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Effect of nitrogen levels and weed control methods on yield and economics of wheat under zero-tillage conditions

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ABSTRACT

A field experiment was conducted during *Rabi* seasons of 2015-16 and 2016-17 to study the effect of nitrogen and weed control on wheat yield, nitrogen uptake and economics of wheat. The treatments comprised of 4 levels of nitrogen, *viz.* 90, 120, 150 and 180 kg/ha, and 5 weed control methods, *viz.* weedy check, hand weedings at 30 and 60 days after seeding (DAS), clodinafop + metsulfuron (60 + 4 g/ha), fenoxaprop + metsulfuron (120 + 4 g/ha) and sulfosulfuron + metsulfuron (25 + 4 g/ha). Weed density was reduced with increased rate of nitrogen from 90 to 180 kg/ha. Crop fertilized with180 kg N/ha was at par with 150 kg N/ha but produced significantly higher weeds biomass than the rest of the nitrogen levels. The uptake of nitrogen by weeds was significantly higher with 180 kg/ha than the other N-levels. Post-emergence spray of clodinafop + metsulfuron (60 + 4 g/ha) recorded significantly the lowest weed population followed by sulfosulfuron + metsulfuron (25 + 4 g/ha) and fenoxaprop + metsulfuron (120 + 4 g/ha). Hand weeding twice (30 and 60 DAS) recorded the significantly lowest weeds biomass, followed by clodinafop + metsulfuron (60 + 4 g/ha). Weedy check recorded significantly maximum amount of nitrogen uptake by weeds. Nitrogen applied at 180 kg/ha recorded the highest wheat grain yield (3.82 and 3.98 t/ha), crop nitrogen uptake (96.81 and 99.69 kg/ha), gross returns (₹ 73700/ha), net returns (₹ 49600/ha) and B:C ratio (2.06).

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the major staple foods of the world. In India, wheat is grown in an area of 29.58 mha with the total production of 99.70 mt and average productivity of 3.37 t/ha (DAC&FW 2018). The productivity of wheat in Eastern Uttar Pradesh is quite low (3.27 t/ ha) as compared to Punjab (5.09 t/ha) and Haryana (4.41 t/ha) (DAC&FW 2018) due to the adoption of long duration rice varieties coupled with late harvesting resulted in delayed sowing of wheat. The field preparation also gets delayed due to high moisture after harvest of rice, which causes poor tilth of soil and creates hindrance in use of seed drill. Thus, to avoid delayed sowing of wheat, the farmers broadcast the seeds in soil which result in uneven distribution and improper depth of sowing in the field caused poor germination and reduced yield. Besides, repeated tillage generally disturbs soil physical properties and enhances air pollution due to higher combustion of fuel. Sowing of wheat by zero-till drill under untilled field advances the sowing by 10-15 days, and emergence of seedling by 8-9 days.

Weeds are one of the major constraints in wheat production as they reduce productivity of crop due to competition for light, space and nutrients, allelopathy effect and increase overhead costs (Dangwal *et al.* 2010). Weed causes 10- 65% yield reduction in wheat (Dangwal *et al.* 2010). Weed management at right time and optimum dose of nitrogen are most important factors which may affect the wheat productivity. Manual weeding is the most widely used practice of weed management. However, it is labour intensial, and costly. Besides, intra-row weeds remain uncontrolled. Chemical weed control is a preferred practice due to scarce and costly labour as well as lesser feasibility of mechanical or manual weeding (Chaudhari *et al.* 2017). Continuous use of a single herbicide may shift the weed flora in favour of the species that are not controlled, thus creating the

problem in controlling weeds (Alemu *et al.* 2016). Therefore, use of herbicide in combinations which have broad-spectrum of weeds control and sometimes such combinations can give spectacularly good control at doses considerably below to those normally applied in single application. It may be additive or synergistic and safer to crops also. Nitrogen is a key factor in crop production and requires by plant out through growing period. Response of nitrogen varied with treatments like irrigation regimes, weed management, sowing dates, spacing, sowing method and other cultural treatments. Under the present experiment, the response of nitrogen levels may varied with different weed control treatments due to its effect on extent of crop – weed competition for light, space, nutrients which directly affect the plant growth (plant height, leaf area and dry matter accumulation *etc*), yield attribute and yield too, Therefore, its optimum level was be worked out for different weed management practices in wheat crop under zero till conditions which may be of immense help to improve the productivity, reduce the crop -weed competition and maximise the benefit

MATERIALS AND METHODS

A field experiment was conducted during *Rabi* season of 2015-16 and 2016-17 at research farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) to study the effect of different nitrogen levels and weed management practices on yield and economics of wheat. The Soil of experimental site was silty loam, having pH 8.3-8.6, organic carbon 0.38-0.39, available nitrogen 132.9-133.5 kg/ha, phosphorus 14.0-15.6 kg/ha and potash 240.0-246.3 kg/ha. The 20 treatment combinations consisted of four levels of nitrogen, *viz*. 90, 120, 150 and 180 kg N/ha, and five weed management practices, *viz*. weedy check, two hand weedings at 30 and 60 DAS, the post-emergence application (PoE) at 35 days after sowing (DAS) of herbicides (PoE) clodinafop + metsulfuron (60 + 4 g/ha), fenoxaprop + metsulfuron at (120 + 4 g/ha) and sulfosulfuron + metsulfuron (25 + 4 g/ha). and replicated three times in randomized block design. The post-emergence spray of herbicide was done with the help of manually operated knapsack sprayer fitted with flat-fan nozzle using water 500 L/ ha. The wheat variety '*NW 1014*' was sown at 20 cm apart row, using 125 kg seed/ha on December 20, 2015 and December 21, 2016. The crop was fertilized uniformly 60 P + 40 K kg/ha at sowing. The ½ dose of N at sowing time, and ¼ dose of N each at first and second irrigation, respectively. The crop was irrigated 4 times as per need of the crop. The data on dry matter accumulation by crop was collected by cutting the plant from ground level of 25 cm row length, first sun dried, and then kept in electric oven at 65^0C temperature to attain the constant weight. The data pertaining to yield attributes were collected on 10 spikes collected randomly from each plot. A quadrate of 0.25 x 0.25 m size was placed randomly at three spots, and weeds plants within quadrate were first pulled and then washed in clean water and counted species wise. Thereafter, weeds were sundried and kept in oven at 65 ^{0}C temperature until attainment of constraint weight. The data on weeds were transformed as per formula of ($\sqrt{x+0.5}$) for statistical analysis. The samples collected on weed and crop were analysed in laboratory for nitrogen contain (%) as per procedure (alkaline potassium permanganate method). The uptake of nitrogen was calculated by formula as given below.

$$\text{N-uptake (kg/ha)} = \frac{\text{N-contain (\%) in grain X grain yield (kg/ha)}}{100}$$

The data collected on crop and weeds were subjected to statistical analysis as per procedure (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect on weeds

Application of nitrogen from 90 to 180 kg/ha reduced the density of weed due to smothering effect of higher crop growth with increasing levels of nitrogen. However, in total biomass of weed was increased with corresponding increase in levels of nitrogen due to increased growth of individual weed plant, thus, resulted in higher weed biomass per unit area. Application of nitrogen from 90 to 180 kg/ha increased nitrogen uptake by weeds significantly at harvest stage due to higher weed bio mass, however difference between 90 kg and 120 kg, and 120 and 150 kg was at par with each other during both the years. The maximum uptake of nitrogen *i.e.* 27.12 and 27.12 kg/ha were recorded under weedy check plot in respective years. Hand weeding twice recorded significantly the lowest weed density and biomass and lowest uptake of nitrogen by weeds mainly due to efficient control of weed. Among the herbicidal treatments, clodinafop + metsulfuron (60 + 4 g/ha) recorded significantly the lowest weed density, weed biomass and lowest nitrogen uptake by weeds followed by sulfosulfuron + metsulfuron (25 + 4 g/ha) and fenoxaprop + metsulfuron (120 + 4 g/ha) owing to efficient control of weeds. Similar, results were reported by Singh *et al*. (2015).

Table 1. Weed density (no./m^2) at harvest as affected by nitrogen levels and weed management practices in zero-till wheat

Treatment	*P. minor*		*C. dactylon*		*A. arvensis*		*M denticulata*		Other weeds		Total weeds	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Nitrogen (kg/ha)												
90	6.14 (38.80)	6.05 (37.71)	3.68 (13.63)	3.60 (13.09)	3.05 (9.05)	2.99 (8.70)	3.08 (9.57)	2.87 (8.24)	2.92 (8.22)	2.86 (7.86)	8.93 (79.27)	8.72 (75.6)
120	5.88 (35.60)	5.85 (35.27)	3.53 (12.50)	3.49 (12.24)	2.93 (8.30)	2.90 (8.14)	2.98 (8.95)	2.76 (7.56)	2.81 (7.54)	2.77 (7.35)	8.56 (72.89)	8.42 (70.56)
150	5.82 (34.89)	5.74 (33.87)	3.49 (12.25)	3.42 (11.76)	2.90 (8.13)	2.85 (7.82)	2.93 (8.59)	2.73 (7.41)	2.78 (7.39)	2.72 (7.06)	8.48 (71.25)	8.27 (67.92)
180	5.67 (33.11)	5.65 (32.82)	3.41 (11.63)	3.37 (11.39)	2.83 (7.72)	2.81 (7.58)	2.88 (8.33)	2.66 (7.03)	2.71 (7.01)	2.68 (6.84)	8.26 (67.8)	8.13 (65.66)
LSD (p=0.05)	0.27	0.26	0.15	0.16	0.12	0.12	0.13	0.12	0.09	0.10	0.37	0.37
Weed management												
Clodinafop + metsulfuron (60 + 4 g/ha)	5.01 (24.70)	4.97 (24.30)	3.08 (9.00)	3.03 (8.70)	2.43 (5.40)	2.49 (5.70)	2.53 (5.90)	2.40 (5.30)	2.45 (5.50)	2.41 (5.30)	7.14 (50.50)	7.06 (49.30)
Fenoxaprop + metsulfuron (120 + 4 g/ha)	5.88 (34.20)	5.85 (33.80)	3.39 (11.00)	3.36 (10.80)	3.16 (9.50)	3.19 (9.70)	2.77 (7.20)	2.57 (6.10)	3.00 (8.50)	2.95 (8.20)	8.42 (70.40)	8.31 (68.60)
Sulfosulfuron + metsulfuron (25 + 4 g/ha)	5.38 (28.50)	5.33 (28.00)	3.17 (9.60)	3.11 (9.20)	2.91 (8.00)	2.95 (8.20)	2.62 (6.40)	2.40 (5.30)	2.77 (7.20)	2.70 (6.80)	7.76 (59.7)	7.62 (57.55)
Weedy check	8.09 (65.10)	8.18 (66.70)	4.89 (23.50)	4.96 (24.20)	3.56 (12.20)	3.60 (12.50)	4.08 (16.20)	4.40 (18.90)	3.40 (11.30)	3.43 (11.10)	11.35 (128.3)	11.57 (133.4)
Hand weeding twice (30 and 60 DAS)	4.93 (23.90)	4.88 (23.40)	3.03 (8.70)	2.98 (8.40)	2.38 (5.20)	2.43 (5.40)	2.53 (5.90)	2.32 (4.90)	2.39 (5.20)	2.34 (5.00)	7.03 (48.9)	6.90 (47.10)
LSD (p=0.05)	0.30	0.29	0.17	0.17	0.14	0.14	0.15	0.13	0.10	0.11	0.41	0.42

*Data subjected to square root ($\sqrt{x+0.5}$) transformation and original data presented in parentheses

Table 2. Weed biomass and nitrogen uptake by weed as affected by nitrogen levels and weed management practices in zero-till wheat

Treatment	Weed biomass at harvest stage (g/m^2)						Nitrogen uptake by weeds (kg/ha)	
	Grassy		Broad-leaf		Sedge			
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
N- kg/ha								
90	7.13(52.3)	7.08(51.6)	2.97(8.83)	2.74(7.45)	2.63(6.87)	2.37(5.49)	14.32	14.44
120	7.32(55.1)	7.19(53.2)	3.01(9.11)	2.81(7.85)	2.68(7.15)	2.45(5.89)	14.78	15.21
150	7.39(56.3)	7.34(55.4)	3.07(9.49)	2.83(8.01)	2.75(7.53)	2.48(6.05)	15.39	15.52
180	7.72(61.3)	7.59(59.3)	3.17(10.14)	2.95(8.73)	2.86(8.18)	2.61(6.77)	16.45	16.92
LSD (p=0.05)	0.34	0.33	0.13	0.12	0.12	0.10	0.85	0.84
Weed management								
Clodinafop + metsulfuron (60 + 4 g/ha)	6.32(39.5)	6.23(38.5)	2.60(6.25)	2.47(5.62)	2.34(4.98)	2.19(4.32)	11.56	11.00
Fenoxaprop + metsulfuron (120 + 4 g/ha)	7.41(54.6)	7.33(53.4)	2.85(7.63)	2.64(6.47)	2.57(6.13)	2.33(4.97)	14.15	13.83
Sulfosulfuron + metsulfuron (25 + 4 g/ha)	6.98(48.3)	6.89(47.2)	2.70(6.78)	2.38(5.19)	2.35(5.05)	2.21(4.42)	13.54	13.28
Weedy check	9.93(98.5)	10.05(100.9)	4.20(17.17)	4.52(20.03)	3.69(13.17)	4.06(16.03)	27.12	27.12
Hand weeding twice (30 and 60 DAS)	6.20(38.0)	6.11(37.0)	2.60(6.25)	2.47(5.62)	2.33(4.95)	1.97(3.39)	11.25	10.93
LSD (p=0.05)	0.39	0.37	0.14	0.15	0.13	0.12	0.94	0.95

*Data subjected to square root ($\sqrt{x+0.5}$) transformation and original data presented in parentheses

Effect on yield

Application of nitrogen 180 kg/ha gave significantly higher wheat grain (3.82 and 3.98 t/ha) and straw (5.14 and 5.23 t/ha) yields and higher nitrogen uptake being at par with 150 kg N/ha with grain (3.66 and 3.83 t/ha) and straw (5.12 and 5.22 t/ ha) yield. This was mainly due to higher values of yield contributing characters owing to maximum availability of nitrogen with increasing N- levels resulted in higher grain and straw yield. Similar results have been reported by Upasani *et al.* (2013). Hand weeding twice was found at par with clodinafop + metsulfuron but produced significantly higher grain yield and straw yield during both the years. Among the herbicide treatments, clodinafop + metsulfuron produced higher wheat grain (3.70 and 3.90) and straw (5.14 and 5.23) yield followed by sulfosulfuron + metsulfuron. Hand weeding twice was at par with clodinafop + metsulfuron. Hand weeding twice recorded the highest gross (₹ 75000/

Table 3. Effect of nitrogen levels and weed management practices on wheat grain yield, nitrogen uptake and economics

Treatment	Grain yield (t/ha)		Straw yield (t/ha)		Nitrogen Uptake by crop (kg/ha)		Gross income (x10^3₹/ha)	Net income (x10^3₹/ha)	B:C ratio
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17			
N - kg/ha									
90	3.01	3.05	4.61	4.69	82.64	85.05	58.60	35.70	1.57
120	3.52	3.61	4.57	4.96	88.82	91.45	67.70	44.50	1.91
150	3.66	3.83	5.12	5.22	94.89	97.72	71.10	47.40	2.00
180	3.82	3.98	5.14	5.23	96.81	99.69	73.70	49.60	2.06
LSD (p=0.05)	0.19	0.19	0.26	0.25	4.65	4.72	-	-	-
Weed management									
Clodinafop + metsulfuron (60 + 4 g/ha)	3.70	3.90	5.14	5.23	96.08	98.96	72.10	48.90	2.11
Fenoxaprop + metsulfuron (120 + 4 g/ha)	3.47	3.55	4.84	4.93	88.35	90.93	66.80	44.20	1.96
Sulfosulfuron + metsulfuron (25 + 4 g/ha)	3.68	3.75	4.95	5.04	91.02	93.74	70.30	47.00	2.02
Weedy check	2.87	2.76	4.57	4.49	83.31	80.92	54.70	33.10	1.54
Hand weeding twice (30 and 60 DAS)	3.90	4.03	5.26	5.36	97.57	100.46	75.00	50.50	2.05
LSD (p=0.05)	0.21	0.21	0.29	0.28	5.19	5.28	-	-	-

ha) and net income (₹ 50500/ha) followed by clodinafop + metsulfuron (₹ 72100/ha) and (₹ 48900/ha). However, clodinafop + metsulfuron recorded higher B:C ratio (2.11) than twice hand weeding (2.05) due to higher cost incurred with hand weeding twice.

It was concluded that application of 180 kg N/ha along with clodinafop + metsulfuron PoE produced higher wheat yield and benefit cost ratio under zero-tillage situation.

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