

Productivity, nutrient uptake and economics of wheat (*Triticum aestivum*) under various tillage and fertilizer management practices

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ABSTRACT

A field experiment on sandy clay-loam soil was conducted during 2003–2005 at Chatha, Jammu to study the productivity, nutrient uptake and economics of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) under different (zero and conventional) tillage practices, and 3 fertility levels (75, 100 and 125% of recommended fertilizer dose) in main plots and 5 N splits (N₁, 0:50:50; N₂, 20:40:40; N₃, 33:33:33; N₄, 50:25:25; and N₅, 50:50:0) in subplots replicated thrice. Zero-tilled wheat recorded yield attributes as well as grain and straw yield similar to conventionally tilled crop. Increasing fertility level from 75 to 100% of recommended fertilizer dose (100, 50 and 25 kg N, P and K/ha) significantly increased the grain yield and yield-attributing characters of wheat during both the years. Further increase to 125% of recommended fertilizer dose did not prove beneficial. Application of N in 3 splits (33:33:33, 20:40:40 and 50:25:25) recorded statistically similar but significantly higher grain and straw yields than application of N in 2 splits (0:50:50 and 50:50:0). Wheat sown under zero-tillage with 125% recommended fertilizer dose receiving N in splits proved profitable and beneficial option than conventionally sown crop.

Key words : Fertility level, Grain yield, Nutrient uptake, Tillage, Wheat

Conventionally, wheat is sown on a fine seedbed but now-a-days mindset of farmers and scientists has changed to reduce the number of tillage operations to minimize the cost of production. Tillage in wheat assumes great importance due to disturbed soil structure caused by the puddled conditions created in the previous rice crop and availability of limited time for preparation of land for wheat sowing. Delayed sowing of wheat beyond November reduces grain yield by 30–50 kg/ha/day (Chauhan *et al.*, 2001). Moreover, to overcome the energy crisis and pollution hazards, zero tillage practice can be a tool for reducing fuel consumption during land preparation operations. Delayed wheat sowing after rice and poor plant stand limits the productivity of wheat. Plant stand is influenced by moisture content, tillage and time of sowing. The sowing with zero-till drill facilitates timely sowing of wheat on residual soil moisture. Therefore, a study was undertaken to assess the performance of zero and conventional tillage in wheat crop sown after the harvest of rice under various tillage and fertilizer management practices.

MATERIALS AND METHODS

An investigation was conducted on sandy clay loam (52.7% sand, 21.4% silt and 25.95% clay) soils at Re-

search Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology (Jammu) at Chatha, from winter (*rabi*) 2003–04 to *rabi* 2004–05. The soil was low in available N (214.0 kg/ha) and medium in available P (13.8 kg/ha) and K (129.8 kg/ha).

The experimental layout accommodated 30 treatment combinations imposed to wheat crop, comprising 2 tillage methods (zero and conventional) and 3 fertility levels (75, 100 and 125% of recommended fertilizer dose) in main plots, and five N-splits (N₁, 0:50:50; N₂, 20:40:40; N₃, 33:33:33; N₄, 50:25:25; and N₅, 50:50:0) in subplots, replicated thrice. The wheat variety 'PBW 343' was sown at a distance of 18 cm between the lines under both conventional and no-till method with a seed rate of 100 kg/ha. The recommended dose of fertilizer for wheat crop was 100, 50 and 25 kg N, P and K/ha. Conventional plots were prepared for sowing wheat after giving presowing irrigation, and sowing was accomplished on 26 and 21 November of 2003–04 and 2004–05, respectively, whereas sowing in zero-tilled plots was taken directly after harvesting *basmati* rice on 18 and 14 November of 2003–04 and 2004–05, respectively, on residual soil moisture. Full dose of P and K was applied basal under both tillage methods, whereas N was applied in splits as per the treatment at basal, crown-root initiation (CRI) and earing stages of the

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crop. Data on various yield attributes, grain and straw yields of wheat and economic returns were calculated as per the standard procedures. The rainfall received during 2003–04 crop season was slightly higher (1,250 mm) than that received during 2004–05 (1,030 mm) against normal rainfall of 11,00 mm.

RESULTS AND DISCUSSION

Yield performance

Data recorded on yield attributes, viz. no. of spikes/m², grains/spike, spike length and 1,000-grain weight as well as grain and straw yields of wheat crop (Table 1) exhibited insignificant differences under different tillage methods. This could be due to various favourable factors under zero tillage like advancing the sowing date, proper placement of seed in the narrow slit made by zero-till drill, early emergence of wheat seedlings and availability of higher moisture content, which might have helped the crop to compete with the crop sown under conventional tillage. These results confirm the findings of Kumar and Yadav (2005).

Increasing fertilizer dose from 75 to 100% of recommended dose significantly increased yield attributes such as spikes/m², grains/spike, spike length and 1,000-grain weight) and grain and straw yields. However, upon further increasing the fertilizer dose to 125% of recommended dose the various yield attributes and grain and straw yields did not exhibit significant variation. Tripathi and Chauhan (2000) also reported that recommended dose of fertilizer may have supplied nutrients to crop in optimum and bal-

anced proportion required for its better growth and development, thereby leading to higher grain yield.

Interaction of tillage system with fertility levels revealed that zero-tilled wheat responded up to 125% of recommended fertilizer dose. Grain yield of wheat was significantly highest at 125% (F₃) fertility level than 100 and 75% (F₂ and F₁) fertility levels. In turn, under same tillage system, F₂ fertility level also resulted in significantly higher grain yield than F₁ fertility level. However, under conventional tillage system grain yield increased significantly only up to 100% fertility level and it remained at par with 125% fertility level. This may be due to requirement of extra nutrients for proper decomposition of paddy (preceding crop) stubbles under zero-tilled conditions. Further, upon decomposition, paddy stubbles may have supplied available nutrients to the crop and also had solubilizing effect on fixed forms of other nutrients. Singh *et al.* (2001) also reported higher N requirements for wheat in rice-wheat cropping system.

Out of various N splits, N₃ (33:33:33) schedule receiving N in 3 equal splits produced significantly more spikes/m² than N₁ (0:50:50) and N₂ (50:50:0) splits but remained at par with N₄ (50:50:25) and N₂ (20:40:40) treatment (Table 1). This may be on account of better availability of N at critical stages of growth, resulting in reduced tiller mortality and build up of high reserve pool of assimilates. The grains/spike and spike length remained unaffected by various N splits. And 1,000-grain weight was statistically higher in treatments receiving higher dose of N at later crop growth stages, viz. N₁, N₂ and N₃ treatments than

Table 1. Effect of tillage and fertilization management on yield attributes and yield of wheat

Treatment	Spikes/ m ²		Grains/ spike		Spike length (cm)		1,000-grain weight (g)		Grain yield (t/ha)		Straw yield (t/ha)	
	2003– 04	2004– 05	2003– 04	2004– 05	2003–04 04	2004– 05	2003– 04	2004– 05	2003– 04	2004– 05	2003– 04	2004– 05
<i>Tillage</i>												
Zero	240.5	248.5	40.1	40.1	8.9	9.1	39.56	39.75	3.48	3.64	4.66	4.74
Conventional	246.1	256.0	42.3	42.5	9.9	10.1	41.24	41.45	3.66	3.76	4.97	4.93
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
<i>Fertility level (% recommended dose)</i>												
75	233.1	241.9	40.1	40.0	8.9	9.1	39.40	39.59	3.23	3.43	4.56	4.57
100	244.6	254.0	41.4	41.6	9.5	9.7	40.70	41.00	3.64	3.73	4.86	4.89
125	251.3	269.8	42.2	42.2	9.8	10.1	41.10	41.22	3.85	3.93	4.90	5.05
CD (P=0.05)	8.2	10.7	1.1	1.0	0.4	0.4	0.67	0.62	0.26	0.20	0.29	0.25
<i>N splits (basal : tillage : earing)</i>												
0:50:50	236.1	237.6	40.0	40.2	9.3	9.2	40.93	41.26	3.36	3.50	4.47	4.55
20:40:40	244.6	255.2	41.7	41.5	9.6	9.6	40.75	40.80	3.63	3.72	4.86	4.90
33:33:33	248.7	263.2	42.2	42.4	9.5	10.2	40.55	40.64	3.79	3.92	4.98	5.08
50:25:25	245.8	259.4	41.7	41.9	9.4	10.0	40.00	40.30	3.66	3.79	4.84	4.90
50:50:0	241.2	245.9	40.4	40.4	9.3	9.2	39.83	40.40	3.43	3.57	4.73	4.76
CD (P=0.05)	8.4	11.1	NS	NS	NS	NS	0.51	0.63	0.27	0.22	0.25	0.30

Table 2. Effect of tillage and fertilizer treatments on nutrient uptake and economics of wheat

Treatment	Total uptake (kg/ha)						Net returns (Rs/ha)		Benefit : cost ratio	
	N		P		K		2003-04	2004-05	2003-04	2004-05
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05				
<i>Tillage</i>										
Zero	73.66	76.23	13.41	14.21	92.13	93.63	17,683	20,073	1.74	1.87
Conventional	77.75	80.60	14.29	15.18	96.13	98.51	16,696	18,800	1.33	1.47
CD (P=0.05)	NS	NS	NS	NS	NS	NS				
<i>Fertility level (% recommended dose)</i>										
75	70.23	73.02	12.54	12.96	89.06	91.10	13,562	16,762	1.10	1.30
100	77.12	79.51	14.17	15.06	95.11	96.77	16,480	19,038	1.31	1.44
125	79.78	82.73	14.87	16.08	98.24	100.35	17,929	20,402	1.43	1.53
CD (P=0.05)	5.06	4.79	NS	NS	5.15	5.32				
<i>N-splits (basal : tillage: earing)</i>										
0:50:50	69.67	78.61	12.18	12.18	88.06	90.50	14,154	17,053	1.14	1.38
20:40:40	76.54	83.68	14.49	15.38	95.17	96.60	16,464	18,970	1.31	1.44
33:33:33	80.94	81.52	15.76	16.12	98.95	100.37	17,706	20,516	1.41	1.56
50:25:25	78.50	81.52	14.64	15.78	96.91	98.99	16,648	19,408	1.32	1.48
50:50:0	72.93	75.33	12.21	14.02	91.60	93.91	15,051	17,855	1.21	1.37
CD (P=0.05)	5.08	5.29	NS	NS	5.09	5.66				

early application of N in N₄ and N₅ schedules. Our results confirm the findings of Kumar and Yadav (2005).

Grain and straw yields were significantly higher under N₃ schedule, receiving 3 equal splits (33:33:33) which remained at par with N₄ (50:25:25) and N₂ (20:40:40) splits but superior to other treatments receiving N in 2 equal splits, i.e. N₁ (0:50:50) and N₅ (50:50:0). The increase in grain and straw yields appears to be associated with the beneficial effects of nitrogen splits on the various yield attributes and build up of very good reserve pool of assimilates as evidenced from better biological yield (grain + straw yields).

Nutrient uptake

Uptake of nutrients (N, P and K) in wheat crop was at par under zero and conventional tillage methods (Table 2). The total nutrient uptake (by wheat grain and straw) did not differ significantly under the 2 tillage systems. The non-significant difference in wheat grain and straw yields under the 2 tillage systems and similar N, P and K content under both the tillage systems may be the reason for non-significant difference in nutrient uptake. Similar results were also noticed by Sharma and Acharya (1999).

Nutrient uptake (except P uptake) in wheat increased significantly with increase in fertility level from 75 to 100% of recommended fertilizer dose. Further increase in fertility level to 125% of recommended fertilizer dose could not bring about significant increase in N, P and K uptake. The increase in nutrient content was in consonance with higher grain and biological yields and increase in nutrient content in plant tissues with increase in fertility levels. Singh *et al.* (2003) also marked an increase in the nutrient uptake with the

increase in fertilizer dose in wheat crop.

Splitting of N in 3 equal splits (N₃) recorded significantly higher nutrient uptake in wheat than application of N in 2 splits (N₁ and N₅) but remained at par with other schedules involving 3 splits of N, i.e. N₂ and N₄. However, P uptake in wheat during both the years showed non-significant increase. Application of N in splits coinciding with the crop requirements might have reduced rapid mineralization and losses through different pathways and thereby increased nutrient contents in wheat grain and straw. These results are in line with the findings of Patel *et al.* (2004).

Economics

Zero tillage practice exhibited 5.17 and 6.77% higher net returns over conventional tillage (Table 2) during 2003-04 and 2004-05 respectively. The corresponding increase in benefit : cost ratios was 9.33 and 5.76%. It may be due to the saving in operational cost, diesel and time under zero tillage.

Net returns as well as benefit : cost ratio increased with increase in fertilizer dose and highest returns were observed at 125% of recommended fertilizer dose (F₃) during first and second years respectively. Three N splits noticed higher net returns and benefit : cost ratio values than the treatments receiving 2 N splits. These observations substantiate the findings of Sharma *et al.* (2002). The impact of treatments on improvement in grain yield might have helped in accruing higher profit.

It was concluded that the introduction of zero-tillage practice for sowing wheat with a fertilizer dose of 125, 62.5 and 31.25 kg N, P and K/ha, respectively, supplying

nitrogen in 3 splits, i.e. at basal, crown-root initiation and earing stages of the crop can be a better and profitable option under subtropical conditions of Jammu.

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