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Effect of tillage and integrated nutrient management on productivity of wheat (*Triticum aestivum* L.)

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Abstract
The present experiment was carried out at Experimental farm of University Institute of Agricultural Sciences, Chandigarh University, Gharuan (Mohali) during *Rabi* season, 2020-21 to investigate the "effect of tillage and integrated nutrient management on productivity of wheat". The experiment consisted of 2 tillage practices *i.e.* zero and conventional in main plots and 8 treatments comprising of 4 nutrient management practices, *i.e.* organic nutrient management [seed inoculation with Azotobacter (5 g kg^{-1} seed) + vermicompost (10 t ha^{-1})], inorganic nutrient management (recommended dose of NPK), integrated nutrient management [vermicompost (5 t ha^{-1}) + 50% of recommended dose of NPK)] and farmer's practice [vermicompost (2.5 t ha^{-1}) + 25% of recommended dose of NPK]. Results revealed yield attributes, grain and straw yield of wheat were increased with conventional tillage and nutrient management practices. The conventional tillage recorded 2.4 per cent higher net returns per rupee invested over zero tillage. Integrated nutrient management recorded maximum grain yield followed by inorganic nutrient management, organic nutrient management and farmer's practice. Integrated nutrient management recorded maximum net returns per rupee invested (1.57) compared to other treatments.

Keywords: economics, organic, inorganic, integrated, tillage, wheat

Introduction
Wheat (*Triticum aestivum*) is second most important cereal crop in the world after rice and is one of the most important stable food crop. Wheat is cereal grain, originated from the Levant region but now cultivated in at least 43 countries of the world. The tillage practices play an important role in influencing crop growth, yield and crop micro environment. Conservation tillage has its own advantages over conventional tillage. It improves various properties of soil. It adds organic matter, improves soil and water quality, increases infiltration, decreases run-off and pollution in addition to less soil disturbance and lesser erosion. It optimizes water storage capacity in the soil profile. Among the crop production factors, tillage contributes up to 20% and affects the sustainable use of soil resources through its influence on soil properties (Lal and Stewart, 2013) [4]. The judicious use of tillage practices overcomes edaphic constraints, whereas inopportune tillage may cause a variety of undesirable outcomes, for example, soil structure destruction, accelerated erosion, loss of organic matter and fertility, and disruption in cycles of water, organic carbon, and plant nutrient (Lal, 1993) [3].

If in the past, the emphasis was on increased use of fertilizer; the current approach should aim on educating farmers to optimize use of organic, inorganic and biological fertilizer in an integrated way. The organic sources of nutrients supply micro nutrients in addition to major nutrients to the crops. Organic sources like vermicompost and farm yard manure are environment friendly, rich in nutrients and enzymes, adds organic matter into the soil and helps in conversion of waste into manures. They are also cost effective and food grown through these manures is safe to eat. Continuous application of farmyard manure and green manure improves the soil fertility, soil health, adds organic matter, enhances microorganisms, increases moisture retention capacity of soil and increases soil organic carbon content and photosynthetic rate. But it is not possible to meet out total nutrient requirement of a crop from organic manures due to their insufficient availability. Continuous application of only chemical fertilizers in the crops results in poor crop productivity, poor soil health and unsustainability. Reducing quantity of chemical fertilizers by applying organic manure/compost in combination with fertilizers enhances crop productivity, profitability and sustainability in addition to keeping the environment healthy. The integrated nutrient supply including the use of chemical fertilizers, organic manures like FYM along with bio-fertilizers helps not only in bridging the existing gap between the nutrient removal and addition but also in ensuring balanced nutrient proportion as well as boost the productivity of wheat. Through the application of bio-fertilizers, vermicompost and farm yard manure (FYM), the use of fertilizers in field crops has been made important efforts for the economics. Integration of various sources of nutrients (biological, inorganic and bio fertilizers) is more suitable because it reduces the cost of chemical fertilizer and cost of cultivation, in addition to eco-friendly approach (Ram and Mir, 2006) [6]. Therefore, an experiment was conducted during *Rabi* 2020-21 to study the effect of tillage along with organic and inorganic sources of nutrients on productivity of wheat.

Materials and Methods
A field experiment was conducted during the *Rabi* season of 2020-21 at the Experimental farm of University Institute of Agricultural Sciences, Chandigarh University, Gharuan,

Mohali (Punjab). The experiment consisted of 2 tillage practices *i.e.* zero and conventional in main plots and 8 treatments comprising of 4 nutrient management practices, *i.e.* organic nutrient management [seed inoculation with Azotobacter (5 g kg^{-1} seed) + vermicompost (10 t ha^{-1})], inorganic nutrient management (recommended dose of NPK), integrated nutrient management [vermicompost (5 t ha^{-1}) + 50% of recommended dose of NPK)] and farmer's practice [vermicompost (2.5 t ha^{-1}) + 25% of recommended dose of NPK]. Under conventional tillage the plots were prepared with the help of power tiller after pre sowing irrigation when the field attained optimum soil moisture condition. During seed bed preparation the crop stubble and weeds were removed to facilitate the planting operation. In zero tillage, glyphosate 3 l ha^{-1} was applied prior to wheat and rice to tackle weed menace. 100 kg ha^{-1} seed of 'Unnat PBW-343' variety of wheat was used for sowing. Sowing of wheat was done keeping row spacing of 22.5 cm. The vermicompost was incorporated in soil at the time of sowing of crop as per the treatment with nutrient composition of 1.5 per cent nitrogen, 1 per cent phosphorus and 0.60 per cent potassium. The recommended dose of NPK in wheat crop used was 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} in irrigated condition, respectively. Half dose of nitrogen and whole P_2O_5 and K_2O were incorporated in soil, as per the treatments, as basal dose and remaining half dose of nitrogen was top dressed at tillering stage of the wheat crop. To obtain the true treatment effects, four outer rows (two on each side) and 0.25 m on either side of each row were removed and then net plot of 6.0 m x 2.5 m was harvested manually with the help of sickles.

Results and Discussion

Yield attributes

Data on different yield attributes of wheat presented in Table 1 revealed that number of effective tillers, spike length, number of grains per spike and 1000 grain weight were significantly higher due to conventional tillage over zero tillage. It might be due to the fact that conventional tillage helps in maintaining optimum moisture which is very important for the balanced metabolic activities of the plants which in turn might have resulted in enhancing these characters.

Among different nutrient management treatments, integrated nutrient management recorded significantly more number of effective tillers per meter square, spike length, number of grains per spike and 1000 grain weight as compared to other treatments. However, spike length was statistically at par with inorganic nutrient management. The beneficial effect of nitrogen and vermicompost on crop growth influenced the yield attributes characters positively. The increase in yield attributes could be attributed to the fact that balanced nutrients from integrated nutrient sources increased the nutritional environment and hence, resulted in more nutrient uptake and improved the meristematic activity of the plant. Similar finding were also reported by Kachroo and Razdan (2006) [1].

Yield of wheat crop

The data on grain yield as influenced by tillage and nutrient management have been presented in Table 2. The data revealed that conventional tillage significantly increased the grain yield of wheat over zero tillage by 3.8 per cent. Conventional tillage produced significantly higher grain yield (4089 kg ha^{-1}) over zero tillage (3939 kg ha^{-1}). Among nutrient management treatments, integrated nutrient management produced significantly higher grain yield. It produced 6.9, 15.3 and 37.3 per cent higher grain yield over inorganic, organic and farmer's practice, respectively. The organic and inorganic nutrient management practices produced statistically similar grain yield which were significantly higher over the farmer's practice of nutrient management. It might be due to the enhanced biological processes by microbes in plant and soil enzymatic activity which increased the yield contributing characters of wheat and hence, resulted in higher yield. These results are in accordance with those of Singh *et al*, (2011) [7] who had reported that combined application of organic manures and inorganic fertilizers increased the grain yield of wheat.

The straw yield presented in Table 2 revealed that conventional tillage significantly increased the straw yield by 6.6 per cent over zero condition. All the four nutrient management levels differed significantly from each other and integrated nutrient management resulted in 5.3, 14.4 and 27.1 per cent higher yield over inorganic, organic and farmer's practice treatments, respectively. This might be due to adequate quantities and balanced proportions of plant nutrients supplied to the crop as per need during the growth period resulting in favourable increase in yield attributing characters which ultimately led towards an increase in economic yield. Similar findings were also reported by Pandey *et al*, (2009) [5]. The different tillage and nutrient management practices did not significantly influence the harvest index of the wheat crop.

Economics

Data presented in Table 3 revealed that conventional tillage recorded higher cost of cultivation, gross returns, net returns and net returns per rupee invested as compared to zero tillage. Among nutrient management, organic nutrient management recorded higher cost of cultivation over other treatments. However, integrated nutrient management recorded maximum gross returns, net returns and net returns per rupee invested. Similar findings were observed by (Kaur *et al*, 2018) [2] who reported that application of 75% NPK + vermicompost @2.5 t ha^{-1} gave maximum net returns per rupee invested

Conclusion

Conventional tillage significantly increased the grain yield and net returns per rupee invested of wheat by 3.8 and 2.4 per cent, respectively over zero tillage. Integrated nutrient management recorded maximum yield of wheat crop followed by inorganic nutrient management, organic nutrient management and farmer's practice. Integrated nutrient management recorded maximum net returns per rupee invested (1.57) compared to other treatments.

Table 1: Effect of tillage and nutrient management on yield contributing characters of wheat

Treatments	No. of effective tillers m^{-2}	Spike length (cm)	No. of grains $spike^{-1}$	1000 grain weight (g)
Tillage				
Zero	251.26	9.53	52.84	38.88
Conventional	260.31	10.23	54.92	40.96
SEm (±)	0.44	0.08	0.16	0.29
CD (P=0.05)	2.68	0.51	0.98	1.79
Nutrient Management				
Organic	251.79	9.65	52.82	39.68
Inorganic	258.82	10.37	54.70	40.57
Integrated	266.46	11.34	57.63	42.62
Farmer's practice	246.07	8.17	50.36	36.80
SEm (±)	1.21	0.33	0.68	0.51
CD (P=0.05)	3.72	1.01	2.09	1.57

Table 2: Effect of tillage and nutrient management on grain yield, straw yield, biological yield and harvest index of wheat

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index
Tillage				
Zero	3939	5975	9914	0.40
Conventional	4089	6373	10463	0.39
SEm (±)	23	35	47	0.002
CD (P=0.05)	140	211	284	NS
Nutrient Management				
Organic	3943	5979	9922	0.40
Inorganic	4253	6496	10748	0.40
Integrated	4548	6841	11389	0.40
Farmer's practice	3312	5382	8694	0.38
SEm (±)	75	82	122	0.01
CD (P=0.05)	230	252	375	NS

Table 3: Effect of tillage and nutrient management on economics of wheat

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Net returns per rupee invested
Tillage				
Zero	49501	110650	61148	1.25
Conventional	51276	115814	64538	1.28
SEm (±)		540	540	0.01
CD (P=0.05)		3283	3283	NS
Nutrient Management				
Organic	59103	110751	51648	0.87
Inorganic	48857	119719	70862	1.45
Integrated	49510	127448	77938	1.57
Farmer's practice	44087	95011	50925	1.15
SEm (±)		1628	1628	0.03
CD (P=0.05)		5018	5018	0.10

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