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Effect of Crop Establishment, Weed Control Method and Time of Nitrogen Application on Late Sown Wheat

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In north-eastern plains, especially eastern Uttar Pradesh and Bihar, late wheat is grown on more than 50% area of the rice-wheat system leading to poor productivity. Grain yield of wheat is reduced to the tune of 35-40 kg ha^{-1} day^{-1} due to delayed sowing beyond November (Sharma *et al.*, 1978). Growing of long duration high yielding varieties of rice reduces the turn-around-time between the harvesting of paddy and sowing of wheat, resulting in delayed sowing of wheat. However, puddled soil after rice requires extra time and energy to get the fine seed bed for sowing of wheat. Sowing by zero-till-drill may be an alternative for conventional sowing, and to save time and energy. The nitrogen is often applied in two splits to wheat crop but its response may be modified with tillage systems.

With the introduction of dwarf wheat, weeds such as *Phalaris minor, Avena fatua, Convolvulus arvensis, Cynodon dactylon, Cirsium arvense, Chenopodium album, Vicia hirsuta* and few others became serious and difficult to manage. The management of *P. minor* by hand weeding is costly as well as difficult due to its morphological similarity with wheat crop. For last two decades, continuous use of isoproturon leads to the selection of resistant *P. minor* biotypes and also shifts in weed flora. The present study was an attempt to find out the impact of zero tillage in reducing turn-around time, and herbicides for weed management and suitable times of N application in wheat.

The field experiment was carried out at Agricultural Research Farm, Institute of Agricultural Sciences, B. H. U., Varanasi during **rabi** seasons of 2000-01 and 2001-02. The soil of experimental site was gangetic alluvial (Ustochrept) having sandy clay loam texture with 7.3 pH. Soil was low in organic carbon content (0.46%) and available nitrogen (218.80 kg N ha^{-1}), and medium in available phosphorus (22.20 kg P_2O_5 ha^{-1}) and potassium (252.80 kg K_2O ha^{-1}). The experiment was laid out in split-plot design keeping two tillage systems (conventional and zero-tillage) and three weed control methods (weedy, sulfosulfuron 25 g ha^{-1} and isoproturon 1.0+2, 4-D 0.50 kg ha^{-1}) in main plots, and five times of nitrogen application (50% N at sowing+50% N at tillering, 33.3% N at sowing+66.6% N at tillering, 50% N at sowing+25% N at tillering+25% N at flowering, 25% N at sowing+50% N at tillering+25% N at flowering and 33.3% N at sowing+33.3% N at tillering+33.3% N at flowering) assigned to sub-plot with three replications. Wheat crop received a uniform dose of 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}. The whole amount of P_2O_5 and K_2O was applied at the time sowing. Nitrogen was applied as per treatment. Wheat crop variety HUW-234 was sown at 125 kg seed ha^{-1} with the help of seed-cum-ferti-drill after the required tillage operations (two harrowing+two cultivator ploughing and planking) in conventional tilled plots, whereas zero tilled plots were directly sown with the help of Pant-zero-till-drill at a row spacing of 20 cm. The crop was sown on November 26 and 29 and December 9 and 8 under zero and conventional tillage systems during 2000-01 and 2001-02, respectively. The density and dry weight of weeds were recorded by keeping a quadrate (0.25 m^2) randomly at three places in each plot at 50 DAS. The grain yield was recorded from each plot and expressed at 14%

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Table 1. Effect of various treatments on weeds and wheat yield

Treatment	Weed population (m^{-2})		Weed dry weight (g m^{-2})		Number of spikes (m^{-2})		Grain yield (kg ha^{-1})	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Tillage system								
Conventional tillage	11.56	12.50	8.20	8.90	307.2	325.5	3853.5	3920.0
	(174)	(207)	(67)	(79)				
Zero tillage	9.67	10.64	7.51	8.25	343.8	361.8	4219.7	4327.9
	(129)	(156)	(56)	(68)				
LSD (P=0.05)	0.50	0.40	0.32	0.28	12.8	11.1	151.1	140.5
Weed control method								
Weedy	19.13	21.10	11.99	13.21	300.0	321.4	3484.6	3561.1
	(369)	(449)	(145)	(176)				
Sulfosulfuron 25 g ha^{-1}	7.21	7.57	4.66	4.98	326.5	344.4	4155.9	4233.5
	(52)	(58)	(22)	(24)				
Isoproturon+2,4-D (1.0+0.5 kg ha^{-1})	5.64	6.03	4.17	4.55	349.9	365.2	4469.2	4577.3
	(32)	(37)	(18)	(20)				
LSD (P=0.05)	0.61	0.49	0.39	0.35	15.8	13.8	185.1	175.1
N application								
50% basal+50% tillering	10.32	11.28	7.25	7.85	330.5	353.0	4143.8	4216.1
	(141)	(173)	(52)	(64)				
33.3% basal+66.6% tillering	10.82	11.84	8.34	9.17	315.7	331.6	3922.0	4014.6
	(154)	(187)	(69)	(84)				
50% basal+25% tillering+25% flowering	10.04	10.99	6.98	7.50	345.1	363.4	4342.8	4416.9
	(136)	(166)	(47)	(57)				
25% basal+50% tillering+25% flowering	11.59	12.52	8.60	9.40	307.4	321.6	3808.6	3890.5
	(177)	(209)	(75)	(88)				
33.3% basal+33.3% tillering+33.3% flowering	10.53	11.21	8.06	8.66	320.7	339.7	3966.2	4081.1
	(149)	(172)	(65)	(75)				
LSD (P=0.05)	0.58	0.48	0.28	0.41	18.3	15.5	208.0	215.8

Figures in parentheses are the original values which were transformed to $\sqrt{X+0.5}$ for analyses.

moisture content.

The major weed flora observed in experimental crop were *Rumex dentatus* (65%), *Phalaris minor* (8%), *Parthenium hysterophorus* (6%), *Anagalis arvensis* (5%), *Melilotus alba* (4. 5%) and *Cynodon dactylon* (4%). Zero tillage wheat significantly reduced the density and dry weight of weeds, and registered higher weed control efficiency over conventional tillage (Table 1). The per cent reduction in weed population and weed dry weight was recorded to the tune of 25 and 15 in zero tillage as compared to conventional tillage system. Zero tillage reduced the germination and growth of weeds resulting in higher weed control efficiency as compared to conventional tillage. This might be due to the fact that puddling operation carried out during rice buried weed seeds in deeper soil layer, whereas intensive tillage in conventional tillage brought them in favourable moist upper soil layer for germination while they remained in deeper layer under zero-tillage system. The results are in close agreement with those of Singh *et al.* (2004).

Application of the herbicides significantly reduced the population and dry matter production of weeds over no herbicide application (Table 1). Isoproturon+2, 4-D had less weed population and dry matter as compared to sulfosulfuron. The per cent reduction in weed population (88 and 89) and weed dry matter production (86 and 87) was recorded with application of isoproturon+2, 4-D and sulfosulfuron over weedy check. The higher efficiency of isoproturon+2, 4-D was due to dominance of broad-leaved weeds in crop field which were effectively controlled by this treatment. Similar findings of maximum reduction in weed density and dry weight was obtained with herbicide mixture of isoproturon+2, 4-D by Singh *et al.* (2004).

Nitrogen applied in three splits (50% N at sowing+25% N at tillering+25% N at flowering) recorded lower population and dry weight of weeds, and higher weed control efficiency being at par with two splits (50% N at sowing+50% N at tillering) and three splits (33.3% N at sowing+33.3% N at tillering+33.3% N at flowering) but significantly superior over two splits (33.3% N at sowing+66.6% N at tillering) and three splits (25% N at sowing+50% N at tillering+25% N at flowering). Improved crop growth with former treatment as compared to later caused smothering effect on weed growth and development.

Zero tillage treatment produced significantly more number of spikes (m^{-2}) and grain yield as compared to conventional tillage. Increase in grain yield due to zero tillage sowing was recorded to the tune of 10% over conventional tillage. Early and timely sowing of wheat by zero tillage immediately after harvesting of the preceding rice crop facilitated early establishment of wheat which ultimately leads to its better growth, development and yield.

The reduction in grain yield due to weedy check was recorded to be 22% as compared to isoproturon+2, 4-D (Table 1). Isoproturon+2, 4-D produced significantly higher number of earheads and grain yield over sulfosulfuron. Higher yield under isoproturon+2, 4-D treatment was due to efficient control of weeds, reduced the crop-weed competition for nutrients, water, space and light and resulted in better growth and yield attributes. Wheat crop received nitrogen in three splits (50% N at sowing+25% N at tillering+25% N at flowering) being at par with application of nitrogen in two splits (50% N at sowing+50% N at tillering), and was significantly superior to rest times of nitrogen application.

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