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Influence of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract
Background: The organic manures (FYN, Vermicompost and RDF) has potential to play the role in promoting growth and providing immunity in the plant system, resulting in increase overall yields. Hence, the present study was carried out to assess the fertilization effect of integrated sources of nutrient on growth, yield and qualitative traits of wheat.
Methods: During *rabi* season 2022, a field experiment was undertaken at the Agronomy Farm, central region of Uttar Pradesh, Rama Agriculture university, Kanpur, Uttar Pradesh, comprising eight nutrient management strategies, laid out in a randomised complete block design with three replications.
Result: Application of 75%N RDF + 25% N through vermicompost in wheat resulted in significantly higher grain yield and net return in comparison to others.

Keywords: Wheat, organic sources, yield, content, uptake

Introduction
Wheat (*Triticum aestivum* L.) is one of the major food crops produced in globally (Anon 2018). India rank has the second place of wheat producer in the world after China. Production and productivity of wheat was improved by a plateau level after the green revolution.
Cereal crops are necessarily grasses, a composite term which refers to monocot plants under the family Poaceae or Gramineae. Wheat (*Triticum spp*.) is the world's leading cereal crop. It is the third most-produced cereal after maize and rice. India achieved remarkable progress in wheat production during the last four decades and is the second largest wheat producer in the world. It is the second most important crop in India after rice, both in terms of area and production. Mexican Dwarf Wheat (*Triticum aestivum* L.) presently grown in India everywhere called common bread wheat, it was evolved by Dr. N. E. Borlaug of Mexico at CIMMYT. Its origin is South West Asia. Generally, wheat is a self-pollinated, C3 and hexaploid plant.
Wheat is the dominant crop in temperate countries being used for human food and livestock feed. Its success depends partly on its adaptability and high yield potential but also on the gluten protein fraction which confers the viscoelastic properties that allow dough to be processed into bread, pasta, noodles, and other food products. It also contributes essential amino acids, minerals, vitamins, beneficial phytochemicals and dietary fibre components to the human diet and these are particularly enriched in whole-grain products.
Wheat is cultivated in almost all countries of the world; the most important wheat producing countries are China, India, USA, Canada and European Union, Australia. In India, the total cultivated area under wheat crop is 43.78 million hectare with production of 107.59 metric tones and whereas the average productivity of 3216 Kg ha^{-1} (Anonymous, 2019-20) [1, 2].
Uttar Pradesh occupied leading state among area and production of wheat in India (9.8mt) but productivity of wheat also (2561 Kg ha^{-1}) is still less than the national average (Directorate of Economics and statistics, DAC&FW).
A proper and economically justifiable recycling of crop residues in the form of compost, FYM, vermicompost, green manure, (Tandon, 1992) [15] and so on, as well as the use of bio-fertilizers, can provide a significant supply of nutrients to the soil plant system (Dixit and Gupta, 2000) [4]. In the current agricultural scenario, where FYM availability is limited, vermicompost can be another potential source of organic matter in cultivated soils, which not only provides macronutrients and plant growth promoting hormones, but also provide micronutrients, which are otherwise limited crop growth and yields in many intensively cultivated areas (Singh, 1999; Massod Ali and Mishra, 2000) [11, 12].

The application of Farm Yard Manure (FYM) in the soil helps in enhanced and restore the fertility of the soil as well as physical condition of soil including its water holding capacity. The use of organic manures, which were perhaps the main sources of plant nutrients in traditional agriculture, receives less importance with the advent of high analysis and synthesis chemical fertilizers. The decision on the optimum and balanced use of fertilizer required knowledge of crop response to applied fertilizer, inherent nutrients by soil and its short or long-term fate effects on soil or crops.

Plant Growth Promoting Rhizobacteria (PGPR), are especially phosphate solubilizing bacteria (PSB), which is inhabit in the plant rhizosphere and increase the availability of phosphorus for the plants by solubilization of fixed Phosphate in soil. Because of limited diffusion and formation of a p-depletion zone surrounding the root system of plant, the phosphate made available by *PSB* from sparingly soluble inorganic phosphorus sources that may not reach the root surface of plant.

Vermicompost is an organic manure produced by earthworm feeding on biological waste material and plant residue & it contains 2.1-2.6% N, 1.5-1.7% P and 1.4-1.6% K, 10 to 52 pVC Cu, 186.60 pVC Zn, 930.00 pVC Fe and plant growth promoting substances such as, NAA, cytokinins, gibberellins, etc. (Giraddi, 2001 and Giraddi *et al*., 2006) [6, 7]. These plant nutrients are adsorbed on the humic acid molecules and are released slowly and gradually into the soil solution and made available for plant growth and development processes (Arancon *et al*., 2005) [3, 8].

Materials and Methods

The field experiments were conductedat central region of Uttar Pradesh in Kanpur Nagar during *Rabi*, season of 2022 to study "Effect of Integrated Nutrient Management on Growth, Yield and Quality of Wheat (*Triticum aestivum* L.)"

The experiment was conducted at central region of Uttar Pradesh in Kanpur Nagar. The soil is alluvial with slightly sodic in nature due to lower terrain region. Kanpur (U.P.) situated at 25° 56' to 28° 58' North and longitude 79° 31' to 80° 34' East and is located on an elevation of about 125.9 meters above mean sea level in Gangetic plain The experimental farm falls under the Indo-Gangetic alluvial tract and irrigated by tube well. The soil of top 15 cm depth of experimental site was loamy sand in texture, low in organic carbon (0.42%) and available nitrogen (185 kg/ha), medium in available phosphorus (13 kg/ha) and available potash (174 kg/ha) with 7.79 soil pH. The details of the ten treatments viz., (T_1) 0% (Control)), (T_2) 100% RDF, (T_3) 25% N RDF + 75% through FYM, (T_4) 50% N RDF + 50% through FYM, (T_5) 75% N RDF + 25% through FYM, (T_6) 25% N RDF + 75% N through vermicompost, (T_7) 50% N RDF + 50% N through vermicompost, (T_8) 75% N RDF + 25% N through vermicompost. The organic manures (FYM, Vermicompost) was applied 10 days before sowing, incorporated in soil. The wheat variety ''HUW-234'' used in experiment. It is one of the most popular of variety among farmers and is cultivated in the wheat growing area of U.P. Wheat was sown on 22 cm between the rows spacing. The soil samples were kept in the oven for drying at 65 °C for 24-72 hours to obtain a constant weight. Since most analytical methods require grinding of a dry sample, therefore, mechanical grinding of seed and straw materials was carried out with stainless mills usually to pass a 60- mesh sieve. Afterwards, grinded seed and straw materials were used for further chemical analysis using the following formulas (Kumar 2019): N uptake in seed/straw (kg ha^{-1}) = Seed/straw yield (kg ha^{-1}) × % N/100 in seed/straw ($kgha^{-1}$).

Results and Discussion

Crop growth

Data presented in Table 1 indicated that significantly higher values of growth parameters were obtained from application of 75%N RDF + 25% N through vermicompost as compared to others. The said treatment produced significantly taller plants (58.12, 95.36 and 95.13 cm) at 60 DAS, 90 DAS and at harvest respectively. Other growth parameters included total number of tillers/m^2 (68.29, 97.24, 96.00 and 93.72) at 30, 60 DAS, 90 DAS and at harvest respectively. Application of 75% N RDF + 25% N through vermicompost. This might be due to the fact that application of manure improves overall growth of wheat. Rajeshwari (2011) [14] and Prajapati (2014) [13] reported that application of vermicompost had a significant effect on all growth parameters of wheat. The results indicated the need for adding manures to the soil which increased the availability of nutrients over a long period and have a positive effect on the height of the plant. Balanced nutrition might have resulted in better development and robust growth. Nitrogen is one of the most important factors affecting the leaf area index which might have helped in enhancing photosynthesis and productivity of the crop. The positive effect of organic manure on the leaf area index might be due to the fact that vermicompost as reported by Rajeshwari (2011) [14] and Prajapati (2014) [13] is a source of macro and micronutrients, vitamin and growth hormones like gibberellins which enhanced leaf area resulting in higher photo assimilates.

Yield attributes and yield

Critical perusal of data presented in Table 2 indicated that application of 75% N RDF + 25% N through vermicompost significantly increased spike length (12.46 cm), number of grain/ear (40.51), grain weight/ear (2.58g), number of spikelet/ear (22.10) and test weight (43.52 g) over other treatments. 75% N RDF + 25% N through vermicompost was at par with that of application of 75% N RDF + 25% N through FYM. Significantly higher seed and straw yield was recorded with the application 75%N RDF + 25% N through vermicompost (57.30 and 83.83 q ha-1) over other treatments. Selvaraj (2003) [16] observed a 36% increased yield of French bean with the application of vermicompost + panchgavya. Prajapati (2014) [13] and Kachariya (2015) [9, 10] reported an increased yield of crop plants with vermicompost application due to enhancement in the biological efficiency of crop plants.

Economics

Data presented in Table 3 indicated that net returns in wheat was influenced significantly due to various treatments of INM. Results presented in Fig 4 indicated that the higher net return (₹74607/ha) and B:C ratio (1.65) were obtained with application of 50% N RDF + 50% N through vermicompost and 75% N RDF + 25% N through FYM respectively which could be due to the higher seed yield during the growing season, low cost of FYM. The lowest B:C ratio of 1.48 was recorded under 0% (Control). The results are in close proximity to tune reported by Tak *et al.*, (2013).

Table 1: Effect of different INM treatments on growth parameters of wheat.

Treatment	Plant height			Tillers/m^2		
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
T_1	46.95	80.62	80.49	82.23	82.20	80.21
T_2	49.29	86.70	86.67	86.34	86.15	82.32
T_3	50.39	87.34	87.29	87.24	87.00	82.48
T_4	52.72	88.12	88.08	88.38	88.13	85.32
T_5	53.32	89.10	88.85	89.48	90.17	87.29
T_6	54.62	90.72	90.45	92.16	92.37	89.42
T_7	56.90	92.98	92.75	94.76	93.10	90.51
T_8	58.12	95.36	95.13	97.24	96.00	93.72
SEm ±	1.415	2.393	2.390	2.411	2.403	2.320
CD (p=0.05)	4.335	5.330	5.330	4.901	7.358	7.106

Table 2: Effect of INM treatments on yield attributes

Treatment	Spike length (cm)	No. of grain ear^{-1}	Grain weight ear^{-1} (g)	No. of spikelets ear^{-1}	Test weight (g)
T_1	9.23	34.25	1.23	18.20	36.31
T_2	10.34	36.89	1.48	19.32	38.62
T_3	10.86	37.13	1.56	19.57	38.94
T_4	11.87	37.83	1.67	20.12	39.62
T_5	11.89	38.10	1.86	20.37	39.86
T_6	11.95	39.72	1.92	21.12	40.23
T_7	12.24	39.95	2.47	21.42	41.95
T_8	12.46	40.51	2.58	22.10	43.52
SEm ±	0.30	1.02	0.04	0.5451	1.075
CD (p=0.05)	0.93	3.13	0.15	668	3.292

Table 3: Effect of INM treatments on yield

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
T_1	46.42	77.86	124.28	37.35
T_2	47.37	79.28	126.65	37.40
T_3	48.87	79.39	128.26	38.10
T_4	52.22	82.88	135.10	38.65
T_5	53.75	82.94	136.69	39.32
T_6	55.17	83.10	138.2	39.90
T_7	56.62	83.80	140.42	40.3
T_8	57.30	83.83	141.13	40.60
SEm ±	1.39	2.20	3.59	1.04
CD (p=0.05)	4.27	0.87	7.00	1.00

Conclusion

In order to increase yield of wheat, use of the organic sources for fulfilling nutrient requirement to sustain crop productivity and safeguard soil human-environment health is recommended. Thus, it can be inferred that the application of 75% N RDF + 25% N through vermicompost for enhancing wheat productivity in the U.P. (India) and similar eco-regions elsewhere for advancing nutritional security. Application of 75% N RDF + 25% N through vermicompost gave significantly, higher seed yield (57.30 q/ha) over the treatments.

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