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Assessment of inorganic fertilizer and organic manure on growth, yield and economics of wheat (*Triticum aestivum* L.) Cv. HD2967

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Abstract
As the current farming system is heavily reliant on chemical fertilizers, which negatively affect crop growth and crop productivity. Improving crop production on a sustainable basis is a challenging issue in the present agricultural system. To address this issue, a field experiment was conducted during *Rabi* 2020 at Crop Research Farm of Department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj to know the interaction effect on assessment of Inorganic Fertilizer and Organic Manure on growth, yield and economics of Wheat. The experiment consisted of 9 treatments which includes 3 levels of inorganic fertilizer (0, 50 and 100%) and 3 levels of organic manure (0, 50 and 100%). The treatment T9 receiving @ 100% (NPK + Zn) + @ 100% FYM produced significantly higher plant height (113.76cm), length of spike (12.13cm), number of grains per spike (84.73), grain weight per spike (5.83g), test weight (44g), grain yield (8.16 t ha-1) and straw yield (7.85 t ha-1). However, Gross Return (199367.5 ₹ ha-1), Net return (131827.1 ₹ ha-1) and B:C ratio (1.95:1) was also obtained maximum with the application of T9 @ 100% (NPK + Zn) + @ 100% FYM. This experiment reveals that treatment T9 receiving @ 100% (NPK + Zn) + @ 100% FYM provides a sustainable nutrient management strategy to improve crop yield with high economic returns.

Keywords: Sustainable nutrient management, inorganic fertilizer, organic manure, growth attributes, yield attributes, economic returns

1. Introduction
Wheat is the world leading cereal crop with the production of 765.8 million metric tonnes. In India the wheat production is about 107.59 million tonnes (FAOSTAT 2020) [6]. Wheat is an important source of carbohydrates. Globally, it is the leading source of vegetable protein in human food, having a protein content of about 13%. Wheat productivity components are affected by physical, chemical and biological soil properties and climatic conditions (Dwivedi and Tiweri 1992) [5]. Nitrogen is a primary nutrient absorbed by wheat crop from soil in large proportions @ 80-120 kg ha-1 is the most limiting factor affecting crop production. However low nitrogen content of Indian soils further accelerates the problem delaying crop establishment, hence there is a need for heavy application of nitrogenous fertilizers for replenishing the crop requirement. The top dressing of N at later stage of the crop proved most effective in increasing grain protein concentration, yield and fertilizer use efficiency (Richa *et al*. 2017) [13]. Phosphorous is the most important nutrient needed by a wheat crop. Phosphorous (P) is vital for plant development starting when wheat is just a seedling and continuing all the way to maturity and strengths the plant to help survive the winter. Wheat requires potassium for optimal growth and development. Adequate potassium results in superior quality of the whole plant due to improved efficiency of photosynthesis, increased resistance to sun diseases and greater water use efficiency. After wheat straw is incorporated into the soil, a large quantity of potassium (75%) is released back into the soil for subsequent crop use. Deficiency of zinc is widespread and covers about 48% area in the country. Zinc was one of the first micronutrients, essentiality of which for plant growth has been confirmed. Zinc is an important element for terrestrial life since it is required as either a structural component or reaction site in numerous proteins. (Singh 2015) [15]. The integration of farm yard manure with fertilizers may improve N use efficiency in the cropping system.

There is an intensive application of organic materials to crops due to (i) increased availability of processed and marketed off-farm residues, (ii) increased environmental concern, promoting the utilization of organic waste rather than its disposal in landfills and (iii) the development and effort put into organic farming.

Materials and methods Experimental site

A field experiment was conducted during *Rabi* 2020 at Crop Research Farm of Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) which is located at 25^0 24′ 42″ N latitude, 81^0 50′ 56″ Elongitude and 98 meter above the sea level. The climate of this region is semi-arid subtropical.

Fertilizer application

The fertilizers were applied in each plot according to treatment combinations. Treatments comprised of T1 – Control RDF, T2 – 0% (NPK + Zn) + 50% FYM (7.5 t ha- 1), T3 – 0% (NPK + Zn) + 100% FYM (15 t ha-1), T4 – 50% (NPK + Zn) (60:30:20 + 15 kg ha-1) + 0% FYM, T5 – 50% (NPK + Zn) (60:30:20 + 15 kg ha-1) + 50% FYM (7.5 t ha-1), T6 – 50% (NPK + Zn) (60:30:20 + 15 kg ha-1) + 100% FYM (15 t ha-1), T7 – 100% (NPK + Zn) (120:60:40 + 30 kg ha-1) + 0% FYM, T8 – 100% (NPK + Zn) (120:60:40 + 30 kg ha-1) + 50% FYM(7.5 t ha-1), T9 –100% (NPK + Zn) (120:60:40 + 30 kg ha-1) + 100% FYM(15 t ha-1) were applied at the time of sowing in the form of Urea, SSP, MOP and Zinc Sulphate.

Plant sampling Growth attributes

Plant height (cm) was measured from the ground level to the tip of the plant. Five randomly selected plants were tagged and recorded at 30, 60, 90 and 120 DAS from each plot. The length of spike (cm) was recorded from selected five spikes of the tagged plants from each plot.

Yield attributes

The number of grains per spike and grain weight per spike (g) was recorded from five productive spikes of the tagged plants of each plot. The weight of randomly selected 1000 seeds were taken from each plot to measure the test wight (g). Seeds from the harvest area (1.0 m2) were dried in sun, cleaned and weighed separately from each plot for calculating the grain yield in tonnes/hectare. After separating seeds from harvested wheat plants, the remaining produce was sun dried to constant weight and straw yield per plot was recorded.

Economics

The economics regarding the cultivation of the crop were calculated separately for all the treatments on per hectare basis. As per as existing market prices, the input and output costs were computed treatment wise and different economics parameters *viz*. Net profit and benefit: Cost ratio were calculated.

Statistical analysis

Experimental data collected was subjected to statistical analysis by the method "Analysis of Variance (ANOVA) technique" as given by Fisher (1957). The significant and non-significant effect was judged with the help of "F" (variance ratio) table. The significant difference between the means was tested against the critical difference of 5% level of significance.

Results and discussion Growth attributes

Data presented in Table 1 showed the assessment of Inorganic Fertilizer and Organic Manure on growth attributes of wheat. Where, plant height (cm) and length of spike (cm) exhibited a significant difference among the treatments. Plant height was observed highest with the application of treatment combination T9 - (NPK + Zn) @100% + FYM @100% at 30DAS (28.99 cm), 60DAS (52.04 cm), 90DAS (111.49 cm) and 120DAS (113.76 cm) and the lowest plant height was recorded with the application of treatment combination T1 - (NPK + Zn) @0% + FYM @0% at 30DAS (28.99 cm), 60DAS (52.04 cm), 90DAS (111.49 cm) and 120DAS (113.76 cm). The optimum dose of inorganic fertilizer and organic manure and their interaction increased the plant height significantly. Increase in plant height at high fertilizer level due to proper nutrition availability which resulted in increase in vegetative growth of plants and it is mainly due to the high dose of nitrogen which enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth. Similar findings also been observed by Bhardwaj *et al*. (2009) [3], Hussian *et al*. (2002) [9], Agarwal (1997) [1]. Length of spike was recorded maximum at T9 - (NPK + Zn) @100% + FYM @100% (12.13 cm) and the minimum length of spike was recorded at T1 - (NPK +Zn) @0% + FYM @0% (8.73 cm). There is significant difference among the treatments. Increase in length of spike at high fertilizer level due to proper nutrition availability. Similar findings also reported by Kharub and Chander (2010) [10].

Yield attributes

Data presented in table 2 showed the assessment of Inorganic Fertilizer and Organic Manure on yield attributes of wheat. Where, number of grains per spike, grain weight per spike (g), test weight (g), grain weight (q ha-1) and straw yield (q ha- 1) exhibited a significant difference among the treatments. The maximum number of grains per spike was recorded at T9 - (NPK + Zn) @100% + FYM @100% (84.73) and the minimum number of grains per spike was recorded at T1 - (NPK +Zn) @0% + FYM @0% (51.06). The optimum dose of inorganic fertilizers and organic manures and their interaction increased the number of grains per spike significantly which helps in improving the number of grains per spike that ultimately increases the yield. Similar findings also reported by Chandra *et al*. (2011) [4], Ghulam *et al*. (2010) [7] and Bhardwaj *et al*. (2009) [3]. The maximum grain weight per spike was recorded at T9 - (NPK + Zn) @100% + FYM @100% (5.83 g) and the minimum grain weight per spike was recorded at T1 - (NPK +Zn) @0% + FYM @0% (4.1 g). As grain weight per spike drastically influence the final yield, nitrogen alters plant growth more than any other mineral nutrient. In wheat over supply of nitrogen may cause lodging, disease incidence and lower grain quality. Similar findings also reported by Kharub and Chander (2010) [10]. The maximum test weight recorded at T9 - (NPK + Zn) @100% + FYM @100% (44 g) and the minimum test weight was recorded at T1 - (NPK +Zn) @0% + FYM @0% (41.16 g). Increasing rate of K and P favoured tillering in wheat and reduce lodging. Addition of P increased tiller numbers, improved photosynthetic activity, enhanced transport to grain ripening which resulted heavier grains and test weight of 1000 grains. Similar findings also reported by Ghulam *et al*. (2010) [7], Patil *et al*. (2008) [11], Balwinder *et al*. (2008) [2] and Hakeem (2004) [8]. The maximum grain yield recorded at T9 - (NPK + Zn) @100% + FYM @100% (8.16 t ha-1) and the

minimum grain yield was recorded at T1 - (NPK +Zn) @0% + FYM @0% (4.81 t ha- 1). Brar *et al*. (2015), Prakash *et al*. (2013) [12], Taybeh (2010) [17] and Bharadwaj *et al*. (2009) [3] reported similar observations of getting higher yields of wheat grain with combined application of FYM and inorganic fertilizers. The maximum straw yield recorded at T9 - (NPK + Zn) @100% + FYM @100% (7.85 t ha-1) and the minimum straw yield was recorded at T1 - (NPK +Zn) @0% + FYM @0% (5.27 t ha- 1). Urea was indicated as a quick and more potent source of nitrogen for increasing the vegetative growth as compared to FYM but the combination of the two sources was found more effective. Similar findings were reported by Singh *et al*. (2013) [16] and Shah *et al*. (2009) [14].

Economics

Data presented in Table 3 showed the assessment of Inorganic Fertilizer and Organic Manure on economics of wheat. As for the economy of different treatment is concerned, the treatment T9 - (NPK + Zn) @100% + FYM @100% resulted in the maximum net return (₹ 131827.1 ha-1) and minimum net return was resulted in T3 - (NPK +Zn) @0% + FYM @100% (₹ 74822.5 ha-1). The treatment T7 - (NPK + Zn) @100% + FYM @0% was recorded the highest B:C ratio of 2.48:1.

Table 1: Assessment of Inorganic Fertilizers and Organic Manure on growth attributes of Wheat

Treatments	Plant height (cm)							Length of Spike (cm)							
	30 DAS				60 DAS			90 DAS			120 DAS				
T1	23.62				34.90			91.270			97.300			8.730	
T2	24.25				36.31			94.260			98.200			8.970	
T3	24.44				38.32			97.470			98.820			9.200	
T4	25.14				40.17			100.07			101.44			9.630	
T5	25.16				41.48			100.94			102.16			9.960	
T6	26.06				43.62			101.04			106.72			10.27	
T7	26.54				44.06			101.71			106.38			10.40	
T8	27.07				47.86			104.38			109.36			10.95	
T9	28.99				52.04			111.49			113.76			12.13	
F-test	S.Em.(±)		C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%
Due to Inorganic Fertilizer	S	0.24	0.51	S	0.59	1.25	S	1.02	2.17	S	0.67	1.43	S	0.15	0.32
Due to Organic Manure	S	0.24	0.51	S	0.59	1.25	S	1.02	2.17	S	0.67	1.43	S	0.15	0.32
Interaction	S	0.41	0.88	S	1.02	2.17	S	1.77	1.77	S	1.17	2.49	S	0.26	0.56

Table 2: Assessment of Inorganic Fertilizers and Organic Manure on yield attributes of Wheat

Treatments	Number of grains per spike			Grain weight per spike (g)			Test weight (g)			Grain yield (t ha-1)			Straw yield (t ha-1)		
T1	51.06			4.10			41.16			4.81			5.27		
T2	53.33			4.30			42.33			5.18			5.47		
T3	56.00			4.50			42.45			5.31			5.49		
T4	58.20			4.56			43.16			6.03			6.02		
T5	62.96			4.76			43.23			6.98			6.26		
T6	71.13			4.83			43.30			7.37			6.30		
T7	72.16			4.86			43.46			7.57			6.41		
T8	75.00			4.93			43.56			7.70			6.64		
T9	84.73			5.83			44.00			8.16			7.85		
F-test		S.Em.(±)	C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%	F-test	S.Em.(±)	C.D. at 5%
Due to Inorganic Fertilizer	S	1.06	2.26	S	0.89	0.19	S	0.14	0.30	S	0.11	0.25	S	0.18	0.39
Due to Organic Manure	S	1.06	2.26	S	0.89	0.19	S	0.14	0.30	S	0.11	0.25	S	0.18	0.39
Interaction	S	1.85	3.92	S	0.15	0.32	S	0.24	0.52	S	0.20	0.43	S	0.32	0.67

Table 3: Assessment of Inorganic Fertilizers and Organic Manure on economic of Wheat

Treatments	Total cost of cultivation (₹ha-1)	Gross returns (₹ ha-1)	Net returns (₹ ha-1)	B:C ratio
T1	40700.0	118832.5	78132.5	1.91:1
T2	48200.0	127490.0	79290.0	1.64:1
T3	55700.0	130522.5	74822.5	1.34:1
T4	46620.2	147850.0	101229.8	2.17:1
T5	54120.2	169570.0	115449.8	2.13:1
T6	61620.2	178425.0	116804.8	1.89:1
T7	52540.4	183212.5	130672.1	2.48:1
T8	60040.4	186665.0	126624.6	2.10:1
T9	67540.4	199367.5	131827.1	1.95:1

Conclusion

It is concluded from trial that treatment T9 - (NPK + Zn) @100% + FYM @100% was best with respect to the "Assessment of Inorganic Fertilizers and Organic Manure on Growth, Yield and economics of Wheat (*Triticum aestivum* L.) Cv. HD2967" and in comparison, to other treatment combinations. As the treatment T9 - (NPK + Zn) @100% + FYM @100%exhibited foremost result with respect to plant

height (cm) @ 30DAS, 60DAS, 90DAS and 120DAS, length of spike (cm), Number of grains per spike, grain weight per spike (g), test weight (g), grain yield (t ha-1), straw yield (t ha-1) and from the economic point of view, it gave the maximum gross return of ₹ 199367.5 ha-1 and maximum net return of ₹ 131827.1 ha- 1 with a B:C ratio of 1.95:1.

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