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Effect of tillage and nitrogen scheduling on growth and yield attributes of wheat (*Triticum aestivum* L.) in central Punjab

Navdeep Kaur and Santosh Kumar

Abstract
A field experiment was conducted at Research Farm of the Department of Agriculture, Mata Gujri College, Shri Fatehgarh Sahib, Punjab during *Rabi* season of 2016-2017 to study about “The Effect of tillage and nitrogen scheduling on growth and yield attributes of wheat under winter season (*Triticum aestivum* L.). The experiment was laid out in randomized block design with twelve treatments and three replications. On the basis of results summarized at 30 DAS, the maximum growth were recorded with the application of T_5 – CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS which was at par with T_{11} – ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS and T_{12} – ZT + N_6 i.e. N@150 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS. However at 60, 90 DAS and at harvest stage, the application of T_{11} – ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS gave the best result in the terms of growth character and yield which is statistically at par to the application of T_5 - Application of ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS.

Keywords: conventional tillage, organic residue, nitrogen scheduling, zero tillage

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop and ranks second in production after rice in India. In the respect of area and production also, China stands first followed by India. The production of wheat can be improved and enhanced by using better inputs, proper production technology and appropriate tillage methods. Important factors like soil tillage and manure application can improve soil physical properties and enhance wheat yields. Farmers normally use wheat straw as animal feed but rice straw is either burnt or used as fuel source in rural areas or incorporated in the field to avoid clogging of seeding equipment and to facilitate subsequent sowing of crop (Ahmed *et al*. 2013) [1]. Conservation tillage and nitrogen may improve soil fertility, yield and income on sustainable basis. The conservation tillage embraces crop production system involving management of surface residues. The continuous adoption of conventional tillage makes the soil more compact and a hardpan is usually developed underneath the plough layer which hinder the movement of water and air, inhibits root growth and reduces crop yield (Huang *et al*., 2012) [5]. Moreover conventional tillage practices declined soil structure and stability over years due to depletion of soil organic matter (80 m) which is already low in the soils of India affecting crop yield (Fan *et al*., 2005) [2]. Zero tillage is an alternative to address the problems associated with the conventional tillage. Unlike CT, ZT may facilitate wheat planting at optimum time and reduce cost of production. Zero tillage improves water and nutrient use efficiencies and increase crop productivity and carbon sequestration, ameliorate soil properties and mitigate green house gases emission. Zero tillage with residue retention is characterized by a slower initial crop growth, compensated for by an increased growth in the later stages, positively influencing final grain yield (Verhulst *et al*., 2011) [16]. Zero tillage exhibited highest grain yield (4.8 t/ha) of wheat after rice as compared to conventional till (4.5 t/ha), deep tillage (4.4 t/ha) and reduced tillage (4.3 t/ha) (Imran *et al*., 2013) [6]. Nitrogen is often the most limiting factor in crop production. Nitrogen often affects amino acid composition of protein and in turn its nutritional quality. Moreover, the application of nitrogen fertilizers to crops especially to cereals increases leaf area, plant height and photosynthesis rate and thus increases dry matter production. Split application of nitrogenous fertilizers is an established practice in wheat cultivation.

Splitting nitrogen fertilizer to many doses increases efficiency of the fertilizers used by decreasing leaching to a large extent and increased both yield and quality of wheat crop in favour of the highest number of splitting (Shelby *et al*., 2006) [11]. Nitrogen use efficiency of wheat was the maximum when nitrogen fertilizer was applied in three splits rather than two splits or applied as all basal in zero tillage condition Rehman *et al*., (2002) [10]. Kumar *et al*., (2005) [7] observed that under zero tillage condition, retention of rice residue enhanced the wheat grain yield 21.3% at zero nitrogen, 8.3% at 150 kg N/ha (whole basal) and 5.4% at 150 kg N/ha (three splits) applications. Singh *et al*., (2013) [13] reported that highest plant height (97 cm) and yield of wheat was found when 75 kg N/ha at land preparation and 40 kg N/ha at CRI + 35 kg N/ha at panicle initiation.

Materials and Methods

A field experiment was conducted at the student's Research Farm, Mata Gujri College, Shri Fatehgarh Sahib during *Rabi* season of year 2016-2017. The experiment laid out in randomized block design with three replications. The total treatment combinations were twelve. The treatments details are as T_1 – CT (Conventional tillage) + N_1 i.e. Control, T_2 – CT + N_2 i.e. N@100 kg (2 splits) applied ½ at basal and ½ at 4 WAS, T_3 – CT + N_3 i.e. N@100 kg (3 splits) applied at ½ at basal, ¼ at 4 WAS and ¼ at 8 WAS, T_4 – CT + N_4 i.e. N@125 kg (2 splits) applied at ½ at basal and ½ at 4 WAS, T_5 – CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS, T_6 – CT + N_6 i.e. N@150 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS, T_7 – ZT (Zero tillage) + N_1 i.e. Control, T_8 – ZT + N_2 i.e. N@100 kg (2 splits) applied ½ at basal and ½ at 4 WAS, T_9 – ZT + N_3 i.e. N@100 kg (3 splits) applied at ½ at basal, ¼ at 4 WAS and ¼ at 8 WAS, T_{10} – ZT + N_4 i.e. N@125 kg (2 splits) applied at ½ at basal and ½ at 4 WAS, T_{11} – ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS, T_{12} – ZT + N_6 i.e. N@150 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS. The soil of the experimental field was alluvial having sandy loam texture with pH 7.3. It was moderately fertile with available nitrogen (215.5 kg/ha), available phosphorus (24.4 kg/ha), available potassium (122.30 kg/ha), organic carbon (0.42%) and electrical conductivity (0.50 dS/m). The sowing of wheat variety "HD 3086" was sown in the experimental field on 25th November 2016. The wheat crop was sown using seed rate 100 kg/ha at row to row spacing of 22.5 cm by zero tillage. The recommended dose of fertilizer of P and K for wheat is 62 and 30 kg/ha respectively. The amount of nitrogen was applied at per treatment wise. Regular biometric observations were recorded at periodic intervals of 30, 60, 90 DAS and at harvest stage. Yield attributes parameters were recorded just before the harvesting of crop. The grain yield of each plot was recorded and converted in hectare. Statistical analysis was done as per the procedures given by Gomez and Gomez (1984) [4].

Result and Discussion

Effect on Growth characters of Crop

The result of the present study indicated that the growth parameters of plant such as plant height, LAI and dry matter accumulation of wheat crop were significantly influenced by different tillage and nitrogen scheduling positive correlation with yield.

Among treatments, the maximum plant height, leaf area index, and dry matter accumulation were recorded with the application of T_5 - CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS which was at par with T_{11} - ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS and T_{12} – ZT + N_6 i.e. N@150 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS at 30 DAS. However, at 60, 90 DAS and at harvest stage, the maximum growth attributes was recorded with application of T_{11} - ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS which was at par with T_5 - CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS and T_{12} – ZT + N_6 i.e. N@150 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS and significantly superior over rest of treatments. The reason for higher values of growth parameters can be discussed in light of fact of crop under these treatments had comparatively more availability of nutrients, and thereby more availability of nutrient than other treatments which resulted in better crop growth, dry matter accumulation and more number of tillers. Crop residue is not completely decomposed at initial stage. The added organic residue with readily available inorganic fertilizer sources might have improved the soil physical conditions and increased nutrient availability resulting in better plant growth. Organic residue contents various type growth hormones and other secondary metabolites, these helps in faster mineralization of organic residue. Therefore availability of nutrient is more under these treatments. Nutrient losses also lower than other treatments. The integration of organic residue in combination with inorganic fertilizer was found significant in improving overall plant growth and soil macro nutrient than sole application of either of the nutrients. Similar results were reported by Singh *et al*., (2005) [12] and Mohammad *et al*., (2012) [8].

Effect on Yield attributes of Crop

The various treatments were influenced significantly on yield attributing characters. Among the various treatments, the maximum number of effective tillers, spike length, number of grain spike^{-1}and test weight were recorded with the application of T_{11} - ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS which was found at par with T_5 - CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS and it was significantly superior over rest of treatments. This was due to effect of integration of inorganic fertilizer and organic residue. The higher plant height, number of tiller and also increase in total dry matter of crop. The mineralization of crop residue coupled with increased doses of inorganic NPK might have contributed higher in yield attributes of crop. The minimum yield attributes were recorded in T_1 - control treatments. Similar results were reported by Raigar and pareek (2003) [9], Usman *et al*., (2012) [15] and Singh *et al*., (2013) [13].

Effect on Crop Yield

Yield is the result of co-ordinate interplay of various growth characters. Grain yield (q/ha), Straw yield (q/ha), Biological yield (q/ha) and Harvest index (%) were significantly influenced by different treatments. The application of T_{11} - ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS recorded higher grain yield which was at par with T_5 - CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS & T_{12} - ZT + N_6 i.e. N@150 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS and it recorded significantly superior over rest of treatments. However in case of biological yield, the highest value was recorded with the application of ZT + N_5 i.e.

N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS and found at par with T_5 - CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS which was significantly superior over rest of treatments. This was due to adequate availability of nutrient. Further seed and yield of wheat enhanced significantly at higher levels of NPK and integrated with organic residue and inorganic fertilizers. Application of organic residue increased grain yield of wheat. The highest yields were recorded under the treatment of integration of NPK with crop residue. There was positive correlation between grain yield and yield components like number of effective tillers and grain spike which were increased in nutrient availability and high nutrient uptake due to higher nutrient availability to crop. Similar results were reported by Fisher *et al*., (2003) [3], Imran *et al*., (2013) [6] and Tripathi *et al*., (2015) [14].

Conclusion

On the basis of results summarized above, it can be concluded that application of T_{11} - ZT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS gave best results of respect to all the parameters of growth and yield and second best treatment is T_5 - CT + N_5 i.e. N@125 kg (4 splits) applied at ¼, ¼, ¼ and ¼ at basal, 4, 6 and 8 WAS.

Table 1: Effect of tillage and nitrogen scheduling on growth attributes of crop

Treatments	Plant height (cm)				Dry matter accumulation (g)				LAI (%)		
	30DAS	60DAS	90DAS	Harvest stage	30DAS	60DAS	90DAS	Harvest stage	30DAS	60DAS	90DAS
T_1 –CT+N_1	19.64	30.95	66.40	88.14	5.23	29.19	83.99	178.70	0.67	2.12	4.09
T_2 –CT + N_2	21.06	33.98	72.71	92.79	6.91	34.53	94.47	191.85	0.71	2.51	4.37
T_3 – CT + N_3	22.18	36.49	79.76	101.91	8.35	38.30	102.21	202.80	0.75	2.83	4.71
T_4 – CT + N_4	24.03	41.92	86.33	109.68	10.84	45.64	115.79	216.18	0.81	3.08	4.95
T_5– CT + N_5	27.99	44.94	95.48	119.83	16.40	57.08	139.81	241.03	0.95	3.68	5.57
T_6– CT + N_6	25.47	42.90	90.48	113.10	12.56	50.28	127.39	229.07	0.86	3.44	5.29
T_7– ZT + N_1	20.34	32.38	69.68	89.47	6.02	31.64	88.52	183.23	0.69	2.39	4.24
T_8 - ZT + N_2	21.91	35.83	75.53	96.79	7.63	36.06	97.16	196.58	0.74	2.65	4.53
T_9 - ZT + N_3	23.72	38.87	83.62	104.76	9.15	41.42	108.29	209.90	0.77	2.97	5.55
T_{10} - ZT + N_4	24.54	42.40	88.29	111.93	12.59	48.20	121.68	223.42	0.84	2.93	5.16
T_{11} - ZT + N_5	26.51	45.63	97.68	122.80	15.39	59.85	144.75	248.56	0.93	3.79	5.68
T_{12}- ZT + N_6	26.00	43.67	92.76	116.62	13.77	53.39	132.44	235.31	0.89	3.52	5.42
SEm ±	0.78	0.92	1.14	1.67	0.72	1.25	2.23	2.68	0.03	0.36	0.45
CD at 5%	2.28	2.71	3.35	4.90	2.10	3.66	6.53	7.86	0.08	1.07	1.33

Note: CT- conventional tillage, ZT - Zero tillage

Table 2: Effect of tillage and nitrogen scheduling on yield attributes and yield of crop

Treatments	No. of effective tillers in running meter	No. of grain spike^{-1}	Spike Length (cm)	Test Weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)
T_1 –CT+N_1	64.50	29.81	8.03	36.71	28.27	52.34	80.61	35.07
T_2 –CT + N_2	69.94	32.59	9.45	39.45	34.55	55.09	89.94	38.54
T_3 – CT + N_3	76.38	36.27	10.88	41.92	40.46	58.94	99.40	40.70
T_4 – CT + N_4	80.53	39.45	12.31	43.58	43.71	59.45	103.16	42.37
T_5– CT + N_5	95.16	48.62	15.38	48.20	51.92	64.81	116.73	44.47
T_6– CT + N_6	88.72	44.93	13.97	45.33	46.38	62.63	109.01	42.54
T_7– ZT + N_1	67.07	30.76	8.79	37.47	30.04	53.57	83.61	35.52
T_8 - ZT + N_2	73.49	34.14	10.12	40.89	35.59	56.18	91.77	38.78
T_9 - ZT + N_3	77.25	37.08	13.56	42.61	42.13	59.21	101.34	41.57
T_{10} - ZT + N_4	84.15	41.50	13.34	44.36	44.51	61.93	106.44	41.81
T_{11} - ZT + N_5	98.92	50.97	16.72	49.48	52.96	66.09	119.05	44.49
T_{12}- ZT + N_6	91.61	45.35	14.60	46.07	49.60	63.72	113.32	43.76
SEm ±	1.79	1.51	0.86	1.21	1.32	1.35	1.36	1.40
CD at 5%	5.25	4.43	2.53	3.54	3.87	3.96	4.00	4.10

Note: CT- conventional tillage, ZT - Zero tillage

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