and 2,4-D. Lower weed density and weed biomass, and high weed-control efficiency in sulfosulfuron was due to its broad-specturm activity on established plants of both narrow- and broad-leaved weeds. These results confirm the findings of Brar *et al.* (2002). Unweeded control (weedy check) plots recorded more than double weed density and weed biomass compared with sulfosulfuron.

NPK depletion by weeds

Maximum reduction in N, P and K depletion by weeds was registered with criss-cross sowing, which was on a par with normal line sowing, and both were superior to broadcasting technique, perhaps due to lower weed-biomass production under the former planting technique.

Application of sulfosulfuron significantly minimized the depletion of N, P and K, by weeds, which was found on a par with hand-weeding and significantly superior to others. The results are in close conformity with the findings of Pandey *et al.* (2001). The reduction of nutrient depletion by weeds under sulfosulfuron and hand-weeding was due to less production of weed biomass under these treaments. Nutrient depletion by weeds was significantly reduced by all weed-control treatments, and it was nearly four-folds high under weedy check treatment compared with sulfosulfuron and hand-weeding as well as 2.5 times more than with isoproturon and 2,4-D applications.

Grain yield

Criss-cross sowing resulted in significantly higher production of effective tillers/m^2 and grain yield compared with line sowing and broadcast methods, and this technique increased the grain yield by 7.29 and 19.93% than the normal and broadcast sowing (Table 2). A similar trend was observed in straw yield. These results confirm the finding of Gogoi and Kalita (1995). Higher grain yield under criss-cross and normal line sowing may be due to optimum number of plants per unit land area, which reduced the intensity of crop-weed competition during the crop-growth period. On the contrary, improper and uneven distribution of seeds in broadcasting caused significant reduction in plant population per unit area, which provided sufficient space for weeds to grow and create nutritional stress for the crop plant by intense crop-weed competition.

Table 2. Effect of sowing technique and weed management on grain yield and nutrient uptake by wheat

Treatment	Effective tillers/m^2		Grain yield (t/ha)		Straw yield (t/ha)		Nutrient uptake (kg/ha)					
							N		P		K	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Planting pattern												
Broadcast	327.10	321.33	3.29	2.96	4.68	4.42	73.67	68.31	21.12	20.35	73.10	71.20
Normal line sowing	347.27	339.40	3.57	3.32	5.17	4.83	81.64	75.87	23.13	22.11	76.68	77.08
Criss-cross sowing	360.96	351.93	3.84	3.60	5.50	5.11	87.46	80.95	24.50	23.24	83.96	80.85
SEm±	3.10	1.58	0.10	0.67	0.13	0.12	1.20	1.04	0.55	0.37	1.12	1.14
CD (P=0.05)	10.81	6.22	0.33	0.24	0.38	0.43	3.59	4.10	1.64	1.44	3.36	4.46
Weed-control treatment												
Weedy check	316.50	310.44	2.91	2.69	4.43	4.14	65.30	60.57	18.22	17.46	62.93	62.71
Hand-weeding at 30 DAS	365.81	356.44	3.87	3.60	5.48	5.17	90.10	84.93	25.75	24.67	88.24	85.71
Isoproturon 0.75 kg/ha (pre-eme)	348.68	338.0	3.64	3.34	5.22	4.81	84.08	77.22	23.84	22.41	81.89	77.34
Sulfosulfuron 33.3 g/ha (post-eme)	360.67	349.77	3.81	3.53	5.42	5.18	86.77	80.41	24.66	23.28	84.71	80.98
2-4-D Na salt 0.8 kg/ha (post-eme)	339.98	332.78	3.40	3.23	5.00	4.72	78.43	72.07	22.25	21.69	76.78	74.49
SEm±	2.71	2.67	0.07	0.07	0.08	0.08	1.09	1.27	0.36	0.37	1.06	1.29
CD (P=0.05)	8.36	7.80	0.25	0.20	0.23	0.25	3.24	3.71	1.11	1.08	3.17	3.74

Hand-weeding recorded significantly higher grain and straw yields than isoproturon and 2,4-D Na salt, but was on a par with post-emergence application of sulfosufuron. Among the herbicides, application of sulfosulfuron resulted in significantly higher grain and straw yields than 2,4-D Na salt but was on a par with isoproturon (except straw yield in the second year). The result confirms the finding of Sharma *et al.* (1999). Due to better control of weeds in the weed-control treatments, weeds were unable to compete with the crop plants for different growth factors, which consequently resulted in better expression of yield components and thus gave higher grain yield. Non-control of grassy weed with 2,4-D Na salt application resulted in lower grain yield. Weed-crop competition reduced the wheat yield by 26.8% under weedy check treatment.

Nutrient uptake by crop

Criss-cross and normal line sowing significantly increased the uptake of N, P and K by the crop compared with broadcast method of wheat sowing. The highest uptake of these nutrients in criss-cross and normal line sowing might be attributed to greater production of effective tillers/m^2 and crop biomass.

Maximum N, P and K uptake by crop was recorded in hand-weeded plots, which was significantly superior to herbicidal treatments, except P uptake. Among the herbcides, sulfosulfuron resulted in significantly higher N, P and K uptake than 2,4-D Na salt but was on a par with isoproturon. However, lowest nutrient uptake by crop under weed-control treatments was associated with weedy check (no weeding) practice under experimentation.

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