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Effect of zero and minimum tillage in conjunction with nitrogen management in wheat (*Triticum aestivum*) after rice (*Oryza sativa*)

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ABSTRACT

An experiment was conducted to find out the effect of tillage and nitrogen management on the productivity of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) after rice (*Oryza sativa* L.) during winter seasons of 1997–98 and 1998–99 at Faizabad, Uttar Pradesh. Sowing of wheat by Chinese seeder recorder significantly higher values of growth characters, yield attributes, yield and nitrogen uptake by wheat followed by Pantnagar zero till drill and lowest in conventional tillage. Chinese seeder recorded 23.83 and 25.85% more grain yield over conventional tillage during first and second year respectively. All the growth characters, yield attributes, yield and N uptake were significantly higher with 150 kg N/ha over 120 kg N/ha. Application of N as half basal + half after first irrigation recorded significantly higher yield and N uptake over rest of the treatments but test weight was higher with the application of N as half after first irrigation + half after second irrigation.

Key words : Wheat productivity, Tillage, N management, Rice, N uptake

Rice–wheat is the most predominant cropping system. Sowing of wheat in this tract is generally delayed due to the cultivation of long- and medium-duration rice varieties and time required in field preparation of wheat. The advancing of wheat seeding is possible by using Pantnagar zero till drill or Chinese seeder on the residual soil moisture after the harvest of rice, as there is no need to prepare the field for sowing. But in this system, nitrogen management may differ because of rice stubbles cause higher nitrate depression for 4–6 weeks under zero tillage which may result immobilization of nitrogen. Therefore, higher rates of nitrogen may be required. As the information on the these aspects of wheat is meagre, the present investigation was conducted to find out the effect of tillage and nitrogen management on growth and yield of wheat.

MATERIALS AND METHODS

An experiment was carried out at Agronomy Research Farm, Faizabad, Uttar Pradesh, during winter seasons of 1997–98 and 1998–99. The soil was silty loam with bulk density of 1.42 g/cc and pH 8.2. The available N, P and K content of soil was 206.50, 20.00 and 302.76 kg/ha respectively. The treatments comprised 3 tillage systems (conventional tillage, Chinese seeder and Pantnagar zero till drill), 2 nitrogen levels (120 and 150 kg/ha) and 4 times of nitrogen application [½ basal dressing + ¼ top-dressing after first irrigation + ¼ top-dressing after second irrigation (S_1), ⅓ basal + ⅓ top-dressing after first irrigation + ⅓ after second irrigation (S_2); ½ basal dressing + ½ top-dressing after first irrigation (S_3), ½ top-dressing after first irrigation + ½ top-dressing after second irrigation (S_4)] were tested in split-plot design with 4 replications.

The sowing of the crop with Chinese seeder and Pantnagar zero till drill was done just after harvesting the rice crop on residual soil moisture. In conventional tillage, the field was ploughed with *desi* plough and left for 7 days for drying, thereafter, 1 pre-sowing irrigation was given to the field. At the right tilth, 4 cross-ploughings were done with *desi* plough. The planking was done invariably after each cross-ploughing to get fine seed-bed. After this *desi* plough was used for sowing. The wheat 'HUW 234' with a common seed rate and row spacing of 125 kg/ha and 20 cm respectively was sown. A uniform dose of P and K @ 60 kg/ha each through single superphosphate and muriate of potash was applied to all the treatments as basal dressing. Full dose of N as per treatment was applied through urea. Data on growth, yield components and yield were recorded as per normal procedure.

After harvest of the crop, bulk density was recorded with the help of soil core. Grain and straw samples of wheat were analysed for N content by micro-kjeldahl method (Jackson, 1973) and N uptake was calculated by multiplying it with respective yield values and total uptake

was computed. Further, composite soil samples taken from 0–15 cm depth were analysed for organic carbon, electrical conductivity and pH. The crop was harvested on 13 and 18 April in first and second year respectively.

RESULTS AND DISCUSSION

Growth characters

Tillage system, nitrogen level and time of N application influenced the growth characters significantly except plant population at 20th stage (Table 1). Values of all the growth characters were higher under Chinese seeder, followed by Pantnagar zero till drill and lowest under conventional tillage. However, each tillage system varied significantly for all the characters except dry-matter accumulation for which, Pantnagar zero till drill was at par with conventional tillage. These differences were due to earlier seeding and proper placement of the seed. Similar findings were also reported by Ellis *et al.* (1979).

Application of 150 kg N/ha produced significantly higher values of growth characters over 120 kg N/ha. This might be due to increased cell division and cell expansion with the increased N availability.

All the growth characters except leaf-area index were maximum and significantly superior to others when ½ N applied as basal and half at first irrigation. This might be owing to the better availability of N at critical stages of the growth. The results confirm the findings of Gill *et al.* (1970).

Yield attributes and yield

Yield attributes such as ears/running m, test weight, grain and straw yields were significantly higher under Chinese seeder than that with other treatments (Table 2). This might be owing to earlier sowing and proper placement of seed which resulted better growth characters, yield attributes and ultimately the yield. The results are in accordance with those of Ciha (1982).

Application of 150 kg N/ha improved significantly the values of yield attributes and yield as compared to 120 kg N/ha. All yield attributes except test weight and yield were superior when ½ of N applied as basal and ½ after first irrigation. But for test weight, higher values were observed when ½ N applied after first irrigation and ½ after second irrigation. It was mainly due to late N application. The results are in confirmity with those of Verma *et al.* (1988).

Nitrogen uptake by wheat

Nitrogen uptake by wheat increased significantly with Chinese seeder over Pantnagar zero till drill and conventional tillage during both the years (Table 3). The difference between zero tillage and conventional tillage was non-significant, might be due to good soil pulverization under Chinese seeder which resulted in higher yield. These findings corroborate the results of Ellis and Howse (1980).

Application of 150 kg N/ha increased uptake of N over 120 kg N/ha–3.58% in 1997–98 and 3.62% in 1998–99. It appears that availability of N increased in soil as reflected by higher N (Table 2) which resulted in more uptake of N. These findings confirm the results of Lal and Sharma (1974). Time of N application had significant effect on

Table 1. Effect of tillage systems and nitrogen levels with its times of application of growth characters

Treatment	Initial plant population/running m (20th day)		Shoots/running m at harvest		Dry matter/ running m (g) at harvest		Leaf-area index at		Plant height at harvest (cm)	
	1997–98	1998–99	1997–98	1998-99	1997–98	1998–99	1997–98	1998-99	1997–98	1998–99
Tillage system										
Conventional tillage	41.9	37.9	69.0	61.0	164.2	161.7	3.40	3.30	77.6	88.2
Chinese seeder	43.0	39.0	79.5	70.5	215.2	212.7	3.96	3.85	89.4	76.6
Pantnagar zero till drill	42.3	37.8	72.9	65.9	166.6	164.1	3.66	3.56	80.0	79.1
CD (P=0.05)	NS	NS	3.6	4.7	2.7	2.5	0.17	0.20	2.2	2.5
Nitrogen (kg/ha)										
120	42.0	37.8	71.8	63.8	178.4	175.9	3.52	3.42	81.1	79.9
150	42.9	38.7	75.8	67.8	185.6	183.1	3.83	3.72	83.6	82.7
CD (P=0.05)	NS	NS	2.6	3.3	3.0	3.0	0.18	0.25	2.2	1.7
Times of N application										
B I_1 I_2										
½ ¼ ¼	41.3	37.3	75.9	67.9	184.1	181.6	3.78	3.65	82.9	81.9
⅓ ⅓ ⅓	42.6	38.6	74.0	66.0	180.9	178.4	3.62	3.55	81.5	80.6
½ ½ 0	43.6	38.8	81.3	73.3	189.0	186.5	3.92	3.82	87.5	86.0
0 ½ ½	42.2	38.2	64.1	56.1	174.0	171.5	3.38	3.25	77.6	76.6
CD (P=0.05)	NS	NS	3.67	4.6	4.4	4.3	0.25	0.36	2.4	2.4

B, Basal; I_1, application after first irrigation; I_2, application after second irrigation

Table 2. Effect of tillage and nitrogen levels with its time of application on yield attributes and yield of wheat

Treatment			Ears/running m		Grains/ spike		Spike length (cm)		Test weight (g)		Grain yield (q/ha)		Straw yield (q/ha)	
			1997–98	1998–99	1997–98	1998–99	1997–98	1998–99	1997–98	1998–99	1997–98	1998–99	1997–98	1998–99
Tillage system														
Conventional tillage			65.6	58.4	40.7	40.2	8.42	8.17	35.28	35.03	36.55	33.55	63.7	60.0
Chinese seeder			75.2	68.7	41.7	41.2	8.94	8.69	42.73	42.62	45.26	42.26	71.8	68.8
Pantnagar zero till drill			67.7	60.7	40.0	39.6	8.61	8.36	40.95	40.70	38.30	34.62	66.9	63.9
CD (P=0.05)			2.1	2.8	NS	NS	NS	NS	1.20	1.51	3.57	3.87	4.4	4.6
Nitrogen (kg/ha)														
120			68.0	61.3	40.1	39.6	8.26	8.01	39.15	38.99	38.85	35.72	66.1	62.7
150			69.7	63.9	41.6	41.1	9.05	8.81	40.16	39.91	41.23	39.90	68.9	65.7
CD (P=.05)			1.7	2.4	1.1	1.4	0.27	0.44	0.66	0.78	1.39	1.42	2.6	2.8
Time of N application														
B	I_1	I_2												
½	¼	¼	70.1	64.3	41.4	40.9	8.79	8.60	39.43	39.18	40.99	37.71	68.2	64.5
$^1/_3$	$^1/_3$	$^1/_3$	68.7	62.4	40.5	40.0	8.43	8.12	40.35	40.05	39.67	36.34	65.2	62.3
½	½	0	72.0	66.4	42.5	42.0	9.78	9.53	38.00	37.89	42.98	40.02	73.6	70.6
0	½	½	64.6	57.3	38.9	38.4	7.63	7.38	40.84	40.68	36.51	33.18	62.8	59.5
CD (P=0.05)			2.4	3.4	1.6	1.9	0.38	0.62	0.93	1.10	1.97	2.01	3.7	3.9

B, Basal; I_1, application after first irrigation; I_2, application after second irrigation

Table 3. Nitrogen uptake and physico-chemical properties of soil after 2 years of experimentation

Treatment			N uptake by wheat		Bulk density (g/cc)		Organic carbon (%)		EC (dS/m)		pH	
			1997–98	1998–99	1997–98	1998–99	1997–98	1998–99	1997–98	1998–99	1997–98	1998–99
Tillage system												
Conventional tillage			92.17	91.17	1.32	1.36	0.30	0.34	0.37	0.36	7.87	7.90
Chinese seeder			97.67	96.67	1.42	1.46	0.31	0.35	0.38	0.37	0.08	8.12
Pantnagar zero till drill			93.56	92.57	1.43	1.47	0.31	0.36	0.38	0.38	8.12	8.16
CD (P=0.05)			2.45	2.45	0.06	0.014	NS	NS	NS	NS	NS	NS
Nitrogen (kg/ha)												
120			92.81	91.81	1.38	1.42	0.30	0.34	0.38	0.37	8.06	8.09
150			96.63	95.13	1.40	1.44	0.31	0.36	0.39	0.38	7.98	8.02
CD (P=0.05)			1.61	1.61	NS	NS	NS	NS	NS	NS	NS	NS
Time of N application												
B	I_1	I_2										
½	¼	¼	95.06	64.06	1.39	1.43	0.30	0.35	0.38	0.37	8.05	8.08
1/3	1/3	1/3	93.79	92.80	1.38	1.42	0.31	0.35	0.39	0.37	8.03	8.07
½	½	0	99.02	98.02	1.42	1.46	0.30	0.34	0.39	0.38	8.08	8.11
0	½	½	90.01	89.01	1.37	1.41	0.31	0.36	0.40	0.39	7.94	7.97
CD (P=0.05)			2.28	2.28	NS	NS	NS	NS	NS	NS	NS	NS
Initial values					1.42		0.30		0.36		8.2	

B, basal; I_1, application after first irrigation; I_2, application after second irrigation

nitrogen uptake by wheat. Split application of N, ½ as basal + ½ as top-dressing after first irrigation significantly increased the N uptake over all other treatments. The increase in N uptake under this treatment was 4 to 10% higher during 2 years over other split doses. This might be due to application of N at critical stages of crop growth, which resulted higher yield and uptake.

Physico-chemical properties of soil

The fertility status of soil after 2 years of experimentation showed that the various tillage treatments had significant effect on bulk density of soil (Table 3). The lower bulk density (1.34 g/cc) was noticed under conventional tillage than Chinese seeder and Pantnagar zero till drill. In conventional tillage, bulk density reduced from initial value (1.42 g/cc), while it increased when Chinese seeder (1.44 g/cc) and Pantnagar zero till drill (1.45 g/cc) were used. Field was ploughed repeatedly and soil was pulverised due to planking under conventional tillage. The volume of soil was increased due to pulverization which ultimately resulted in lower value of bulk density under conventional tillage. Mehta *et al.* (1996) and Kumar (2000) also found lower value of bulk density under conventional tillage in comparision to reduced or zero tillage systems. The values of organic carbon and electrical conductivity were either equal or slightly higher than their initial values. However, soil pH decreased slightly than initial value of 8.2 in all the treatment.

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