**Impact of Integrated Nutrient Management on yield in wheat (*Triticum aestivum* L.) in Agra region, India**

**Abstract**

The present research entitled “Impact of Integrated Nutrient Management on Yield in Wheat (*Triticum aestivum* L.) in Agra Region” was conducted during the *Rabi* season of 2024–2025 at the Agricultural Research Farm, R.B. (PG) College, Agra, and Uttar Pradesh. The objective of the study was to evaluate the impact of various combinations of inorganic and organic nutrient sources on growth and yield in wheat. The experiment was laid out in an randomized block design (RBD) comprising ten treatments with three replications. Treatments included different combinations of recommended doses of fertilizers (RDF) with farmyard manure (FYM), vermicompost, and poultry manure. The results reveal that integrated nutrient management (INM) practices significantly influenced growth and yield parameters. Among the treatments, T₁ (100% RDF) recorded the highest grain yield (68.610 q/ha), while T₅ (25% RDF + 75% RDN through 1/3 FYM + 1/3 vermicompost + 1/3 poultry manure) achieved the maximum biological yield (101.943 q/ha-1) and straw yield (56.220 q/ha-1), along with superior performance in plant height and number of tiller per plant. The highest harvest index (58.150%) was observed in T₇ (50% RDF + 50% RDN through vermicompost), indicating efficient assimilates partitioning. The study concludes that integrated nutrient management, particularly treatments T₅ and T₇, effectively enhances wheat productivity and sustainability under the agro-climatic conditions of the Agra region.

**Keyword:** Wheat, Organic matter, INM, Growth, Yield

**Introduction**

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops after rice in the world and serves as a staple food for a large part of the global population, particularly in India. As the second most cultivated crop in the country, wheat plays a vital role in ensuring food security and supporting rural and urban livelihoods. However, in recent years, declining soil fertility, imbalanced fertilizer use, and unsustainable farming practices have posed serious challenges to wheat production and productivity. To address these issues, there is a growing emphasis on adopting sustainable nutrient management strategies that can enhance crop yields while preserving soil health (Panta and Parajulee, 2021; Payal et al., 2024). The inorganic fertilizers are applied to fulfill the plant requirement for nitrogen, phosphorus, potassium and other micronutrients, but excessive use of chemical fertilizers reduces soil fertility by affecting the soil’s physical and chemical properties (Kaur *et.al*., (2024)) Integrated Nutrient Management (INM) is a holistic approach that combines the use of chemical fertilizers with organic manures, green manures, crop residues, and bio fertilizers. The objective of INM is not only to supply essential nutrients to the crop but also to maintain soil biological activity and improve the physical and chemical properties of the soil. Unlike conventional methods that rely heavily on synthetic inputs, INM ensures a balanced nutrient supply, minimizes nutrient losses, and promotes efficient nutrient uptake by the crop (Aulakh & Grant, 2019; Panta and Parajulee, 2021). Several studies have highlighted the benefits of INM in improving wheat growth, yield and overall productivity. Moreover, it contributes to long-term soil fertility and reduces the environmental impact associated with excessive chemical fertilizer use. Despite its proven advantages, the adoption of INM practices among farmer remains limited due to a lack of awareness and region-specific recommendations. Therefore, it becomes essential to generate localized data and validate the effectiveness of INM under different agro-climatic conditions (Payal et al., 2024; Aulakh & Grant, 2019). This study aims to evaluate the effects of different nutrient combinations on the growth, yield, and nutrient uptake of wheat under the agro-climatic conditions of the Agra region, with the goal of recommending sustainable nutrient management practices for enhanced productivity and soil health.

### ****Materials and Methods****

#### ****Experimental Site****

The field experiment was conducted during the *Rabi* season of 2024–2025 at the Agricultural Research Farm of R.B. (P.G.) College, Agra, and Uttar Pradesh. The site falls under the semi-arid agro-climatic zone of western Uttar Pradesh. The experiment was laid out in a randomized block design (RBD) with ten treatments and three replications using the wheat variety **PBW -226**, following the methodology of Patel and Patel (2011) and Sharma and Yadav (2017).

#### ****Soil, Climate, and Weather Conditions****

The experimental field had alluvial soil with a sandy loam texture, neutral pH, and moderate fertility. Initial soil testing showed low available nitrogen, medium phosphorus, and adequate potassium content. The region has a semi-arid climate with hot summers and cold winters. During the crop period, the average temperature ranged between 8°C and 24°C with occasional winter rainfall. The experimental procedures and field preparation followed standard agronomic protocols as outlined in long-term wheat nutrient management studies (Kumar et al., 2015).

***Technical Programme (Treatment Details)***

The experiment consisted of ten treatments involving combinations of inorganic fertilizers and organic manures, where the **recommended dose of fertilizers (RDF)** was considered as **150 kg N + 60 kg P₂O₅ + 50 kg K₂O per hectare**. Nitrogen from organic sources was adjusted based on their nutrient content. The treatment details are as follows:

**List-1. Treatment details**

|  |  |
| --- | --- |
| **Treatment** | **Treatment Description** |
| T₀ | Control (No fertilizer or organic manure) |
| T₁ | 100% RDF (150 kg N + 60 kg P₂O₅ + 50 kg K₂O per hectare) |
| T₂ | 25% RDF + 75% RDN through FYM |
| T₃ | 25% RDF + 75% RDN through Vermicompost |
| T₄ | 25% RDF + 75% RDN through Poultry Manure |
| T₅ | 25% RDF + 75% RDN through ⅓ FYM + ⅓ Vermicompost + ⅓ Poultry Manure |
| T₆ | 50% RDF + 50% RDN through FYM |
| T₇ | 50% RDF + 50% RDN through Vermicompost |
| T₈ | 50% RDF + 50% RDN through Poultry Manure |
| T₉ | 50% RDF + 50% RDN through ⅓ FYM + ⅓ Vermicompost + ⅓ Poultry Manure |

(Abbreviation: INM (Integrated Nutrient Management), RDF (Recommended Dose of Fertilizer), RDN (Recommended Dose of Nutrients), FYM (Farm Yard Manure) C.V (Commercial variety),cm (centimeter)

Here, **RDF** refers to the Recommended Dose of Fertilizers, and **RDN** denotes the Recommended Dose of Nitrogen supplied through organic sources such as FYM, vermicompost, and poultry manure. The treatments were applied as per standard INM trials conducted in similar agro-climatic conditions (Patel & Patel, 2011; Kumar et al., 2015; Sharma & Yadav, 2017).

**Results and discussion**

The present investigation was carried out to assess the impact of integrated nutrient management (INM) on yield in wheat (*Triticum aestivum* L.) in Agra region. The experiment, conducted during the Rabi season of 2024–2025 at the Agricultural Research Farm of R.B. (PG) College, Agra, included ten treatments comprising various combinations of recommended dose of fertilizers (RDF) and organic nutrient sources such as farmyard manure (FYM), vermicompost, and poultry manure. Initial plant population / meter square recorded at 20 days after sowing (DAS) did not show significant differences among the treatments, indicating uniform crop establishment across the experimental plots. However, plant height was significantly influenced by the nutrient management practices. Maximum plant height was recorded in treatment T₉ (50% RDF + 50% RDN through FYM, vermicompost, and poultry manure) and T₅ (25% RDF + 75% RDN through the same organic combination), reflecting the positive impact of combined organic and inorganic nutrient sources on vegetative growth. The similar result was reported by Lodhi *et al.,* (2024).The number of tillers per square meter was significantly higher under T₂ (100% RDN through FYM), with 361.33 tillers, indicating that FYM promoted early and vigorous vegetative development. The similar result was reported by Kumar and Kumar (2025). Days to 50% flowering were earliest in T₉ (68.67 DAS), suggesting that integrated nutrient application enhanced physiological development and reproductive transition. Similarly, the crop attained maturity earlier under treatments T₇ and T₈ (116.33 DAS), which included vermicompost and poultry manure, respectively. This indicates that organic manures might have contributed to faster crop development due to improved soil health and nutrient availability. The similar result was reported by Singh *et al.,* (2024). The yield-attributing characters were positively affected by the application of INM treatments. Spike length was maximum in T₈ (23.00 cm), indicating the beneficial role of poultry manure in spike development. The number of spikelets per spike were highest in T₉ (24.07), followed by T₃, showing the advantage of balanced nutrient supply from organic-inorganic combinations. The maximum number of grains per spike were recorded in T₂ (54.87), which can be attributed to the slow and continuous nutrient release pattern of FYM. T₃ (100% RDN through vermicompost) produced the highest grain weight per spike (4.30 g), indicating better assimilate translocation under vermicompost-based nutrition. The similar result found by Verma *et al.,* (2022). Test weight varied slightly among treatments, with the highest value in T₄ (46.33 g) and the lowest in T₉ (43.67 g), but the differences were statistically non-significant, implying minimal effect of nutrient sources on seed weight. Significant differences were observed in the yield. A similar finding was reported by Khan *et al.*, (2018). The highest biological yield (56.22 q ha⁻¹) was recorded in T₅, followed by T₉ and T₇, which reflects the overall improvement in crop productivity due to integrated nutrient use. Similarly, T₅ also registered the highest grain yield (45.72 q ha⁻¹) and straw yield (101.94 q ha⁻¹), establishing its superiority among all treatments in terms of yield performance. These observations are consistent with the findings of Chittimothu (2022). The harvest index was maximum in T₇ (58.15%), which signifies higher efficiency of the plant in translocation photosynthesis toward grain formation, especially under vermicompost-based nutrition. These findings are consistent with those reported by Tabassum *et al.,* (2024)

**Table 1:** Effect of integrated nutrient management on growth parameters of wheat.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments Details** | **Initial plant polpulation (meter square)** | **Plant height (cm)** | **Number of tillers (meter square)** | **Days to maturity** |  **Days to 50% flowering** |
| **30 DAS** | **60 DAS** | **90 DAS** | **Harvest stage** |
|  |  |  |  |  |  |  |  |  |
| T₀ - Control | 28.000 | 20.067 | 71.600 | 90.933 | 92.200 | 163.000 | 117.333 | 73.333 |
| T₁ - 100% RDF (150 kg N + 60 kg P₂O₅ + 50 kg K₂O ha⁻¹) | 34.333 | 20.400 | 70.233 | 98.067 | 97.533 | 279.000 | 117.333 | 73.000 |
| T₂ - 25% RDF + 75% RDN through FYM | 33.333 | 22.000 | 62.933 | 100.067 | 99.800 | 361.333 | 117.333 | 71.000 |
| T₃ - 25% RDF + 75% RDN through Vermicompost | 39.000 | 23.467 | 66.200 | 99.967 | 99.133 | 263.667 | 117.667 | 70.667 |
| T₄ - 25% RDF + 75% RDN through Poultry Manure | 39.000 | 20.200 | 67.633 | 95.133 | 97.000 | 277.667 | 118.000 | 73.333 |
| T₅ - 25% RDF + 75% RDN through ⅓ FYM + ⅓ Vermicompost + ⅓ Poultry Manure | 34.667 | 23.933 | 65.833 | 100.733 | 101.433 | 282.333 | 116.667 | 70.667 |
| T₆ - 50% RDF + 50% RDN through FYM | 40.667 | 22.200 | 67.733 | 93.467 | 99.933 | 285.000 | 116.667 | 69.333 |
| T₇ - 50% RDF + 50% RDN through Vermicompost | 37.000 | 22.200 | 60.667 | 97.267 | 99.400 | 267.333 | 116.333 | 70.000 |
| T₈ - 50% RDF + 50% RDN through Poultry Manure | 40.000 | 22.767 | 68.133 | 95.067 | 99.533 | 300.667 | 116.333 | 69.333 |
| T₉ - 50% RDF + 50% RDN through ⅓ FYM + ⅓ Vermicompost + ⅓ Poultry Manure | 36.000 | 22.667 | 69.867 | 101.400 | 103.733 | 331.333 | 116.667 | 68.667 |
| C.D. | 6.339 | 2.175 | 2.971 | 3.655 | 3.047 | 38.210 | 0.868 | 2.013 |
| SE(m) | 2.117 | 0.726 | 0.992 | 1.221 | 1.018 | 12.761 | 0.290 | 0.672 |
| SE(d) | 2.994 | 1.027 | 1.403 | 1.727 | 1.439 | 18.047 | 0.410 | 0.951 |
| C.V. | 10.130 | 5.722 | 2.562 | 2.175 | 1.781 | 7.862 | 0.429 | 1.641 |

**Table 2:** Effect of integrated nutrient management on yield attributes ayield parameters of wheat.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Spike length (cm)** | **Number of spikelets per spike** | **Number of grain per spike** | **Grain weight(gram)** | **Test weight(gram)**  | **Bio mass(Kg. per hectare)** | **Grain yield(Quintal per hectare)** | **Straw yield(Quintal per hectare)** | **Harvest index(%)**  |
|  |  |  |  |  |  |  |  |  |  |
|  |
| T₀ - Control | 9.600 | 23.267 | 46.133 | 3.700 | 44.667 | 36.253 | 18.947 | 20.943 | 50.313 |
| T₁ - 100% RDF (150 kg N + 60 kg P₂O₅ + 50 kg K₂O ha⁻¹) | 7.300 | 10.333 | 50.933 | 3.467 | 45.667 | 68.610 | 26.947 | 35.000 | 50.307 |
| T₂ - 25% RDF + 75% RDN through FYM | 19.533 | 8.267 | 54.867 | 3.933 | 45.333 | 60.780 | 37.890 | 38.223 | 49.880 |
| T₃ - 25% RDF + 75% RDN through Vermicompost | 9.733 | 23.733 | 43.133 | 4.300 | 44.000 | 75.000 | 42.110 | 42.890 | 46.347 |
| T₄ - 25% RDF + 75% RDN through Poultry Manure | 9.133 | 10.633 | 51.467 | 3.600 | 46.333 | 98.887 | 43.890 | 51.663 | 48.990 |
| T₅ - 25% RDF + 75% RDN through ⅓ FYM + ⅓ Vermicompost + ⅓ Poultry Manure | 22.933 | 8.267 | 54.367 | 3.500 | 44.667 | 101.943 | 45.720 | 56.220 | 45.217 |
| T₆ - 50% RDF + 50% RDN through FYM | 9.233 | 22.267 | 45.533 | 4.067 | 45.333 | 63.887 | 34.113 | 29.777 | 56.917 |
| T₇ - 50% RDF + 50% RDN through Vermicompost | 10.067 | 10.400 | 44.933 | 3.933 | 45.000 | 104.720 | 48.943 | 32.447 | 58.150 |
| T₈ - 50% RDF + 50% RDN through Poultry Manure | 23.000 | 9.733 | 51.733 | 3.800 | 44.000 | 105.277 | 39.110 | 42.500 | 51.823 |
| T₉ - 50% RDF + 50% RDN through ⅓ FYM + ⅓ Vermicompost + ⅓ Poultry | 10.133 | 24.067 | 52.600 | 4.000 | 43.667 | 92.443 | 44.887 | 46.220 | 49.037 |
|  Manure |  |  |  |  |  |  |  |  |  |
| C.D. | 1.087 | 1.882 | 2.138 | 0.324 | N/A | 25.725 | 11.367 | 15.603 | 6.830 |
| SE(m) | 0.363 | 0.629 | 0.714 | 0.108 | 1.084 | 8.592 | 3.796 | 5.211 | 2.281 |
| SE(d) | 0.513 | 0.889 | 1.010 | 0.153 | 1.532 | 12.151 | 5.369 | 7.370 | 3.226 |
| C.V. | 4.811 | 7.211 | 2.495 | 4.895 | 4.183 | 18.422 | 17.188 | 22.800 | 7.793 |

**Conclusion**

The findings of the present study clearly demonstrate the beneficial effects of Integrated Nutrient Management (INM) on enhancing crop growth and yield of wheat (*Triticum aestivum* L.) under the agro-climatic conditions of Agra. Among the all treatments, T₅ (25% RDF + 75% RDN through equal parts of FYM, vermicompost, and poultry manure) proved most effective in enhancing grain yield, straw yield, biological yield, and important growth indicators such as plant height, number of tillers These findings affirm that integrating organic and inorganic nutrient sources provides a sustainable and effective strategy for increasing in yield. Therefore, adoption of INM practices can be suggested for improving agricultural productivity while maintaining soil fertility and long-term sustainability.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript

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