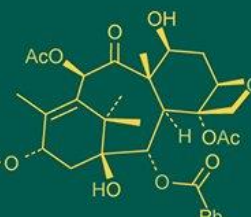
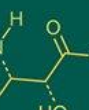
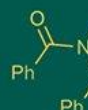
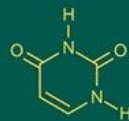
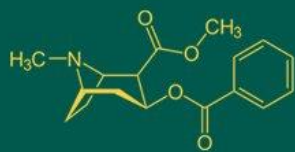


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Impact of combined organic and inorganic nutrient management on soil fertility status and productivity of wheat crop (*Triticum aestivum* L.)

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Abstract

A field experiment in titled- Impact of Combined Organic and Inorganic Nutrient Management on Soil Fertility Status and Productivity of Wheat Crop (*Triticum aestivum* L.) was conducted to evaluate the effect of integrated nutrient management on growth, yield, and yield attributes of the crop using different combinations of inorganic fertilizers and organic manures. The treatments consisted of various levels of Recommended Dose of Fertilizer (RDF) along with Farm Yard Manure (FYM), vermicompost, and poultry manure. Results revealed that integrated application of organic and inorganic sources of nutrients significantly influenced all the growth and yield parameters. Treatment T₉ (50% RDF from Nitrogen + 25% Recommended Nitrogen from FYM + 25% Recommended Nitrogen from Vermicompost) recorded the best performance. It produced the highest initial plant population (58.01 plants m⁻²), plant height (92.37 cm at harvest), dry matter accumulation (71.61 g), grain yield (4469 kg ha⁻¹), straw yield (6141 kg ha⁻¹), and harvest index (42.14). This was followed by treatment T₆ in most of the parameters. The control treatment (T₁) recorded the lowest values for all characters. The study demonstrated that the combined use of chemical fertilizers with organic manures (particularly FYM and vermicompost) resulted in better nutrient availability, improved plant growth, and higher yield through synergistic effects. Treatment T₉ proved to be the most effective and economically viable option. It can be concluded that integrated nutrient management, especially T₉, not only enhances productivity but also helps in reducing the dependency on chemical fertilizers while promoting long-term soil health and sustainability.

Keywords: Integrated nutrient management, vermicompost, FYM, grain yield, harvest index, sustainable agriculture

Introduction

Wheat (*Triticum aestivum* L.) is one of the world's most important staple crops, widely grown across diverse agro-climatic regions. India ranks as the second-largest wheat producer globally, after China, accounting for roughly 14% of total world production. In India, it serves as the second most important food grain after rice and is prized for its nutritional qualities, including a good protein content (typically 10-14% in whole wheat flour), carbohydrates, dietary fiber, B vitamins (such as thiamine and niacin), and minerals. The presence of gluten makes it particularly suitable for baked products.

Major global wheat producers include China, the European Union, India, Russia, the United States, Canada, Australia, and Pakistan. India's wheat output reached a record level of approximately 117.9 million tonnes in 2025 (harvested around June), cultivated over a substantial area, reflecting improvements in high-yielding varieties, irrigation, and management practices. Earlier estimates for the 2022-23 crop year placed production around 115-118 million tonnes.

In South Asian wheat-based rotations (often rice-wheat or maize-wheat), farmyard manure remains a widely accessible organic source. It is frequently applied to the preceding kharif crop, with residual benefits to rabi wheat. Long-term studies show that partial substitution of nitrogen through FYM can sustain or even enhance yields while improving soil organic carbon and microbial activity. For instance, integrating FYM at appropriate rates with reduced inorganic fertilizers has demonstrated comparable productivity to full chemical fertilization in various cropping systems.

Poultry manure, with its higher nutrient concentration and faster mineralization rate (e.g., quicker nitrogen release compared to FYM), serves as an effective alternative or supplement. It supplies readily available nitrogen along with phosphorus and other micronutrients. Studies indicate that combining poultry manure (e.g., 5-10 t/ha) with 75% of the recommended fertilizer dose often matches or exceeds yields from 100% inorganic fertilizers, while enhancing soil biological health.

Green manuring with legumes (e.g., *Sesbania*, cowpea, green gram, or *Leucaena* leaves) or incorporating summer legume residues adds substantial nitrogen (often 20-60 kg N/ha) and organic matter to the soil, benefiting following wheat crops. Preceding wheat with green manure crops or mulching with nitrogen-rich leaves (e.g., *Leucaena*) can reduce synthetic nitrogen requirements while maintaining productivity. These practices improve soil organic carbon, suppress weeds, and enhance microbial diversity.

For timely or late-sown wheat, basal application of fertilizers at sowing is recommended, with adjustments based on soil testing especially for potassium and micronutrients. While higher fertilizer doses have driven past yield gains, future strategies must emphasize site-specific nutrient management (SSNM), split applications, and integration of organics to minimize environmental footprints (e.g., reduced leaching and greenhouse gas emissions) and sustain soil productivity. On degraded or oxide-rich soils, banded or lower-dose applications help maintain balance.

Materials and methods

Initial Plant Populationm: At 30 days after sowing (DAS), the number of plants per meter row length was counted from three locations (designated with sticks) in each plot.

Plant height

In order to record height in centimeters (cm) at 30, 60, and 90 DAS as well as at harvest, five plants were randomly tagged in each plot. Before the ear emergence, the height was measured from the ground to the base of a fully

opened leaf, and after heading, it was measured up to the base of the ear head.

Dry weight

At 30, 60, 90 DAS, and harvest, plants were taken from two locations in each plot's second row on either side, each measuring 25 cm in length. After being sun-dried separately, the plant components were oven-dried at 70°C ± 2°C until they reached a consistent weight. The dry matter accumulation of plants per meter row length was calculated by summing the dry weight values of the plant sections.

Straw yield (kg ha⁻¹)

By deducting the grain yield from the total amount of food gathered and converting it to kilograms per hectare, the straw yield from the net-plot area was calculated.

Harvest index (HI)

The harvest index, which is determined using Donald's (1962) formula, is economic yield expressed as a percentage of biological yield.

$$HI(\%) = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Experimental finding

Initial plant Population

Table 4.1 and Figure 4.1 show the observations made on the initial plant population per m² over the experiment period. Both organic and inorganic fertilizers have a highly noticeable and reliable effect. Treatment T₉ (50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost) followed by T₆ (50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from Poultry manure) with (58.01 plants m⁻²) were significantly better than T₁ (Control) with (42.52 plants m⁻²). There was a significant difference between the application of the various treatments.

Table 4.1: Effect of different organic and inorganic source of nutrient on Plant Population of Wheat

Treatment	Initial Plant Population
T ₁ -Control	42.52
T ₂ -100% RDF from Nitrogen, Phosphorus and Potasic Fertilizers (120:60:40) kg/ha	50.03
T ₃ -100% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures	49.13
T ₄ -75% RDF from Nitrogen +25% Recommended Nitrogen from Poultry manure	55.23
T ₅ -75% RDF from Nitrogen +25% Recommended Nitrogen from press mud	52.53
T ₆ -75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost	58.11
T ₇ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures + 25% Recommended Nitrogen from pressmud	51.04
T ₈ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from Poultry manure	50.54
T ₉ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost	63.55
T ₁₀ -50% RDF from N+25% Recommended Nitrogen though Press Mud +25% Recommended Nitrogen from Poultry manure	57.51
T ₁₁ -50% RDF from Nitrogen +25% Recommended Nitrogen from Presmud +25% Recommended Nitrogen from vermicompost	60.07
T ₁₂ -50% RDF from Nitrogen +25% Recommended Nitrogen from Vermicompost +25% Recommended N from Poultry manure	52.08
SEm(±)	NS
C.D _{5%}	7.23

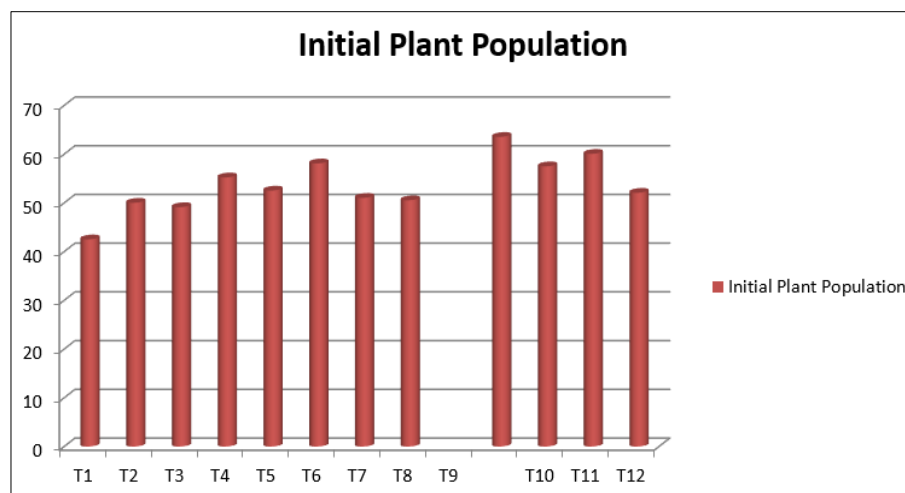


Fig 4.1: Effect of different organic and inorganic source of nutrient on Plant Population of Wheat.

Plant height

Table 4.2 and Figure 4.2 show the plant height observations that were made during the experiment period.

Both organic and inorganic fertilizers have a highly noticeable and reliable effect. T₉ (50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost) had a plant height of 21.52, 53.58, 88.70, and 92.37 cm, followed by T₆ (75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost) with 20.23, 51.87, 84.58, and 89.58 cm, which were significantly higher than T₁ (Control)

with 13.92, 42.52, 69.91, and 74.88 cm in plant height. There was no significant difference between the treatments at 30 DAS and 60, 90 DAS, and harvest.

Treatment T₉ (50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost) had the highest plant height, measuring 92.37 cm. Treatment T₆ (75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost) came in second with 89.58 cm, and treatment T₁ (Control) had the lowest height, measuring 74.88 cm.

Table 4.2: Effect of different organic and inorganic source of nutrient on Plant Height of Wheat

Treatment	Plantheight(cm)			
	30 DAS	60 DAS	90 DAS	At Harvest
T ₁ -Control	13.92	42.52	69.91	74.88
T ₂ -100% RDF from Nitrogen, Phosphorus and Potassic Fertilizers (120:60:40) kg/ha	14.69	46.93	71.38	76.38
T ₃ -100% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures	15.39	48.62	73.48	78.67
T ₄ -75% RDF from Nitrogen +25% Recommended Nitrogen from Poultry manure	16.90	49.53	76.89	81.58
T ₅ -75% RDF from Nitrogen +25% Recommended Nitrogen from press mud	17.52	50.22	75.98	80.66
T ₆ -75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost	20.23	51.87	84.58	89.58
T ₇ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures + 25% Recommended Nitrogen from pressmud	16.59	45.92	79.60	84.14
T ₈ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from Poultry manure	18.04	47.61	77.58	82.33
T ₉ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost	21.52	53.58	88.70	92.37
T ₁₀ -50% RDF from Nitrogen +25% Recommended Nitrogen though Press Mud +25% Recommended Nitrogen from Poultry manure	17.23	44.59	74.57	78.03
T ₁₁ -50% RDF from Nitrogen +25% Recommended Nitrogen from Presmud +25% Recommended Nitrogen from vermicompost	18.58	45.97	75.02	85.25
T ₁₂ -50% RDF from Nitrogen +25% Recommended Nitrogen from Vermicompost +25% Recommended N from Poultry manure	19.27	46.92	76.34	86.26
SEm(±)	NS	3.55	3.43	3.38
C.D 5%	NS	7.59	7.33	7.23

Dry Weight

Table 4.3 and Figure 4.3 show the observations made on the dry weight during the experiment period.

Both organic and inorganic fertilizers have a highly noticeable and reliable effect. T₉ (50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost) had 18.04, 58.35, 68.97, and 71.61 grams of dry weight, followed by T₆ (75% RDF from Nitrogen + 25% Recommended Nitrogen from vermicompost) with 17.37, 57.38, 64.27, and

67.91 grams of dry weight, which were significantly superior to T₁ (Control) with 13.07, 42.37, 51.29, and 55.65 grams of dry weight. At 30 DAS, there was no significant difference between the various treatments, but at 60, 90 DAS, and harvest. T₉ (50% RDF from Nitrogen + 25% Recommended Nitrogen from farm Yard Manures + 25% Recommended Nitrogen from vermicompost) had the highest dry weight (71.61 g), followed by T₆ (75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost) with 67.91 g, and T₁ (Control) had the lowest dry weight (55.65 g).

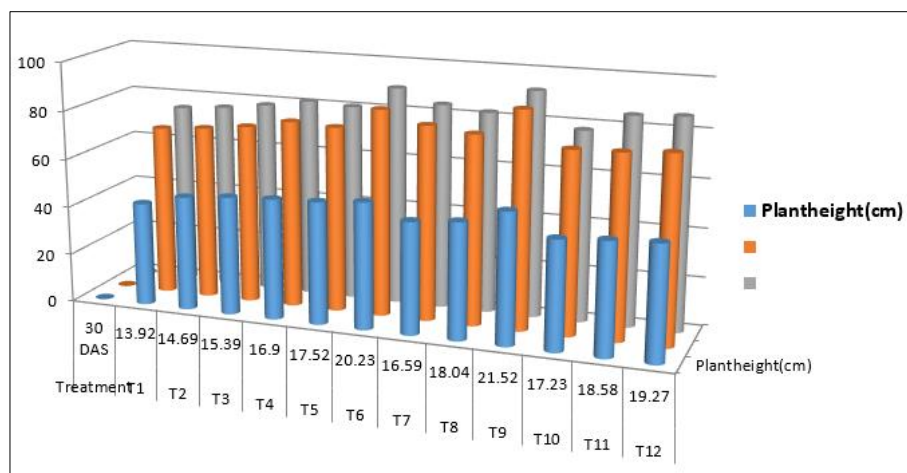


Fig 4.2: Effect of different organic and inorganic source of nutrient on Plant Height of Wheat.

Table 4.3: Effect of different organic and inorganic source of nutrient on Dry weight (g) of Wheat

Treatment	Dry weight (g)			
	30 DAS	60 DAS	90 DAS	At Harvest
T ₁ -Control	13.07	42.37	51.29	55.65
T ₂ -100% RDF from Nitrogen, Phosphorus and Potassic Fertilizers (120:60:40) kg/ha	15.05	51.25	60.58	63.47
T ₃ -100% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures	13.87	53.79	61.61	64.61
T ₄ -75% RDF from Nitrogen +25% Recommended Nitrogen from Poultry manure	15.62	55.33	63.27	65.00
T ₅ -75% RDF from Nitrogen +25% Recommended Nitrogen from press mud	15.52	56.12	63.03	65.61
T ₆ -75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost	17.37	57.38	64.27	67.91
T ₇ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures + 25% Recommended Nitrogen from pressmud	14.88	50.58	58.66	63.51
T ₈ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from Poultry manure	15.37	55.69	57.00	62.61
T ₉ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost	18.02	58.32	68.97	71.62
T ₁₀ -50% RDF from Nitrogen +25% Recommended Nitrogen though Press Mud +25% Recommended Nitrogen from Poultry manure	15.64	44.12	59.67	62.34
T ₁₁ -50% RDF from Nitrogen +25% Recommended Nitrogen from Presmud +25% Recommended Nitrogen from vermicompost	15.03	53.63	57.28	60.58
T ₁₂ -50% RDF from Nitrogen +25% Recommended Nitrogen from Vermicompost +25% Recommended N from Poultry manure	15.06	47.89	63.88	66.28
SEm(±)	NS	3.55	3.43	3.38
C.D _{5%}	NS	7.59	7.33	7.23

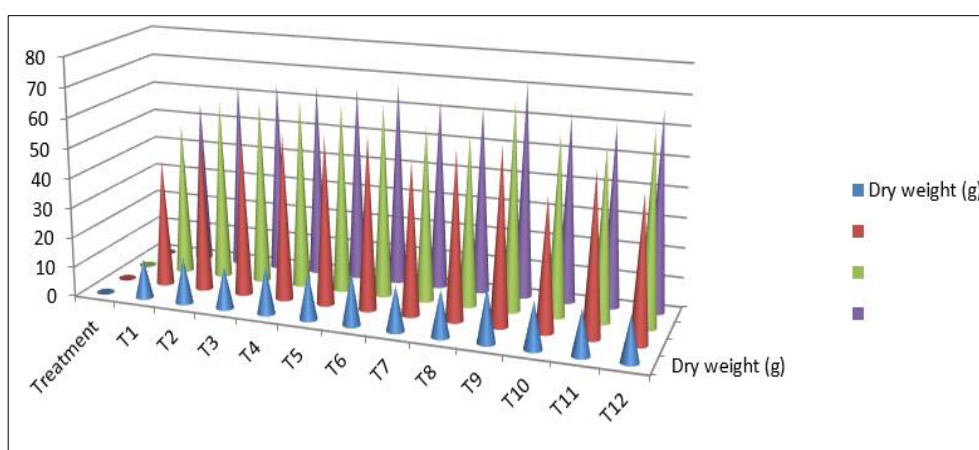


Fig 4.3: Effect of different organic and inorganic source of nutrient on Dry weight (g) of Wheat

Grain Yield, Straw yield

Table 4. 11 and Figure 4.11 show the observations on grain yield and straw yield that were made throughout the experiment period. The application of the various treatments had a significant impact on grain yield. T₉ (50% RDF from nitrogen +25% Recommended Nitrogen from farm yard

manures +25% Recommended Nitrogen from vermicompost) had the highest grain yield (4469 kg ha⁻¹), followed by T₆ (75% RDF from nitrogen +25% Recommended Nitrogen from vermicompost) with 4379 kg ha⁻¹. These treatments were significantly better than T₁ (Control) with 3874 kg ha⁻¹.

Straw yield varied significantly depending on the treatment. T₉ (50% RDF from Nitrogen +25% Recommended Nitrogen from farm yard manures +25% Recommended Nitrogen from vermicompost) had the highest yield (6141 kg ha⁻¹),

followed by T₆ (75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost) with 5700 kg ha⁻¹. These treatments were significantly higher than T₁ (Control) with 5470 kg ha⁻¹.

Table 4.11: Effect of different organic and inorganic source of nutrient on grain yield, straw yield of Wheat.

Treatment	Grain yield Kg ha ⁻¹	Straw Yield kg ha ⁻¹
T ₁ -Control	3874	5470
T ₂ -100% RDF from Nitrogen, Phosphorus and Potassic Fertilizers (120:60:40) kg/ha	3899	5578
T ₃ -100% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures	3907	5485
T ₄ -75% RDF from Nitrogen +25% Recommended Nitrogen from Poultry manure	3897	5590
T ₅ -75% RDF from Nitrogen +25% Recommended Nitrogen from press mud	3956	5639
T ₆ -75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost	4379	5700
T ₇ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures + 25% Recommended Nitrogen from pressmud	4201	5755
T ₈ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from Poultry manure	4334	6071
T ₉ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost	4469	6141
T ₁₀ -50% RDF from Nitrogen +25% Recommended Nitrogen though Press Mud +25% Recommended Nitrogen from Poultry manure	3913	5514
T ₁₁ -50% RDF from Nitrogen +25% Recommended Nitrogen from Presmud +25% Recommended Nitrogen from vermicompost	4122	5324
T ₁₂ -50% RDF from Nitrogen +25% Recommended Nitrogen from Vermicompost +25% Recommended N from Poultry manure	4210	5469
S.E.m.	1.139	2.217
C.D.	2.456	4.894

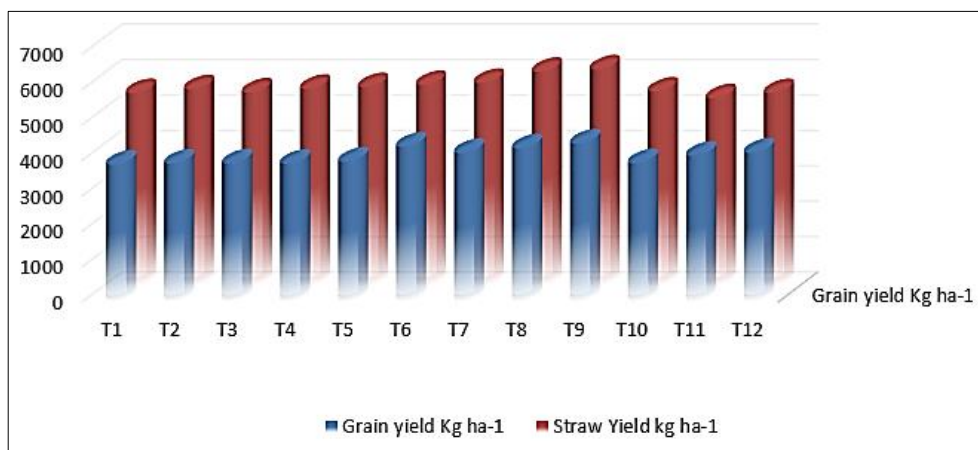


Fig 4.11: Effect of different organic and inorganic source of nutrient on grain yield, straw yield of Wheat

Harvest Index

Table 4.12 and Figure 4.12 show the Harvest index observation that was made during the experiment time. Treatment T₉ (50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost) had the highest

Harvest index of any treatment, with 42.14, followed by T₇ (50% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost) with 42.05, both of which were significantly higher than T₁ (Control) with (40.10) Harvest index.

Table 4.12: Effect of different organic and inorganic source of nutrient on Harvest Index of Wheat

Treatment	Harvest Index%
T ₁ -Control	40.11
T ₂ -100% RDF from Nitrogen, Phosphorus and Potassic Fertilizers (120:60:40) kg/ha	40.59
T ₃ -100% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures	41.68
T ₄ -75% RDF from Nitrogen +25% Recommended Nitrogen from Poultry manure	41.15
T ₅ -75% RDF from Nitrogen +25% Recommended Nitrogen from press mud	41.72
T ₆ -75% RDF from Nitrogen +25% Recommended Nitrogen from vermicompost	42.00
T ₇ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures + 25% Recommended Nitrogen from pressmud	42.05
T ₈ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from Poultry manure	41.83

T ₉ -50% RDF from Nitrogen +25% Recommended Nitrogen from farm Yard Manures +25% Recommended Nitrogen from vermicompost	42.14
T ₁₀ -50% RDF from Nitrogen +25% Recommended Nitrogen though Press Mud +25% Recommended Nitrogen from Poultry manure	41.22
T ₁₁ -50% RDF from Nitrogen +25% Recommended Nitrogen from Presmud +25% Recommended Nitrogen from vermicompost	41.54
T ₁₂ -50% RDF from Nitrogen +25% Recommended Nitrogen from Vermicompost +25% Recommended N from Poultry manure	41.15
SEm (±)	1.137
C.D 5%	2.458

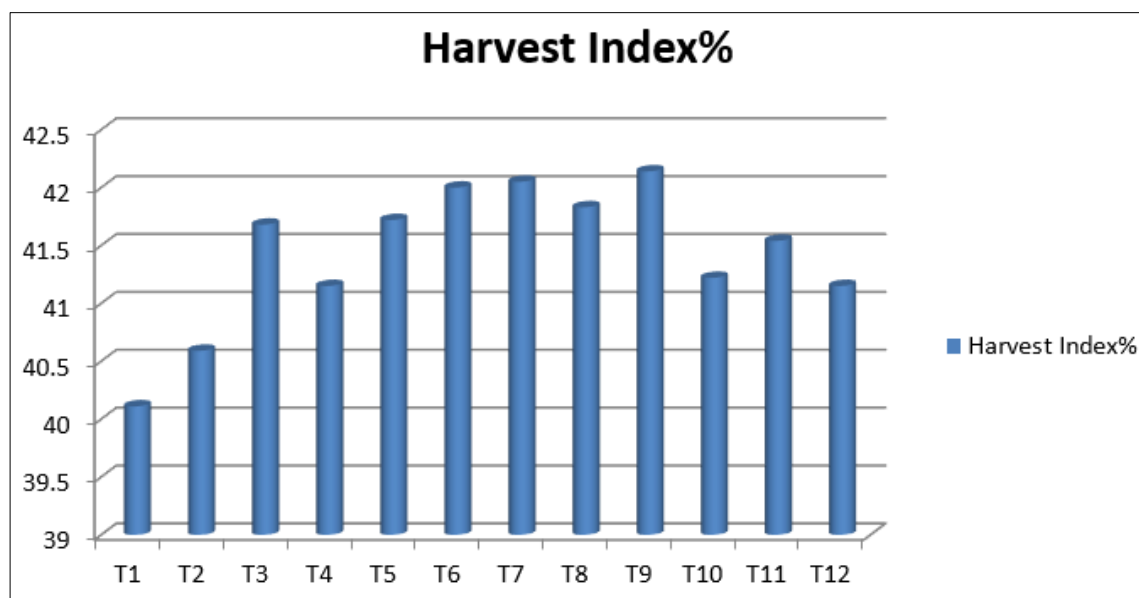


Fig 4.12: Effect of different organic and inorganic source of nutrient on Harvest Index of Wheat

Discussion

The present study demonstrated that integrated application of inorganic fertilizers with organic sources significantly influenced growth parameters, yield attributes, and overall productivity of the crop compared to the control (T₁). Among all treatments, T₉ (50% RDF from Nitrogen + 25% Recommended Nitrogen from Farm Yard Manure + 25% Recommended Nitrogen from Vermicompost) consistently recorded the highest values for most of the studied characters, followed closely by T₆.

Initial plant population was markedly improved under integrated nutrient management treatments. The significantly higher plant population in T₉ and T₆ (58.01 plants m⁻²) over the control (42.52 plants m⁻²) indicates better seedling establishment and survival. This can be attributed to the balanced and sustained supply of macro- and micronutrients, along with improved soil physical conditions provided by organic manures, which enhance root development and reduce early-stage mortality.

Plant height showed a progressive increase across growth stages, with T₉ recording the maximum height at harvest (92.37 cm), followed by T₆ (89.58 cm), compared to the control (74.88 cm). The superior performance of T₉ is likely due to the synergistic effect of inorganic nitrogen for immediate availability and organic sources (FYM and vermicompost) for slow-release nutrients, improved soil microbial activity, and better nutrient uptake. Vermicompost, in particular, is known for its high humic acid content and beneficial microbes that promote cell division and elongation. The lack of significant differences at early stages (30 DAS) suggests that treatment effects become more pronounced as the crop advances and nutrient demand increases.

Similarly, dry matter accumulation was highest in T₉ (71.61 g) followed by T₆ (67.91 g) against the control (55.65 g). Higher dry weight reflects greater photosynthetic efficiency and biomass production, resulting from enhanced leaf area, chlorophyll content, and nutrient assimilation under integrated treatments. Organic amendments improve soil structure, water-holding capacity, and cation exchange capacity, thereby supporting prolonged nutrient availability during critical growth phases.

Summary and Conclusion

Summary

The present investigation was carried out to study the effect of integrated nutrient management using organic and inorganic fertilizers on the growth, yield, and yield attributes of the crop. The experiment was laid out with different treatment combinations involving various proportions of Recommended Dose of Fertilizer (RDF) along with organic sources such as Farm Yard Manure (FYM), vermicompost, and poultry manure.

Results revealed that the application of integrated treatments significantly influenced all the growth and yield parameters compared to the control (T₁). Treatment T₉ (50% RDF from Nitrogen + 25% Recommended Nitrogen from Farm Yard Manure + 25% Recommended Nitrogen from Vermicompost) recorded the highest performance across most characters. It produced the maximum initial plant population (58.01 plants m⁻²), plant height (92.37 cm at harvest), dry matter accumulation (71.61 g), grain yield (4469 kg ha⁻¹), straw yield (6141 kg ha⁻¹), and harvest index (42.14). Treatment T₆ (75% RDF from Nitrogen + 25% Recommended Nitrogen from Vermicompost) was the next

best treatment for most parameters. The control treatment (T₁) consistently recorded the lowest values for all observed characters.

The study clearly demonstrated the beneficial effect of combined application of inorganic fertilizers with organic manures in enhancing crop productivity through improved nutrient availability, better soil physical and biological properties, and efficient assimilate partitioning.

Conclusion

On the basis of the results obtained, it can be concluded that integrated nutrient management (INM) practices are highly effective in improving initial plant population, plant growth, dry matter accumulation, grain yield, straw yield, and harvest index of the crop. Among all the treatments, T₉ (50% RDF from Nitrogen + 25% Recommended Nitrogen from Farm Yard Manure + 25% Recommended Nitrogen from Vermicompost) proved to be the most superior treatment. It recorded the highest initial plant population (58.01 plants m⁻²), plant height (92.37 cm), dry weight (71.61 g), grain yield (4469 kg ha⁻¹), straw yield (6141 kg ha⁻¹), and harvest index (42.14). Treatment T₆ also performed well and was statistically at par with T₉ in several parameters. The combination of organic and inorganic nutrient sources exhibited a synergistic effect, resulting in better nutrient availability, improved soil health, enhanced root proliferation, and efficient translocation of photosynthates. This led to superior yield attributes and higher productivity compared to the control (T₁), which recorded the lowest values for all characters. The study clearly demonstrates that the use of vermicompost and FYM along with a reduced dose of chemical fertilizers can effectively substitute a significant portion of inorganic nutrients without compromising yield while simultaneously promoting long-term soil fertility through increased organic carbon content and microbial activity. Overall, the findings highlight the superiority of integrated nutrient management, particularly treatment T₉, over sole dependence on chemical fertilizers or no fertilization. Adoption of such INM strategies can play a vital role in achieving sustainable agricultural production, higher crop productivity, and improved soil health.

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