

Influence of integrated nutrient supply system comprising inorganic fertilizers and organic manures on growth and yield of wheat (*Triticum aestivum* L.) crop

ABSTRACT

Aim: To study the influence of integrated nutrient supply system, comprising inorganic fertilizers and organic manures on growth and yield of wheat (*Triticum aestivum* L.) crop.

Study design: The field experiment was conducted in randomized block design (RBD).

Place and duration of study: A field experiment was conducted at the research farm of Abhilashi University Chail chowk Mandi in 2022-23 with the concept of Study the influence of integrated nutrient supply system, comprising inorganic fertilizers and organic manures in wheat (*Triticum aestivum* L.) crop.

Methodology: The experiment was laid out in randomized block design with three replications. There are eight treatments of integrated nutrient management viz., T₁- Absolute control, T₂-125% NPK, T₃-100% RDN+ 25% N through vermicompost, T₄-75% RDN + 25% N through vermicompost, T₅-50% RDN + 25% N through vermicompost + Biofertilizer (*Azotobactor*), T₆-75% RDN + Biofertilizer (*Azotobactor*), T₇-75% RDN + *Azotobactor* + PSB (*Phosphate Solubilizing Biofertilizer*), T₈-75% NPK + ZnSO₄ @ 25 kg/ha + *Azotobactor*.

Results: The highest growth of wheat crop was achieved by adopting nutrient supply system through synthetic fertilizer under treatment T₂-125% NPK which was significantly at par with 50% RDN+ 25% N through vermicompost+ 25% N through Biofertilizer (*Azotobactor*), which proved significantly superior to rest of the treatments. The minimum value of growth parameter was recorded under T₁-Absolute control. Result revealed that higher yield attributes viz. No. of effective tillers, Spike length, No. of spike, Grain per spike, test weight, were recorded under T₂-125% NPK followed by 50% RDN+ 25% N through vermicompost+ 25% N through Biofertilizer (*Azotobactor*) and lowest were recorded under T₁- Absolute control. Yield parameter viz. grain yield, straw yield, biological yield was highest recorded under T₂-125% NPK and lowest were recorded T₁- Absolute control.

Conclusion: On the basis of one season study, it can be safely concluded that the application of integrated nutrient supply system 50% RDN+ 25% N through vermicompost+ 25% N through Biofertilizer (*Azotobactor*) gave similar result as 125% NPK in terms of growth and yield.

Keywords: *Azotobactor*, Dry matter, INM, Wheat, RDN, vermicompost.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) $2n = 42$ being a major cereal crop has been cultivated in India and belong to family poaceae, which account for about 60 percent of world's human energy requirement. Wheat is a key staple food that provides around 20 percent of protein and calories consumed worldwide. Wheat contributes more calories (20%) and more protein (11%) to the world's diet than any other food crop. Demand for wheat is projected to continue to grow over the coming decades, particularly in developing in world to feed an increasing population and with wheat being a preferred food, continuing to account for a substantial share of human energy needs in 2050 (**Anonymous, 2016**). It is nutritious, easy to stored, transport and can be processed into various type of food.

Rapid economic and income growth, urbanization, and globalization are leading to dramatic dietary shifts, especially in Asia as consumer are increasing their consumption of wheat products (**Pingali, 2007**). Wheat production needs to increase to meet the combined growing population and expanding demand by the middle of this century (**Tilman et al. 2011**). Currently, wheat yield grains are estimated to be 0.9% per year, much less than 1.5% per year, which is required to meet the projected 60% increase in global production needed by 2050 (**Anonymous, 2016**). A factor which increases the growth and development of wheat crop, plant nutrients are crucial. It is highly responsive to applied nutrient through various sources of integrated nutrient management for proper fertility management optimizing the productivity of wheat crop. The concept of Integrated Nutrient Management should be followed to prevent severe health hazards and to protect the environment. Integrated Nutrient Management refers to combination of all possible sources of nutrients like organic sources inorganic sources and biological sources or components in a judicious way for obtaining an ecologically sound environment and economically optimal farming system. This may be achieved through combined us of all possible sources nutrients and their scientific management for optimum growth, yield and quality of different cropping systems (**Patel et al.2017**) and (**Gupta et al. 2011**). Continuous application of organic manures year after year improves physical and chemical conditions by providing a favorable soil structure enhance soil cation exchange capacity, increase the quality and availability of plant nutrition increase humus content, and providing the substrate for microbial activity. Combined application of organic and inorganic nutrients to the field not only improves yield and productivity but also tends to preserve the fertility level of soil (**Hedge, 1998**).The INM strategy is focused on preserving the supply of plant nutrition to achieve a certain degree of crop production by

cohesively maximizing the benefits of all possible plant nutrition sources, relevant to each crop trend and farming situation (Kaushik et al. 2012). Integrated use of organic and inorganic nutrient sources helps in gaining sustainable yield and improved soil quality for enhanced production.

Organic manure inclusion controls nutrient absorption, positively affects growth, enhance soil quality (physical, chemical, and biological) and generates synergistic effects on crops (Singh et al. 2007). The uptake of nutrients by any crop depends largely on plant output of biomass. However, the accumulation of various nutrients inside the plant system often influences their overall uptake (Bajpai et al. 2006). Organic matter like FYM has supplied available nutrients to the plants provide favorable soil environment and increase water holding capacity of soil for longer time. Also reported that soil density undergoes greater reduction with the use of FYM than chemical fertilizers. Application of FYM @ 10 and 20 tonnesha⁻¹ increased the grain yield and the total N P and K uptake in wheat crop.

2. MATERIAL AND METHODS

Study area

The current study was carried out at the Agriculture Farm, School of Agriculture, Abhilashi University Mandi, Himachal Pradesh, India, which is situated at 77° East longitude and 31° North longitude and has an altitude of 1500 meters, during the *rabi* season of 2022-23. The soil of the experimental field was slightly acidic in reaction, high in EC, high in organic carbon.

Table- .1 Initial chemical parameters of the experimental soil

| Sr. No. | Particular | Content |
|---------|--|---------|
| 1 | pH (1:2.5, soil: water suspension) | 5.4 |
| 2 | Electrical conductivity (dSm ⁻¹) (1:2.5 soil: water extract) | 0.30 |
| 3 | Organic carbon (%) | 0.32 |
| 4 | Available N (kg/ha) | 240 |

| | | |
|----------|---------------------|-------|
| 5 | Available P (kg/ha) | 16.12 |
| 6 | Available K (kg/ha) | 230 |

Experiment details

These treatments were replicated three times following randomized block design. The field experiment was carried out eight treatments of integrated nutrient management as T₁- Absolute control, T₂-125% NPK, T₃-100% RDN+ 25% N through vermicompost, T₄-75% RDN + 25% N through vermicompost, T₅-50% RDN + 25% N through vermicompost + Biofertilizer (*Azotobactor*), T₆-75% RDN + Biofertilizer (*Azotobactor*), T₇-75% RDN + *Azotobactor* + *PSB* (*Phosphate Solubilizing Biofertilizer*), T₈-75% NPK + ZnSO₄ @ 25 kg ha⁻¹ + *Azotobactor*. Recommended dose of N, P and K for wheat was 120:60:40 kg ha⁻¹ respectively. Full quantities of P and K fertilizers were given at the time of sowing. Nitrogen was applied as basal and two splits at first and second irrigation.

Observations recorded

Observations include plant height(cm), no. of tillers(m⁻²), dry matter accumulation (g m⁻²), no. of effective tillers(m⁻²), spike length (cm), no. of spikes (m⁻²), grains per spike⁻¹, test weight(g), Grain yield (q ha⁻¹), straw yield (q ha⁻¹), biological yield (q ha⁻¹) and harvest index (%) of wheat a periodic interval of 30 days.

Statistical Analysis

The data recorded from the field was statistically analysed through the analysis of variance method and treatment means were compared following critical differences (CD) suggested by **Gomez and Gomez (1984)** for significance at 5%. The seed of oat was sown in each plot in second week of November using 100 kg ha⁻¹. Equal amount of water was supplied to every plot at the time of irrigation.

3. RESULTS AND DISCUSSION

3.1 Plant height (cm)

At 30 days after sowing, the different treatments had no discernible effect on the plant height; however, at 60, 90, and harvest, the plant height differed significantly as a result of the different treatment applications. The integration of T₂(125% NPK) at 60, 90 DAS and at maturity recorded the maximum plant height, statistically comparable to

treatment T₅[50% RDN + 25% N through vermicompost + 25% N through Biofertilizer (Azotobactor)]. On the other hand, treatment T₁ (Absolute control) produced the lowest plant height. This may have happened because the plants were able to absorb more water and nutrients due to the favourable conditions created in the root zone. Consequently, this enhanced the metabolic process and more effectively released the produced carbohydrates into amino acids and proteins. Consequently, the wheat plants displayed morphological alterations, accelerated cell division and elongation, and grew taller. Ghosh et al. (2003) observed findings that were similar.

Table 2. Effect of integrated nutrient management on plant height (cm) of wheat crop

| Sr. No | Treatments | Plant height (cm) | | | |
|----------------|--|-------------------|-----------|-----------|------------|
| | | At 30 DAS | At 60 DAS | At 90 DAS | At Harvest |
| T ₁ | Absolute control (No use of fertilizer and chemicals) | 14.51 | 48.21 | 61.21 | 63.98 |
| T ₂ | 125% NPK | 17.68 | 69.33 | 82.33 | 90.23 |
| T ₃ | 100% RDN+ 25% N through vermicompost | 16.88 | 63.45 | 75.45 | 82.22 |
| T ₄ | 75% RDN+ 25% N through vermicompost | 16.52 | 60.83 | 72.83 | 75.03 |
| T ₅ | 50% RDN+ 25% N through vermicompost+ 25% N through Biofertilizer (Azotobactor) | 17.05 | 67.83 | 80.83 | 88.55 |
| T ₆ | 75% RDN+ 25% N through biofertilizer (Azotobactor) | 15.04 | 53.17 | 65.17 | 67.87 |
| T ₇ | 75% RDN + Azotobactor + PSB (Phosphate Solubilizing Biofertilizer) | 16.32 | 58.20 | 71.20 | 73.66 |
| T ₈ | 75% RDN + ZnSO ₄ @ 25 kg/ha+ Azotobactor | 15.42 | 55.62 | 68.62 | 72.11 |
| | SE (m) | 0.75 | 1.04 | 1.18 | 1.46 |
| | C.D. | NS | 3.21 | 3.61 | 4.49 |

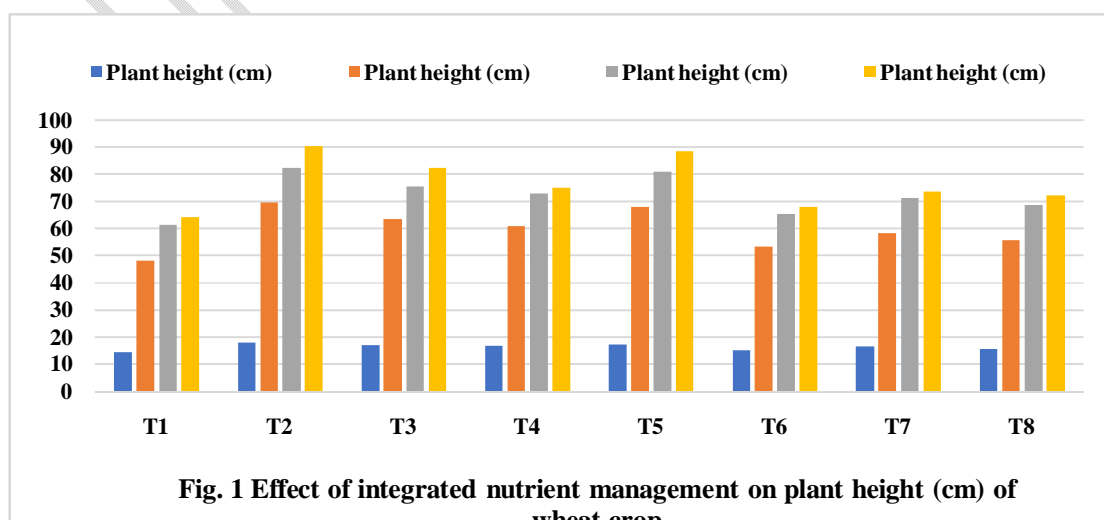


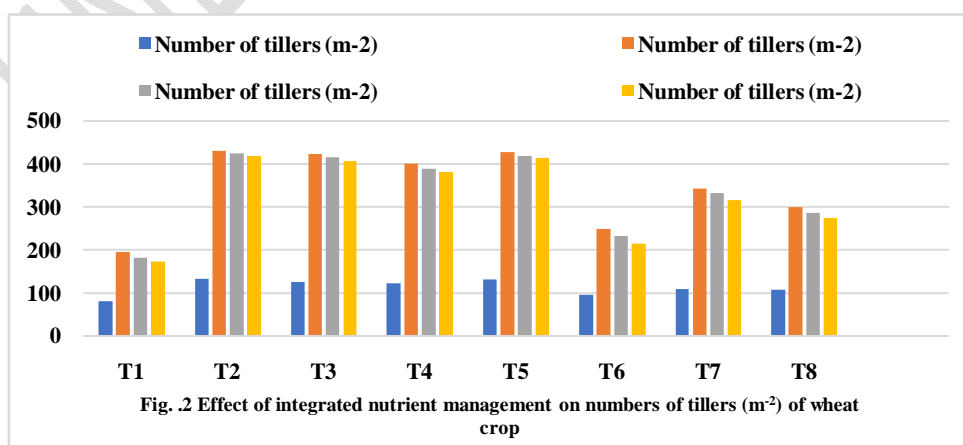
Fig. 1 Effect of integrated nutrient management on plant height (cm) of wheat crop

3.2 Number of tillers(m⁻²)

Tillers were determined to be non-significant at 30 DAS during the investigation. But in treatment T₂ (125% NPK), the maximum number of wheat crop tillers—at 60, 90, and at harvest were noted which was statistically comparable, with treatment T₅ [50% RDN + 25% N via vermicompost + 25% N via biofertilizer (Azotobactor)]. Conversely, under treatment T₁ (Absolute control), the fewest number of tillers was noted. The result concluded that different nutrient management in wheat crop had positive effect on number of tiller due to higher availability of nutrient in the soil. **Panday et al. (2005)** found a similar result.

Table- 3 Effect of integrated nutrient management on number of tillers (m⁻²) of wheat crop

| S.N. | Treatments | Number of tillers (m ⁻²) | | | |
|----------------|--|--------------------------------------|-----------|-----------|------------|
| | | At 30DAS | At 60 DAS | At 90 DAS | At Harvest |
| T ₁ | Absolute control | 76.53 | 173.78 | 195.64 | 182.32 |
| T ₂ | 125% NPK | 106.26 | 418.82 | 431.73 | 426.11 |
| T ₃ | 100% RDN+ 25% N through vermicompost | 100.24 | 408.15 | 424.45 | 415.42 |
| T ₄ | 75% RDN+ 25% N through vermicompost | 96.87 | 381.77 | 401.36 | 389.24 |
| T ₅ | 50% RDN+ 25% N through vermicompost+ 25% N through Biofertilizer (Azotobactor) | 104.62 | 415.21 | 428.58 | 419.36 |
| T ₆ | 75% RDN+ 25% N through biofertilizer (Azotobactor) | 79.98 | 215.03 | 249.47 | 233.64 |
| T ₇ | 75% RDN + Azotobactor + PSB (Phosphate Solubilizing Biofertilizer) | 91.96 | 316.65 | 343.71 | 333.58 |
| T ₈ | 75% RDN + ZnSO ₄ @ 25 kg/ha+ Azotobactor | 84.36 | 274.34 | 299.27 | 287.09 |
| | <i>SEm</i> ± | 7.512 | 2.304 | 1.692 | 2.853 |
| | <i>C.D</i> | NS | 7.057 | 5.182 | 8.736 |

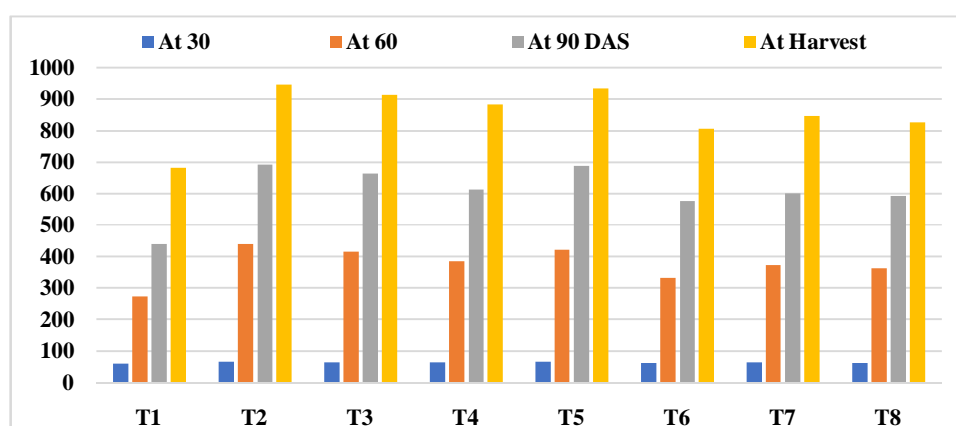


3.3 Dry matter accumulation (g m⁻²)

At 30 days after sowing (DAS), the effect of integrated nutrient management on dry matter accumulation was determined to be non-significant. At 60, 90, and harvest, it was discovered that the integration of treatment T₂(125% NPK) had the maximum dry matter accumulation. At 60, 90 DAS, and the wheat crop's harvest stage, treatment T₂ was discovered to be on par with treatment T₅[50% RDN+ 25% N through vermicompost+ 25% N by biofertilizer (Azotobactor)] during investigation. On the other hand, treatment T₁(Absolute control) showed the least amount of dry matter accumulation. This may be the outcome of plants having more food supplies available for synthesis when they have more tillers and height. Increased accessibility and availability of nourishment could be the reason for this. These results are in good agreement with those of **Singh and Yadav 2006**.

| Sr. No | Treatments | At 30 DAS | At 60 DAS | At 90 DAS | At Harvest |
|--------|--|-----------|-----------|-----------|------------|
| T1 | Absolute control (No use of fertilizer and chemicals) | 79.12 | 270.98 | 440.26 | 680.41 |
| T2 | 125% NPK | 120.55 | 439.71 | 690.18 | 944.40 |
| T3 | 100% RDN+ 25% N through vermicompost | 111.96 | 414.93 | 663.33 | 912.18 |
| T4 | 75% RDN+ 25% N through vermicompost | 104.56 | 385.07 | 611.48 | 882.50 |
| T5 | 50% RDN+ 25% N through vermicompost+ 25% N through Biofertilizer (Azotobactor) | 116.84 | 421.24 | 686.68 | 933.67 |
| T6 | 75% RDN+ 25% N through biofertilizer (Azotobactor) | 85.07 | 330.18 | 575.72 | 805.23 |
| T7 | 75% RDN + Azotobactor + PSB (Phosphate Solubilizing Biofertilizer) | 97.53 | 370.84 | 600.27 | 844.55 |
| T8 | 75% RDN + ZnSO ₄ @ 25 kg/ha+ Azotobactor | 91.39 | 360.52 | 590.59 | 826.07 |
| | C.D | NS | 20.372 | 20.142 | 29.239 |
| | <i>SEm</i> ± | 9.351 | 6.652 | 6.577 | 9.547 |

Table 4. Effect of nutrient management dry matter accumulation of wheat crop.



2. Yield studies:

2.1 No. of effective tillers (m⁻²)

Among the various nutrient management treatments, treatment T₂ (125% NPK) produced the maximum number of productive tillers, and it was statistically comparable to treatment T₅[50% RDN + 25% N via vermicompost + 25% N via biofertilizer (Azotobactor)]. On the other hand, treatment T₁ (Absolute control) showed the fewest effective tillers due to lack of nutrient supply through organic and inorganic fertilizer. An appropriate nutrition supply may lead to increased interception of photosynthetically active radiations and dry matter accumulation, which would account for much higher effective tiller density in high nutritional levels. More productive tillers were produced in nutrient-rich treatments due to increased tillering and better plant development brought about by higher nutrition. Higher nutrient levels and higher tiller density have also been reported by other researchers **Nehra et al. (2000)**.

2.2 Spike length (cm)

Table 5 and Figure 4 shows that wheat crop with the longest spike length was observed in treatment T₂ (125%NPK), which was similar to treatment T₅[50% RDN + 25% N via vermicompost + 25% N via biofertilizer (Azotobactor)]. On the other hand, wheat crop spike length was lowest in treatment T₁ (absolute control). This may be the result of the plant being able to absorb the maximum amount of NPK from the organic source thanks to its well-developed root system. Second, adding chemical fertilizer lengthens the spike and is positively connected with the yield of grains and straw. It also increases the quantity of photosynthesis generated and the transfer of the source to the sink, leading to an increase in the length of spikes (cm). Corresponding findings have also been published by **Verma et al. (2014)**.

2.3 Grain spike⁻¹

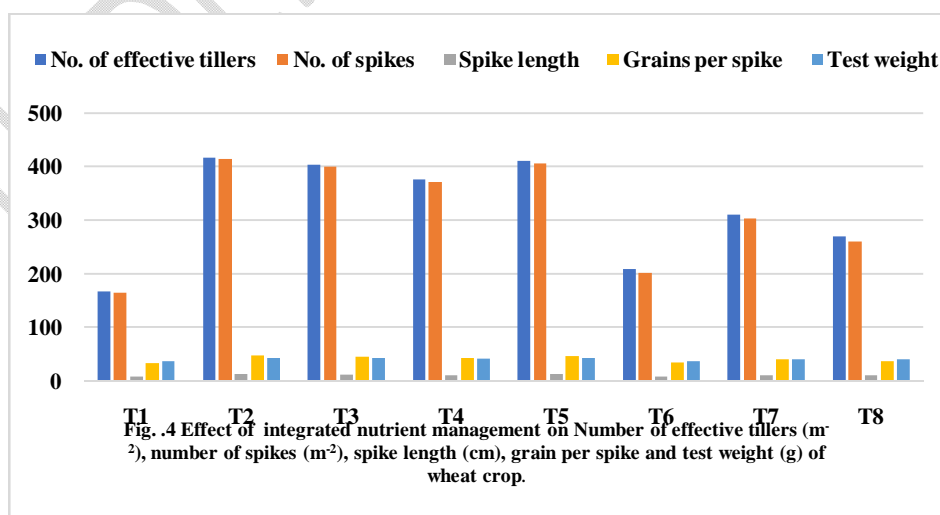
The data from the Table 5 and Figure 4 shows that different nutrient management treatments had no significant effect on grain per spike during the investigation. However, treatment T₂ (125% NPK) had showed the highest number of grains per spike but undertreatment T₁ (Absolute control) had lowest number of grains spike⁻¹. This could be because the number of grains per spike is one of the specific traits of a crop variety, and the number of grains per spike was less affected by changes in the nutrient supply or an increased nutrient supply. **Verma et al. (2014)** have also published similar results.

2.4 Test weight (g)

According to the information in Table 5 and Figure 4, there was no discernible effect of the various nutrient management strategies on grain weight during the study. However, among the various treatments, treatment T₂ (125% NPK) had the highest test weight. Nonetheless, treatment T₁ (Absolute control) showed the lowest 100-grain weight of wheat crop. During the crop's growth period, a higher dose of NPK was administered, which raised the test weight but not significantly.

Table.5 Effect of integrated nutrient management on Number of effective tillers (m⁻²), spike length (cm), grain per spike and test weight (g) of wheat crop.

| Sr. No. | Treatments | No. of effective tillers (m ⁻²) | Spike length (cm) | Grains per spike | Test weight (g) |
|----------------|---|---|-------------------|------------------|-----------------|
| T ₁ | Absolute control | 166.57 | 7.38 | 33.10 | 37.30 |
| T ₂ | 125% NPK | 415.88 | 13.20 | 48.53 | 42.78 |
| T ₃ | 100% RDN+ 25% N through vermicompost | 402.18 | 12.25 | 44.90 | 42.25 |
| T ₄ | 75% RDN+ 25% N through vermicompost | 375.66 | 11.12 | 42.70 | 41.60 |
| T ₅ | 50% RDN+ 25% N through vermicompost+25%N through Biofertilizer(Azotobactor) | 410.62 | 13.05 | 46.30 | 42.47 |
| T ₆ | 75% RDN+ 25% N through biofertilizer (Azotobactor) | 208.58 | 8.09 | 35.13 | 37.53 |
| T ₇ | 75% RDN +Azotobactor + PSB(Phosphate Solubilizing Biofertilizer) | 310.81 | 10.85 | 40.01 | 40.37 |
| T ₈ | 75% RDN + ZnSO ₄ @ 25 kg/ha+Azotobactor | 268.75 | 9.81 | 37.17 | 40.00 |
| | C.D. | 15.397 | 0.493 | NS | NS |
| | SEm± | 5.027 | 0.161 | 4.132 | 1.516 |



6 Grain yield (q ha⁻¹)

Wheat crops treated with integrated nutrient management strategies demonstrated a considerable impact on grain yield, as seen by Table 5 and Figure 5. The treatment T₂ (125% NPK) produced the highest grain yield of the wheat crop, which was statistically comparable to treatment T₅[50% RDN + 25% N via vermicompost + 25% N via biofertilizer (Azotobactor)]. However, treatment T₁ (Absolute control) produced the lowest grain yield.

The main essential nutrient provided to plants is NPK, which is essential to photosynthesis. More nitrogen was added, increasing yield, as a result of the high dose of NPK, which sped up photosynthesis and generated a significant amount of dry matter and assimilates that were transported to fill the seeds. It is also well known that higher fertilizer application amounts lead to improvements in the capacity and intensity of soil nitrogen supply. Thus, higher fertility utilization and enhanced nutrient uptake promoted yield characteristics and plant development, which in turn promoted the production of grains and straw. The observations supported the findings of Wang et al (2012).

7 Straw yield (q ha⁻¹)

When wheat was treated with integrated nutrition management strategies, the results were shown in Table 5 and Figure 5, which indicated a considerable impact on straw yield. The treatment T₂ (125% NPK) produced the highest straw yield of wheat crop, which was statistically comparable to treatment T₅[50% RDN + 25% N via vermicompost + 25% N via biofertilizer (Azotobactor)]. Conversely, the treatment T₁ (Absolute control) produced the lowest straw yield. The lowest straw yield was seen in the control group because the soil was unable to provide the plants with necessary nutrients due to the lack of applied fertilizers. Reduced nutrient availability, particularly in the early phases, caused the crop to grow slowly at initially and had poor root formation. The crop growing season was marred by this poor growth, which led to a much-decreased yield of straw. Similar findings were also reported by Shahi et al. (2016), who showed that higher fertilizer dose treatments led to higher straw yields.

8 Biological yield (q ha⁻¹)

Among the various treatments, T₂ (125% NPK) produced the highest biological yield of wheat crop, which was statistically comparable to treatment T₅[50% RDN + 25% N via vermicompost + 25% N via biofertilizer (Azotobactor)]. In contrast, treatment T₁ (Absolute control) produced the lowest biological yield. Increasing NPK application resulted in taller plants, higher grain output, more tillers per unit, and total dry matter, all

of which boosted biological yield. Numerous studies have shown that biological yield rose when the NPK rate increased (**Ghobadi et al. 2010**).

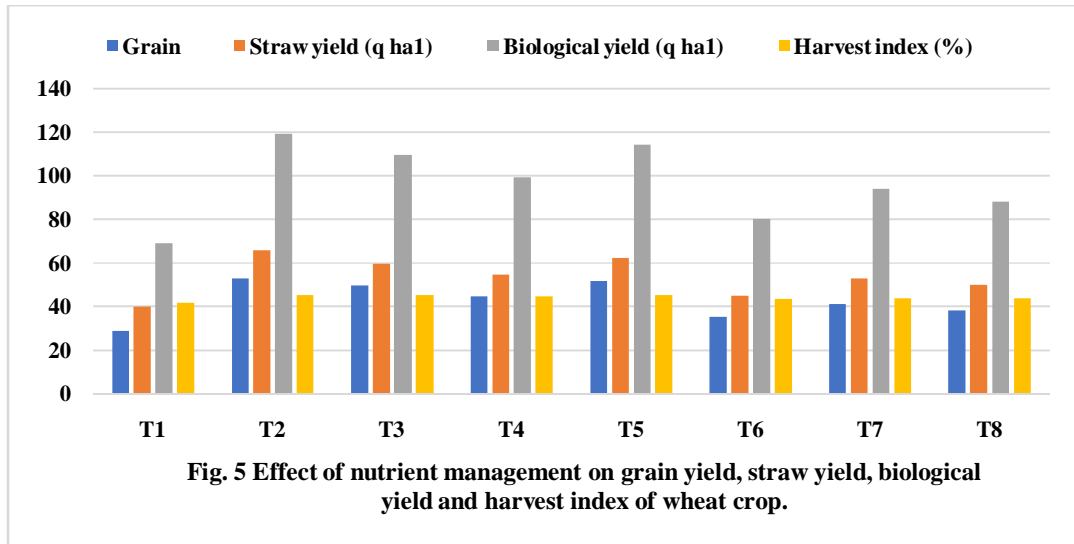
9 Harvest index (%)

The results indicate that treatment T₂ (125% NPK) produced the highest harvest index, while treatment T₁ (Absolutecontrol) produced the lowest harvest index. Seed development is slowed down and grows smaller when the harvest index is low because fewer assimilates are being translocated from the source to the sink. Greater assimilation of the grains from the source is indicated by a high harvest index, which also signifies better fullness and development. Plant dry matter and grain weight have a strong correlation with the harvest index; both are ultimately dependent on the availability and uptake of nutrients, especially nitrogen. To a limited degree, growth and development are positively correlated with nitrogen levels. In addition, **Pandey et al. (2003)** describe similar results.

Table.6 Effect of nutrient management on grain yield, straw yield, biological yield and harvest index of wheat crop.

| Sr. No | Treatments | Grain yield (q ha ⁻¹) | Straw yield (q ha ⁻¹) | Biological yield (q ha ⁻¹) | Harvest index (%) |
|--------|--|-----------------------------------|-----------------------------------|--|-------------------|
| T1 | Absolute control | 29.01 | 40.04 | 69.05 | 42.01 |
| T2 | 125% NPK | 53.05 | 65.95 | 119.00 | 45.33 |
| T3 | 100% RDN+ 25% N through vermicompost | 49.51 | 59.78 | 109.29 | 45.09 |
| T4 | 75% RDN+ 25% N through vermicompost | 44.76 | 54.49 | 99.25 | 44.57 |
| T5 | 50% RDN+ 25% N through vermicompost+ 25%N through Biofertilizer (Azotobactor) | 51.74 | 62.40 | 114.14 | 45.30 |
| T6 | 75% RDN+ 25% N through biofertilizer (Azotobactor) | 35.24 | 45.03 | 80.27 | 43.50 |
| T7 | 75% RDN+ 25% N through biofertilizer Azotobactor + PSB (PhosphateSolubilizing Biofertilizer) | 41.07 | 52.90 | 93.97 | 43.90 |
| T8 | 75% RDN + ZnSO ₄ @ 25 kg/ha+ 25% Nthrough biofertilizerAzotobactor | 38.40 | 49.87 | 88.27 | 43.70 |
| | <i>SEm</i> ± | 0.743 | 1.376 | 1.933 | 0.902 |

| | | | | | |
|--|-----|-------|-------|------|----|
| | C.D | 2.275 | 4.213 | 5.92 | NS |
|--|-----|-------|-------|------|----|



CONCLUSION

The summary given above leads to the following conclusions: The growth and yield of the wheat crop were positively impacted by the combined application of inorganic fertilizer and organic source. The implementation of an integrated nutrition management treatment, such as 50% RDN+ 25% N through vermicompost+25%N through Biofertilizer (Azotobactor), may lead to an increase in wheat yield.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Akshay Kumar 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 manuscripts.

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