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Response of tillage practices and nitrogen levels on nutrient uptake and economics of wheat (*Triticum aestivum* L.)

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Abstract
The present study "Effect of tillage practices and nitrogen levels on nutrient uptake and economics of wheat (*Triticum aestivum* L.)" was carried out at Experimental Farm, Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab during *Rabi* season of 2019-20. The experiment was laid out in split plot design with fifteen treatment combinations with three main plot treatments of tillage which include conventional tillage, minimum tillage, zero tillage and five sub plot treatments which include nitrogen levels are 0, 60, 100, 120 and 150 kg/ha and all the treatments were replicated thrice. The maximum nutrient uptake by crop, gross return (₹/ha), net return (₹/ha) and B: C ratio was recorded under zero tillage which was at par with minimum tillage and it was significantly superior over conventional tillage. The highest nutrient uptake and economics were recorded under N_4 – Nitrogen@ 150 kg/ha which was at par with N_3 – Nitrogen@ 120 kg/ha and it was significantly superior over rest of treatments.

Keywords: Economics, nitrogen, nutrient uptake, and tillage

Introduction
Wheat is one of the major cereal crop of the world ranking first both in acreage and production among the cereal crops. It is the second most important staple food crop in India. Wheat has higher food value over rice as it contains excellent amount of nutrition i.e. 70.10% carbohydrates, 11-12% protein, 2.10% fat and 2.10% mineral (Katayan, 2019) [8]. It has relatively high content of niacin and thiamine. It is consumed in different forms (Ram *et al*., 2017) [14]. Tillage is one of the agro-technical operations in agriculture as it influence on soil properties, environment and crop yield. It also plays important role in changing initial state of soil which modify whole environment such as bulk density and porosity which further affect the infiltration rate of the soil. Bhattachariya *et al*., 2008 [3] reported that change in bulk density is result of intensity of tillage system. Zero tillage promotes soil organic carbon sequestration, improves soil aggregates and result in better pore size allocation, while conventional tillage increases available water capacity, infiltration rate which further leads to decrease in run-off, but continuous adoption of conventional tillage makes soil compact and hardpan is usually developed underneath the plough layer with high bulk density but having low saturated hydraulic conductivity which affects the movement of water and air, inhibits root growth and consequently result in reduction of crop yield (Haung *et al*., 2012) [6]. Zero tillage improves water and nutrient use efficiencies, increases crop productivity (Yadav *et al*., 2005) [19]. Nitrogen play a vital role in plant metabolism, all processes in plants are associated with protein, of which N is essential constituent. It also plays vital role in composition of amino acids and in turn its nutritional quality (Blumenthal *et al*., 2008) [4]. N is an important constituent of chlorophyll and nucleic acid and chlorophyll is primary observer of sun light for photosynthesis and also an imperative element for growth and development of plants, significantly increase and enhance the yield and quality by playing crucial role in biochemical and physiological functions of plant. Optimum rate of nitrogen at various growth stages of the crop is an important factor which helps to enhance yield of crop and nitrogen use efficiency. Maximum use of N can be achieved by matching N supply with crop demand, where appropriate amount of N is applied at right physiological stage of nutrient demand. Usman *et al*., 2012 [18] reported that highest grain yield and number of spikes/m of wheat was obtained with the application of N @ 200 kg/ha applied in three splits and zero tillage.

Materials and Methods

A field experiment was conducted at Experiment farm of Mata Gujri College, Shri Fatehgarh Sahib, Punjab, India during the *rabi* season of 2019-20. The experiment was laid out in split plot design with three tillage practices and five nitrogen doses i.e. total fifteen treatment combinations replicated thrice. The treatment details are as: main plot- Tillage practices, CT- Conventional tillage, MT- Minimum tillage, ZT- Zero tillage and sub plot – Nitrogen management, N_0 – Nitrogen @ 0 kg/ha, N_1 – Nitrogen @ 60 kg/ha, N_2 – Nitrogen @ 100 kg/ha, N_3 – Nitrogen @ 120 kg/ha, N_4 – Nitrogen @ 150 kg/ha. The soil of experimental field was clay loam texture with pH 6.9. It was moderately fertile with available nitrogen (390 kg/ha), available phosphorus (10.09 kg/ha), available potassium (160 kg/ha), organic carbon (0.65%) and electrical conductivity (0.54 dS/m). The sowing of wheat variety 'PBW677' was done in the field on November 06, 2019. The preparation of field was done on the basis of tillage treatments, for conventional tillage field was thoroughly ploughed with disc plough followed by secondary tillage with harrow and leveler, while in minimum tillage ploughing was done with disc plough with 30% crop residue left in field and in case of zero tillage direct sowing is done with the help of happy seeder. The wheat crop was sown using seed rate of 100 kg/ha at row to row spacing of 22.5 cm with the help of hand seed drill in case of minimum and conventional tillage and with happy seeder in case of zero tillage. The recommended dose of fertilizers for wheat crop is 120, 60 and 40 kg/ha of N, P_2O_5 and K_2O respectively. Full dose of P and K fertilizers were applied at sowing time. Nitrogen was applied as split 50% of nitrogen was applied as basal dose; 25% of nitrogen was applied at CRI stage and remaining dose of nitrogen was applied at tillering stage. Pre-sowing irrigation was applied before sowing and total three irrigations were given to the crop. For effective weed control Pendimethalin @ 1 kg/ha was sprayed in the evening after sowing of crop and Clodinofop was sprayed as post emergence herbicide at 30 DAS. All the experimental plots were sprayed with Confidor @ 300 ml/ha to protect crop from aphids. The crop was harvested manually with the help of sickle on April 18, 2020 when spikes and straw colour changed from green to yellow and grains were fully ripened, after harvesting bundles are tied and labeled according to treatment applied. Regular biometric observations were recorded at periodic intervals of 30, 60, 90 DAS and at harvest stage from five randomly selected plants. Yield parameters were observed just before the harvesting of crop from five randomly tagged plants. Economic analysis was carried out using the prevailing market price. Statistical analysis was done as per the procedures given by Snedecor and Cochran (1968). The significance difference between the treatments was compared with the critical difference at ±5%.

Result and Discussion

Effect of tillage practices and nitrogen levels on nutrient content: The result showed that the nutrient content in grain, straw were did not affect significantly due to tillage practices (Table 1). The maximum nutrient content of N, P and K in grain and straw under ZT- Zero tillage followed by MT- Minimum tillage and minimum content N, P and K was reported in CT-Conventional tillage. This is due to proper nutrient availability to crop. Under these treatments nutrient losses are reduced due to no tillage or limited tillage operation. Similar results were recorded by Yadav *et al*., (2005) [19] and Imran *et al*., 2013 [7]. The further result showed that the nutrient content in grain, straw were did not affect significantly due to nitrogen levels except nitrogen (Table 1). The maximum nutrient content of N in grain and straw under N_4 – Nitrogen @ 150 kg/ha which was at par with N_3 – Nitrogen @ 120 kg/ha and minimum uptake of N, P and K was in N_0 – Nitrogen @ 0 kg/ha. Due to increasing rate of nitrogen caused a corresponding increase in tissue contents of N in wheat plants and higher dry matter production increased tissue N content which leads to higher uptake. Similar results were recorded by Meena *et al*., (2020) [13].

Effect of tillage practices and nitrogen levels on nutrient uptake by crop: The result of the present study indicated that the nutrient uptake by grain, straw and crop was significantly affected by tillage practices and nitrogen management (Table 2). Among the tillage practices, maximum nutrient uptake of N, P_2O_5 and K_2O by the crop with ZT- Zero tillage which was at par with MT- Minimum tillage and minimum uptake of N, P_2O_5 and K_2O was in CT-Conventional tillage. This is due to the fact that nutrient uptake was increased due to application of integration of NPK with crop residue. As nutrient availability is higher and also help in solubilizing the nutrients. Similar results were recorded by Kumar and Yadav (2005) [12], Tripathi *et al*., (2010) [17], Kaur *et al*., (2020) [9]. However, in case of nitrogen levels, maximum nutrient uptake of N, P_2O_5 and K_2O by the crop with N_4 – Nitrogen @ 150 kg/ha which was at par with N_3 – Nitrogen @ 120 kg/ha and minimum uptake of N, P and K was in N_0 – Nitrogen @ 0 kg/ha. Increasing nitrogen doses also increased nitrogen uptake significantly. Increasing rate of nitrogen caused a corresponding increase in tissue contents of N in wheat plants and higher dry matter production increased tissue N content which leads to higher uptake. Similar results were reported by Kharub and Chandar (2010) [11], Kaushal *et al*., (2012) [10].

Effect of tillage and nitrogen on economics of crop

The data pertaining to economics of crop analysis are influenced significantly due to tillage practices and nitrogen levels (table 3). The further data indicates that the maximum gross return (96102.87 ₹/ha), net return (79947.49 ₹/ha) and benefit cost ratio (1.65) were recorded with ZT- Zero tillage which was at par with MT- Minimum tillage and significantly superior over conventional tillage. The higher gross return, net return and benefit cost ratio is due to high value of grain yield and straw yield in case of zero tillage followed by minimum tillage, also there was no cost incurred towards land preparation in zero tillage. Similar results were recorded by Gupta *et al*., (2007) [5], Bhattachariya *et al*., (2008) [3] and Singh *et al*., (2013) [15]. Similarly, the maximum gross return (112054.20 ₹/ha), net return (94287.29 ₹/ha) and benefit cost ratio (1.78) were recorded with N_4 – Nitrogen @ 150 kg/ha which was at par with N_3 – Nitrogen @ 120 kg/ha and significantly superior over rest of treatments. This might be due to the fact that the entire yield attributes and ultimately grain yield and straw yield found significantly under N_4 – Nitrogen @ 150 kg/ha than all other treatments, which leads to the maximum gross return, net return and benefit cost ratio. Each incremental dose of nitrogen resulted in proportionate increase in grain yield surplusing the cost incurred towards nitrogen fertilizers. Similar results were recorded by Usman *et al*., (2012) [18], Akhtar *et al*. (2017) [1] and Arif *et al*., (2019) [2].

Table 1: Effect of tillage practices and nitrogen management on nutrient content in grain and straw

Treatment	Grain			Straw		
	N	P	K	N	P	K
CT- Conventional tillage	1.52	0.36	0.34	0.52	0.30	1.29
MT- Minimum tillage	1.77	0.43	0.37	0.60	0.35	1.52
ZT- Zero tillage	1.91	0.45	0.39	0.68	0.37	1.66
S.Em±	0.07	0.01	0.01	0.02	0.01	0.04
CD (5%)	NS	NS	NS	NS	NS	NS
N_0 – Nitrogen @ 0 kg/ha	1.16	0.30	0.28	0.42	0.24	1.01
N_1 – Nitrogen @ 60 kg/ha	1.53	0.35	0.31	0.53	0.28	1.42
N_2 – Nitrogen @ 100 kg/ha	1.80	0.42	0.34	0.62	0.31	1.53
N_3 – Nitrogen @ 120 kg/ha	2.02	0.48	0.44	0.69	0.41	1.67
N_4 – Nitrogen @ 150 kg/ha	2.16	0.51	0.47	0.75	0.46	1.80
S.Em±	0.11	0.03	0.01	0.04	0.03	0.08
CD (5%)	0.34	NS	NS	NS	NS	NS

Table 2: Effect of tillage practices and nitrogen management on nutrient uptake by crop (kg/ha)

Treatment	Nutrient uptake by grain			Nutrient uptake by straw			Total uptake of nutrient		
	N	P	K	N	P	K	N	P	K
CT- Conventional tillage	68.24	15.87	16.75	33.75	19.27	91.19	103.99	35.14	107.93
MT- Minimum tillage	94.69	23.32	26.05	48.94	27.68	124.73	143.63	50.99	151.12
ZT- Zero tillage	111.97	27.27	29.45	57.12	32.40	141.20	169.10	59.68	170.33
S.Em±	5.59	1.71	1.88	2.38	1.95	4.72	6.88	2.84	4.90
CD (5%)	21.94	6.72	7.40	9.36	7.66	18.55	27.02	11.17	19.22
N_0 – Nitrogen @ 0 kg/ha	17.79	4.84	4.84	19	11.54	46.58	36.78	16.38	51.42
N_1 – Nitrogen @ 60 kg/ha	75.95	16.34	18.75	38.61	19.47	106.17	111.55	35.81	124.37
N_2 – Nitrogen @ 100 kg/ha	112.26	27.34	29.49	53.19	30.88	136.96	165.45	58.22	166.44
N_3 – Nitrogen @ 120 kg/ha	122.45	29.89	31.81	60.56	32.95	147.44	183.01	62.84	179.25
N_4 – Nitrogen @ 150 kg/ha	132.73	32.35	35.53	65.01	37.43	158.61	197.74	69.78	194.14
S.Em±	6.58	1.68	1.84	3.92	2.23	6.64	7.09	3.60	7.30
CD (5%)	19.22	4.91	5.36	11.44	6.50	19.37	20.69	10.49	21.32

Table 3: Effect of tillage practices and nitrogen level on economics of crop

Treatment	Gross return	Net return	B:C ratio
CT- Conventional tillage	83889.97	65344.59	1.17
MT- Minimum tillage	95264.41	77604.03	1.53
ZT- Zero tillage	96102.87	79947.49	1.65
S.Em±	1580.84	1399.99	0.03
CD (5%)	6207.14	5497.05	0.12
N_0 – Nitrogen @ 0 kg/ha	69305.09	52365.17	1.04
N_1 – Nitrogen @ 60 kg/ha	80764.53	63388.82	1.23
N_2 – Nitrogen @ 100 kg/ha	90408.11	72858.60	1.39
N_3 – Nitrogen @ 120 kg/ha	106230.16	88593.64	1.69
N_4 – Nitrogen @ 150 kg/ha	112054.20	94287.29	1.78
S.Em±	2073.87	2072.45	0.04
CD (5%)	6053.21	6049.06	0.11

Conclusion

It can be concluded that higher nutrient content and their uptake as well as economics were recorded in ZT- Zero tillage followed by MT- Minimum tillage. Among nitrogen management, the higher nutrient content and uptake i.e. N, P, K content and uptake in grain and straw was recorded in N_4 – Nitrogen @ 150 kg/ha followed by N_3 – Nitrogen @ 120 kg/ha. However, amongst treatment combinations ZT- Zero tillage with nitrogen level N_4 – Nitrogen @ 150 kg/ha was found to be the best treatment in nutrient content, uptake and economic analysis followed by ZTN_3 - ZT- Zero tillage with nitrogen management N_4 – Nitrogen @ 150 kg/ha.

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