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Effect of different level of fertilizer and various organic manure on growth and yield of wheat (*Triticum aestivum* L.) crop in Chitrakoot area

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Abstract
A field experiment was conducted at the Rajaula Agriculture farm, Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya, to evaluate the effects of different fertilizer levels and organic manures on the growth and yield of wheat (*Triticum aestivum* L.) in the Chitrakoot region. The experiment was laid out in a Factorial Randomized Block Design with 10 treatment combinations replicated thrice. Treatments included varying combinations of recommended dose of nitrogen (RDN) with farmyard manure (FYM) and vermicompost. The results indicated significant variations in growth parameters. The maximum plant height of 98.14 cm at 90 days after sowing (DAS) was observed in treatment T_{10} (25% RDN + 75% N through vermicompost), followed by T_8 (50% RDN + 50% N through vermicompost) with a height of 97.23 cm. Similarly, the number of tillers reached a maximum of 5.42 in T10 at 90 DAS. Yield attributes, including the number of spikelets per plant and grain yield, showed significant differences among treatments. T_{10} recorded the highest number of spikelets (52), grains per plant (42.06), and grain yield (3.50 t ha^{-1}), followed by T_8 with a grain yield of 3.40 t ha^{-1}.

Keywords: Wheat, yield, spikelet, nitrogen, tillers

Introduction
Wheat being an energy rich winter cereal contributes around 35% to the food grain basket of the country. In India wheat (*Triticum aestivum* L.) is grown in 124 countries and occupied an area of about 215 million hectares with a production of 1120.19 lakh tons of grain during 2023-24 (Anonymous, 2024) [3].

The major wheat producing states of India are Uttar Pradesh, Madhya Pradesh, and Punjab with the production of 33.95, 22.97, and 14.86 mt., respectively. The Uttar Pradesh ranked first in wheat production with the second of Madhya Pradesh and third of Panjab.

Wheat (*Triticum aestivum L.*) is one of the major cereal crops with a unique protein, which is consumed by humans and is grown around the world in different environments (Abedi T. *et al.*, 2010) [1]. Wheat is foremost among cereals as a main source of carbohydrates and protein for both human beings and animals contains starch (60-90%) protein (11-16.5%), fat (1.5-2%), inorganic ions (1.2-2%) and vitamins (B complex and vitamin E) (Rueda-Ayala *et al.*, 2011) [17].

It is recognized that neither organic manure nor chemical fertilizers alone can achieve yield sustainability under modern farming where nutrient depletion and turn over in soil plant systems are quite high. This has in turn paved the way for integrated plant nutrient management. Thus integrated nutrient management advocates balanced and conjoint use of inorganic fertilizer, organic manure, and bio-inoculants in order to maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop productivity (Rakshit *et al.* 2008, Parewa *et al.* 2014) [16, 14].

Nitrogen (N) is major factor for yield of wheat (Andrews *et al.*, 2004) [2]. The efficiency of wheat cultivars to N use has become increasingly important to allow reduction in N fertilizer use without decreasing yield. Nitrogen rate type of nitrogen and timing ofit's application are important factors to increase wheat yield (Garrido-Lestache *et al.*, 2005) [5].

Some studies showed that N fertilization increases the total quantity of flour proteins resulting in an increase in both gliadins and glutenins (Dupont and Altenbach, 2003) [4].

Phosphorus is essential for enhancing seed maturity and seed development (Ziadi *et al*. 2008) [25]. Phosphorus plays a significant role in several vital functions such as photosynthesis, transformation of sugar to starch, protein information, nucleic acid production, nitrogen fixation and formation of oil. It is also, the part of all biochemical cycles in plants (Mehrvarz and Chaichi, 2008) [12].

Potassium (K^+) is of unusual significance because of it's live role in biochemical functions of the plant like activating various enzymes, improvement of protein, carbohydrates and fat concentration developing tolerance against drought and resistance to frost, lodging, pests and disease attack. Potassium controls the permeability of cellular membranes, maintaining correct protoplasmic hydration, and stabilizing emulsions with high colloidal characteristics, all of which contribute to the preservation of cellular organization. It is thus necessary to devise a fertilizer technology facilitating use of NPK in apt combination for enhancing wheat yield (Jabbar *et al*., 2009) [8].

Plant nutrient management is one of the key components of intensive agriculture. It is well known that addition of organic manures has shown considerable increase in crop yield and exert significant influence on physical, chemical and biological properties of the soil. But its use alone is not sufficient to meet the requirements of nutrients. Therefore there is a need to evaluate the utilization of organic as well as inorganic chemical sources in a rational way to achieve the desired production level. Inflation in chemical fertilizer and the lower purchasing power of most of the farming community limits it's use in proper amount, hampering crop production due to which the use of organic manure as a renewable source of plant nutrients is attaining importance. Judicious use of FYM with chemical fertilizers improves soil physical, chemical and biological properties and improves the crop productivity (Sharma *et al*., 2007) [18]. Application of organic manures may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers (Swarup, 2010) [21].

Methods and Materials

Experimental Sites

The experiment was carried out at Rajaula Agriculture farm, Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya Chitrakoot, Satna (M.P.) which lies in the semi- arid and sub-tropical region of Madhya Pradesh between 25.148° North latitude and 80.855° East longitude. The altitude of town is about 190-210 meter above mean sea level.

Soil Characteristics

Table 1: Chemical properties of the Experimental Soil

S. No.	Parameters	Results	Method Employed
1.	pH (1:2 soil water suspension ratio)	7.29	Glass electrode, pH meter
2.	EC (1:2.5 soil water suspension ratio)	0.34	Conductivity bridge (Jackson, 1973) [9]
3.	Organic Carbon (%)	0.32	Wet Oxidation Method (Walkley and Black's method 1934) [24]
4.	Total Nitrogen (kg ha^{-1})	98.5	Kjeldahl Method (Subbiah and Asija, 1956) [20]
5.	Available Phosphorus (kg ha^{-1})	18.31	Colorimetric method (Olsen *et al*. 1954) [13]
6.	Available Potash (kg ha^{-1})	217.94	Flame photometer Ammonium acetate extract (Hanwey and Heidel, 1952) [7]

Crop Husbandry

A pre-sowing irrigation (Paleva) was done in the experimental field with an object to get optimum moisture conditions for attaining good germination. The field was prepared by ploughing with a tractor drawn disc plough by cross harrowing and planking. FYM @ 3 t $ha^{-1}$and vermicompost @ 1 t ha^{-1} were applied as basal dose as per treatment. After the layout of experimental plot, the fertilizers were weighed and applied in the plots and thoroughly mixed with soil. As per the experimental recommended doses of Nitrogen, Phosphorus and Potassium were applied to all the plots. Recommended dose of Nitrogen, Phosphorus and Potassium were applied through Urea, DAP and MOP (120:60:40 kg ha^{-1}). Sulphur was applied at the time of sowing as per treatment. The seed was sown in line after making a narrow furrow with the help of pointed wooden stick at different row spacing. No. of 5 irrigation was given. The crop was grown totally under rainfed condition.

Detail of treatments and design

The 10 treatments combination of nutrient management practices. Experiment was laid out in Factorial Randomized Block Design with three replications.

Table 2: Detail of the treatment combinations

Symbol	Details of Treatment
T_0	Control
T_1	100% R.D.F.
T_2	100% RDN
T_3	100% RDN + 3 t ha^{-1} FYM
T_4	100% RDN + 1 t ha^{-1} Vermicompost
T_5	75% RDN + 25% N through FYM
T_6	75% RDN + 25% N through Vermicompost
T_7	50% RDN + 50% N through FYM
T_8	50% RDN + 50% N through Vermicompost
T_9	25% RDN + 75% N through FYM
T_{10}	25% RDN + 75% N through Vermicompost

Statistical analysis

The growth parameters and yields were recorded and analyzed as per Gomez and Gomez (1984) [6] the tested at 5% level of significance to interpret the significant differences.

Results and Discussion

Growth parameters: The data of plant height was recorded at after 30, 60 and 90 days after sowing of the crop. The treatment combination T_{10} [25% RDN + 75% N through Vermicompost] gave the maximum plant height (29.48 cm at 30 days, 47.59 cm at 60 days and 98.14 cm at 90 days) followed by the treatment T_8 [50% RDN + 50% N through Vermicompost] with the value 29.22 cm, 47.36 and 97.23 at 30, 60, 90 days respectively.

The data of number of tillers branches was recorded at after 30 and 60 days after sowing of the crop. The results revealed that the number of tillers of wheat varied in between 3.16 to 4.89 and all the treatments were non-significantly superior to T_0 [Control]. The treatment combination T_{10} [25% RDN + 75% N through Vermicompost] gave the maximum number of tillers (4.89 at 30 days and 5.42 at 90 days) followed by the treatment T_9 [25% RDN + 75% N through FYM]. Similar findings were reported by Malav *et al* (2019) [11], Singh *et al*. (2018) [19] and Verma *et al*. (2016) [23].

Table 3: Effect of different treatment combination on plant height at 30, 60, 90 DAS

Treatment	Plant height (cm)			No. of tillers	
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS
T_0	27.58	46.22	95.61	3.35	4.40
T_1	28.68	46.13	96.00	3.16	4.9
T_2	27.87	46.37	95.98	3.37	4.38
T_3	28.08	46.40	96.44	3.32	4.90
T_4	27.99	46.58	96.92	3.46	4.97
T_5	28.16	46.61	95.84	3.43	4.87
T_6	28.67	46.97	96.71	4.29	5.20
T_7	28.75	46.99	96.19	3.80	5.14
T_8	29.22	47.36	97.23	4.38	4.75
T_9	28.70	47.16	96.39	4.48	4.80
T_{10}	29.48	47.59	98.14	4.89	5.42
SEm ±	0.69	0.41	0.65	0.05	0.04
C.D. (P=0.05)	NS	1.21	1.93	0.15	0.14

Yield attributes and yield

The results revealed that the no. of spikelet of wheat varied in between 44 to 52 and all the treatments were significantly superior to T_0 [Control]. The treatment combination T_{10} [25% RDN + 75% N through Vermicompost] and T_7 [50% RDN + 50% N through FYM] gave the maximum no. of spikelet (52) followed by the treatment T_9 [25% RDN + 75% N through FYM] with the value 51. No. of grain plant^{-1}of wheat varied in between 37.64 to 42.06 and all the treatments were significantly superior to T_0 [Control]. The treatment combination T_{10} [25% RDN + 75% N through Vermicompost] gave the maximum no. of grain plant^{-1}(42.06) followed by the treatment T_8 [50% RDN + 50% N through Vermicompost] with the value 41.99. The test weight (g)of wheat varied in between 39.29 to 42.23 g. The treatment combination T_{10} [25% RDN + 75% N through Vermicompost] gave the maximum test weight (42.23 g) followed by the treatment T_8 [50% RDN + 50% N through Vermicompost] with the value 41.61 g. Similar findings were reported by Tejalben *et al.* (2017) [22].

The results revealed that the grain yield (t ha^{-1}) of wheat varied in between 2.02 to 3.50 t ha^{-1}. The treatment combination T_{10} [25% RDN + 75% N through Vermicompost] gave the maximum grain yield (3.50 t ha^{-1}) followed by the treatment T_8 [50% RDN + 50% N through Vermicompost] with the value 3.40 t ha^{-1}. Similar findings were reported by Kumar *et al.* (2022) [10] and Parewa *et al*. (2018) [15].

Table 4: Effect of different treatment combination on number of spikelet per plant

Treatment	No. of spikelet	No. of grain plant^{-1}	Test weight (g)	Grain yield (t ha^{-1})
T_0	44	37.64	39.29	2.02
T_1	47	40.83	40.43	2.65
T_2	46	39.44	39.90	2.93
T_3	47	39.14	40.80	2.72
T_4	45	37.34	40.24	3.14
T_5	48	41.95	41.14	2.83
T_6	50	39.94	41.06	3.23
T_7	52	40.31	40.67	3.26
T_8	51	41.99	41.61	3.40
T_9	51	40.26	41.24	3.35
T_{10}	52	42.06	42.23	3.50
SEm ±	0.56	0.51	0.39	0.39
C.D. (P=0.05)	1.68	1.50	NS	1.18

Conclusion

The study concluded that integrated nutrient management, involving a combination of chemical fertilizers and organic manures, significantly improves the growth, yield, and quality of wheat in the Chitrakoot region. The treatment with 25% recommended dose of nitrogen (RDN) and 75% nitrogen through Vermicompost (T_{10}) was the most effective, producing the highest plant height, number of tillers, spikelets per plant, and grain yield (3.50 t ha^{-1}). This was closely followed by the treatment with 50% RDN and 50% nitrogen through vermicompost (T_8).

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