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ORIGINAL ARTICLE

Analysis of Organic and Conventional Farming on Yield and Nutritional Quality of Wheat (HD-2189)

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ABSTRACT
The present study evaluates the impact of organic, conventional, and integrated nutrient management systems on the yield and nutritional quality of wheat (Triticum aestivum L., cultivar HD-2189) under semi-arid conditions at OFRTC, VNMKV, Parbhani during the Rabi 2022–23 season. A randomized block design with six treatments—ranging from 100% organic to 100% conventional and their combinations—was employed. Results revealed that conventional treatment (T1) produced the highest grain and straw yields due to rapid nutrient availability, while organic treatment (T2) significantly enhanced protein content, iron, and vitamin C concentration. Integrated treatments (T3 and T4) offered a balance, showing moderate yields with improved nutritional profiles, demonstrating their potential for sustainable wheat production. The findings underscore the need to integrate organic and inorganic inputs to optimize both yield and nutritional outcomes in wheat cultivation.
Keywords: *wheat, organic farming, conventional farming, nutrient management, grain quality*

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INTRODUCTION

Wheat (*Triticum aestivum*) is one of the most important cereal crops globally and serves as a staple food for a large segment of the world's population. In India, wheat plays a critical role in ensuring national food security by contributing significantly to both caloric and protein intake across rural and urban populations [1]. Beyond its energy content, wheat provides essential nutrients including protein, dietary fiber, vitamins, and minerals, making it a vital component of the daily diet in both developing and developed countries [2]. With growing concerns regarding the sustainability of agricultural practices, there is an increasing interest in evaluating the comparative impacts of different cultivation systems, particularly organic and conventional farming.

Conventional farming relies heavily on chemical fertilizers, synthetic pesticides, and high-yielding crop varieties to maximize productivity. Although this system has ensured increased crop production and food availability, it is often associated with challenges such as soil degradation, environmental pollution, nutrient imbalance, and chemical residues in produce [3,4]. On the other hand, organic farming promotes the use of natural inputs such as farmyard manure, compost, green manures, and biopesticides, which enhance soil health, promote ecological balance, and reduce environmental impacts. However, concerns persist about the lower yield potential of organic systems, especially in the context of staple crops like wheat [5].

Integrated nutrient management has emerged as a sustainable alternative that combines the benefits of both organic and conventional approaches by using a blend of organic manures and chemical fertilizers. This method seeks to maintain soil fertility, enhance crop productivity, and ensure long-term sustainability of farming systems [6]. Although several studies have focused on individual aspects such as

yield or quality, comprehensive research addressing both yield and nutritional composition of wheat grown under organic, conventional, and integrated systems remains limited in India [7].
The present study aims to evaluate the effects of organic, conventional, and integrated nutrient management practices on the growth parameters, yield traits, and nutritional content of wheat cultivar HD-2189. By conducting this comparative assessment under field conditions, the research contributes to a better understanding of how different nutrient management strategies influence the agronomic and nutritional performance of wheat, ultimately supporting informed decision-making in sustainable agriculture.

MATERIAL AND METHODS

Experimental Site

The experimental investigation was executed at the Organic Farming Research and Training Centre (OFRTC), affiliated with Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra, located within the subtropical agro-climatic zone of India shown in Figure 1. The site is geographically positioned at an altitude of approximately 407 meters above mean sea level, with latitude 19°09′N and longitude 76°46′E. The prevailing climate of the region is semi-arid, characterized by hot summers, mild winters, and erratic rainfall patterns, with a mean annual precipitation ranging between 800 and 900 mm, mostly concentrated during the southwest monsoon. The soil type of the experimental field was classified as medium black clay, belonging to the Vertisol order, which is known for its high clay content, moderate to high water-holding capacity, and relatively alkaline pH. The physico-chemical properties of the soil, such as texture, pH, electrical conductivity, and organic carbon content, were determined prior to sowing to assess baseline fertility status and guide input application [7].

Figure 1. *Satellite view showing the experimental field at the Organic Farming Research Project, OFRTC, VNMKV, Parbhani. The enlarged inset highlights the precise location where the wheat trial was conducted during Rabi 2022–23.*

Crop and Season

The test crop selected for this study was wheat (*Triticum aestivum* L.) cultivar HD-2189, a high-yielding semi-dwarf variety recommended for cultivation under irrigated and timely sown conditions in central India. The crop was sown during the Rabi season of 2022–2023, coinciding with the optimal photoperiod and temperature regime required for wheat phenology, particularly during the tillering and grain-filling stages. The crop duration extended over 120 to 125 days, encompassing the vegetative, reproductive, and grain maturation phases. Seed treatment was done with *Trichoderma viride* in organic plots and with thiram in conventional plots, aligning with the respective input protocols. Standard agronomic practices such as irrigation scheduling, weed management, and pest control were adopted uniformly across all plots except where otherwise stated [2]. The wheat variety used for this study was *Triticum aestivum* L. HD-2189, which is a semi-dwarf, high-yielding cultivar suitable for irrigated and rainfed conditions. It matures in 110–115 days and is widely cultivated in Maharashtra. The morphological development of this variety during the Rabi season at OFRTC is shown in Figure 2.

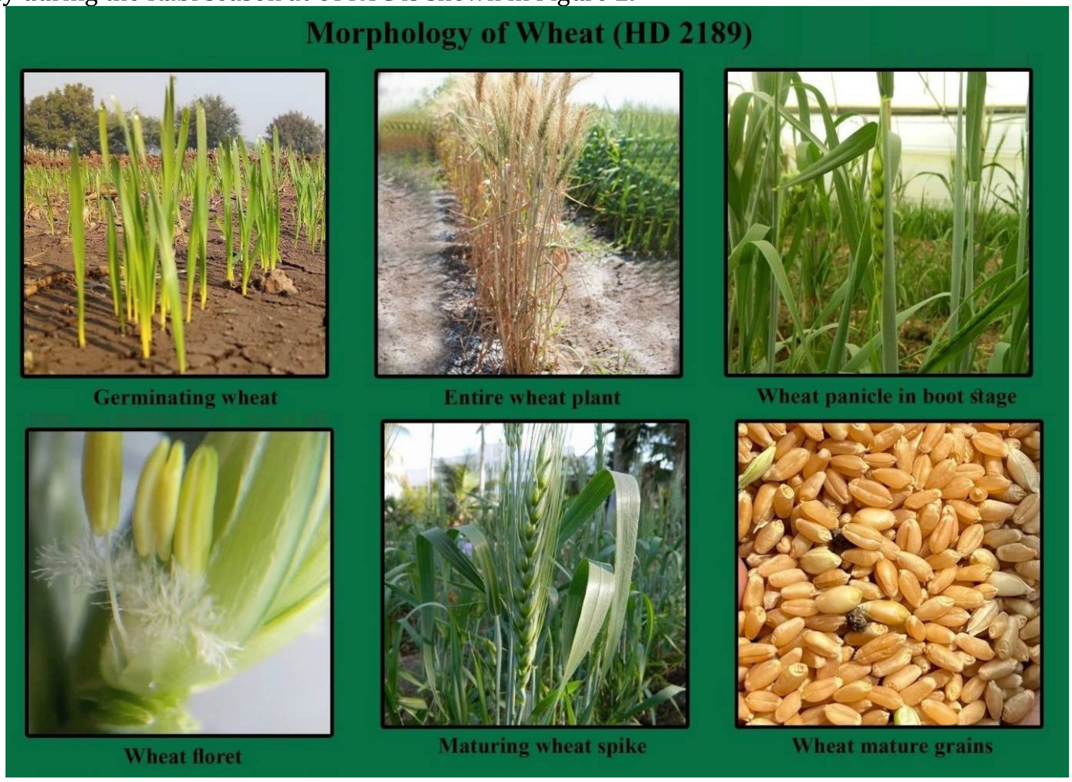

Figure 2. *Morphological stages of wheat (Triticum aestivum L., HD-2189) during the crop growth cycle. (a) Germinating wheat seedlings, (b) Entire wheat plant at maturity, (c) Wheat panicle in boot stage, (d) Enlarged view of wheat floret, (e) Maturing wheat spike, and (f) Harvest-ready mature wheat grains. All photographs were captured during the Rabi 2022–2023 season at the Organic Farming Research and Training Centre (OFRTC), VNMKV, Parbhani.*

Treatment Structure

The experiment followed a randomized block design (RBD) comprising six distinct nutrient management treatments, each replicated thrice to ensure statistical validity. The treatment combinations were meticulously structured to represent a gradient of nutrient input strategies. T1 comprised 100 percent recommended dose of inorganic fertilizers (conventional). T2 was fully organic, using equivalent nutrient content derived from organic manures. T3, T4, and T5 consisted of integrated treatments in which organic and conventional fertilizers were blended in 75:25, 50:50, and 25:75 ratios respectively, based on nitrogen equivalency. T6 served as the absolute control with no nutrient amendments applied. This stratification enabled assessment of linear and non-linear effects of organic input substitution on crop growth, yield, and nutritional quality [8].

Organic and Conventional Inputs

The nutrient inputs for each treatment were calculated on the basis of nitrogen equivalency to ensure balanced nutrient provisioning. In conventional plots, urea (46% N), diammonium phosphate (DAP, 18:46:0), and muriate of potash (MOP, 60% K_2O) were applied at the recommended rates of 120:60:40 kg ha^{-1} for N:P:K, split into basal and top-dressing applications. In organic and integrated treatments, nitrogen was supplied through farmyard manure (FYM), vermicompost, and neem cake. These materials were incorporated into the soil at least 15 days before sowing to facilitate mineralization and synchronization of nutrient release with crop demand. The organic manures were characterized for their nutrient content prior to application to standardize dosage. Organic pest management in respective plots was maintained using neem-based biopesticides, and manual weed control was carried out to avoid cross-contamination [9].

Growth and Yield Parameters

To evaluate the physiological and morphological response of wheat plants to the nutrient management regimes, a comprehensive set of biometric observations was recorded at key phenological stages. This included plant height (cm), determined from ground level to the tip of the tallest spike, number of effective tillers per plant, and panicle (spike) length measured from the base of the spike to its apex. At harvest, yield attributes were recorded including number of grains per spike and thousand kernel weight (TKW), which serves as an index of grain density and plumpness. Grain yield and straw yield per net plot were recorded and later extrapolated to hectare basis using standard conversion formulas. All biometric measurements were conducted on ten randomly selected plants per plot, and mean values were used for analysis [8].

Nutritional Analysis

Harvested wheat grains were cleaned, air-dried, and ground to a fine powder using a stainless-steel grinder for subsequent biochemical assays. Protein content was estimated by the Kjeldahl method, which involves digestion, distillation, and titration to determine total nitrogen, followed by conversion to protein using a factor of 6.25. Carbohydrate content was determined by difference, subtracting total moisture, protein, fat, and ash content from 100. Crude fat was estimated using Soxhlet extraction with petroleum ether, while crude fiber was analyzed through sequential acid and alkali digestion. Vitamin C content was quantified using a redox titration method involving 2,6-dichlorophenolindophenol dye. Micronutrients such as iron (Fe) and copper (Cu) were extracted by wet acid digestion and quantified using colorimetric techniques based on standard curves prepared with known standards. All analyses followed AOAC (2005) protocols and were carried out in triplicate for precision [9].

Statistical Analysis

The experimental data collected on growth parameters, yield components, and nutritional composition were subjected to statistical analysis using Analysis of Variance (ANOVA) suitable for randomized block design. Treatment means were compared using Tukey's Honestly Significant Difference (HSD) test at a confidence level of 95 percent ($p < 0.05$) to identify statistically significant differences among treatments. Statistical analysis was performed using SPSS Version 25.0 software. The coefficient of variation (CV), F-values, and least significant differences (LSD) were computed to support interpretation. The normality of data distribution and homogeneity of variances were verified prior to post-hoc testing to meet ANOVA assumptions .

RESULTS AND DISCUSSION

Growth Parameters

The influence of six nutrient management treatments on the vegetative development of wheat (*Triticum aestivum* L., cultivar HD-2189) was assessed by analyzing plant height, number of tillers per plant, and panicle length. These parameters are critical indicators of crop vigor, assimilate partitioning, and reproductive potential.

Among all treatments, the T1 treatment (100% conventional) exhibited the most pronounced vegetative growth, recording the highest mean plant height of 94.2 cm, 6.8 tillers per plant, and panicle length of 11.4 cm. This can be attributed to the rapid nutrient uptake facilitated by water-soluble chemical fertilizers (urea, DAP, MOP), which provided immediate access to essential macronutrients like nitrogen (N), phosphorus (P), and potassium (K). Nitrogen, in particular, plays a vital role in cell division and elongation, which promotes vertical shoot growth and increased tillering through enhanced apical and axillary meristem activity.

In contrast, the T2 treatment (100% organic), which relied on nutrient release from farmyard manure (FYM), vermicompost, and neem cake, showed relatively reduced growth performance with a plant height of 85.6 cm and 5.7 tillers per plant. This may be due to the slower mineralization rates of organic inputs, where nutrient availability is governed by microbial decomposition processes, often limiting early-stage vegetative expansion. However, organic inputs do improve soil physicochemical properties and foster beneficial microbial populations, which can benefit the crop in the long term.

The integrated treatments T3 (75:25 Org:Conv) and T4 (50:50 Org:Conv) showed intermediate growth responses, with plant heights of 91.1 cm and 88.7 cm respectively, and tiller numbers of 6.5 and 6.3. These results suggest a synergistic effect of combining organic and inorganic inputs, where the quick nutrient availability from chemical fertilizers complements the gradual release from organic amendments, resulting in a more sustained nutrient supply during critical growth phases. Moreover, the presence of organic matter likely improved soil structure, water retention, and root proliferation, thereby supporting shoot elongation and panicle development.

***Table 1**: Growth Parameter Comparison of Wheat (Triticum aestivum L., HD-2189) under Six Nutrient Management Treatments*

Treatment	Plant Height (cm)	Tillers/Plant	Panicle Length (cm)
T1 (100% Conventional)	94.2	6.8	11.4
T2 (100% Organic)	85.6	5.7	10.2
T3 (75:25 Org:Conv)	91.1	6.5	11.1
T4 (50:50 Org:Conv)	88.7	6.3	10.9
T5 (25:75 Org:Conv)	86.9	6.0	10.4
T6 (Absolute Control)	79.3	4.9	9.8

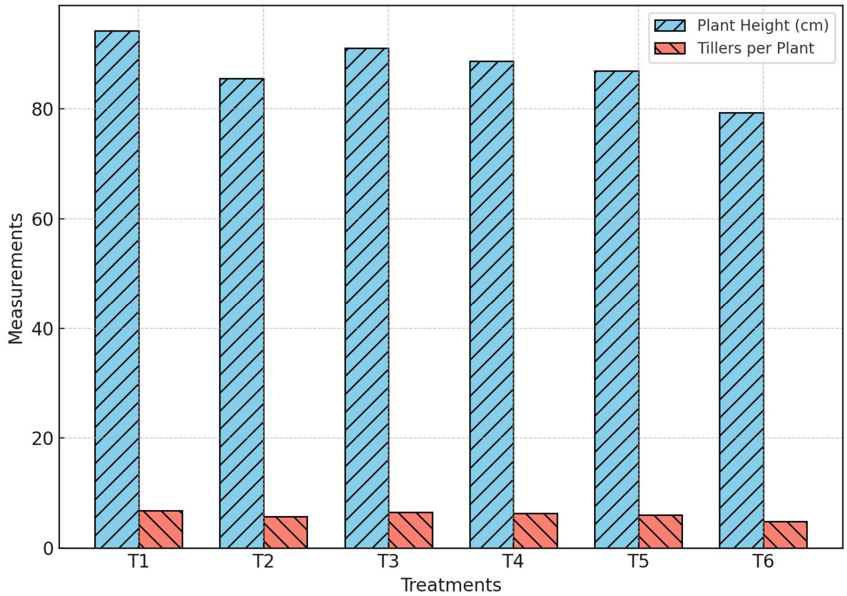

***Figure 3**: Bar Graph Showing Plant Height and Number of Tillers per Plant Across Treatments*

The T5 treatment (25:75 Org:Conv) and T6 (absolute control) recorded comparatively lower values, with the latter exhibiting the least growth vigor due to the absence of any added nutrient input. This underlines the importance of external nutrient supplementation in achieving optimal wheat growth in semi-arid regions like Parbhani.

These results confirm that nutrient management significantly influences wheat vegetative growth. The superiority of T1 in plant height and tillering reflects the immediate efficacy of chemical fertilizers. However, the balanced performance of T3 and T4 supports the feasibility of integrated nutrient management for maintaining growth while promoting sustainability. Similar trends have been reported by [10] and [11], where integration of organic and inorganic sources resulted in improved plant architecture, possibly due to enhanced nutrient synchrony and root-soil interactions.

Yield Parameters

The influence of different nutrient management systems on yield parameters of wheat (*Triticum aestivum* L., HD-2189) was statistically significant. Among all treatments, T1 (100% conventional) recorded the highest values for both grain yield (32.5 q/ha) and thousand kernel weight (TKW) (41.2 g), indicating the effectiveness of readily available nutrients provided through chemical fertilizers such as urea, DAP, and MOP. These results suggest that chemical fertilizers ensure optimal nutrient uptake during critical stages of growth and grain filling, thereby enhancing productivity.

However, this increased productivity comes at a potential environmental cost and raises concerns about long-term soil fertility. In contrast, T2 (100% organic) showed the lowest grain yield (25.4 q/ha) and TKW (36.8 g), attributed to slower nutrient release from organic sources like FYM and vermicompost, which may not meet the immediate nutrient demands of the crop. This is consistent with earlier studies where organic systems initially produced lower yields due to delayed nutrient mineralization [16].

The integrated treatments, particularly T3 (75% organic + 25% conventional) and T4 (50% organic + 50% conventional), provided moderate grain yields (30.6 and 29.2 q/ha, respectively), demonstrating a compromise between sustainability and productivity. These results indicate that partially substituting chemical fertilizers with organics supports yield levels while potentially improving long-term soil health.

The straw yield followed a similar trend to the grain yield, with the highest values in T1 and the lowest in T6. The control treatment (T6) consistently underperformed across all parameters due to the absence of external nutrient inputs. The gradual increase in both grain and straw yield from T6 to T1 suggests a direct correlation between nutrient availability and biomass production.
These findings support earlier reports by Patel et al. [1], who emphasized that nutrient combinations significantly influence wheat productivity and that integrated nutrient management can enhance resource use efficiency.

Table 2: *Yield Attributes (Grain Yield, Straw Yield, and TKW) of Wheat under Different Nutrient Management Systems*

Treatment	Grain Yield (q/ha)	Straw Yield (q/ha)	Thousand Kernel Weight (TKW) (g)
T1 (100% Conventional)	32.5	50.4	41.2
T2 (100% Organic)	25.4	40.3	36.8
T3 (75% Organic + 25% Conv.)	30.6	47.2	39.7
T4 (50% Organic + 50% Conv.)	29.2	45.1	38.9
T5 (25% Organic + 75% Conv.)	27.9	43.7	37.8
T6 (Control)	21.6	36.5	34.5

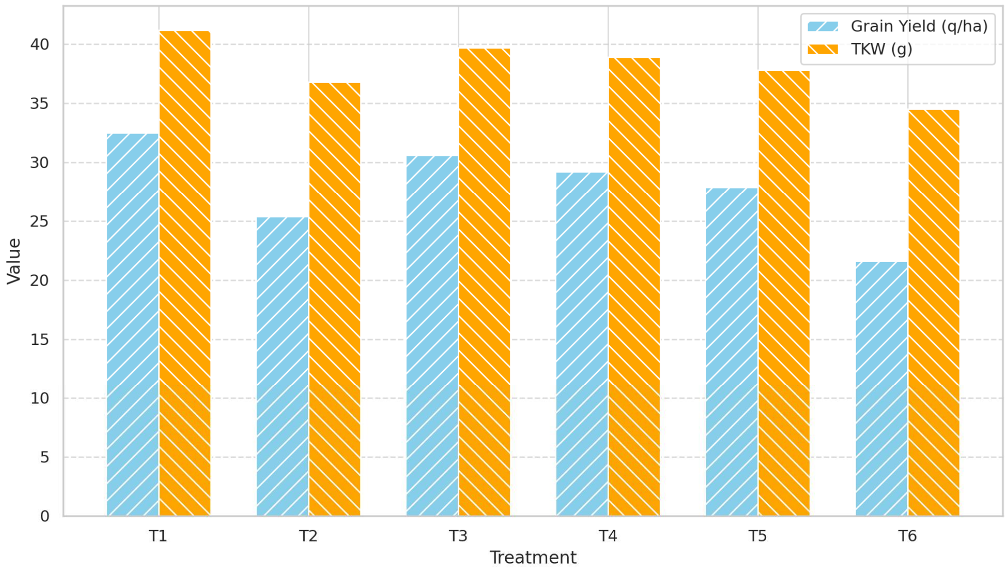

Figure 4: *Comparison of Grain Yield and Thousand Kernel Weight under Various Treatments*

Nutritional Quality

The nutritional composition of wheat grains was notably influenced by the type of nutrient management practice implemented across the six treatments. Among the different systems, the organic treatment (T2) exhibited significantly higher concentrations of protein, iron (Fe), and vitamin C as compared to the conventional (T1) and control (T6) plots. This elevation in nutritional density in T2 is likely attributed to enhanced soil microbial activity and improved organic matter decomposition, which promote effective nutrient cycling and increase the bioavailability of micronutrients to the wheat crop [9].
In particular, the protein content in T2 grains was measured at 13.1%, which is markedly greater than the 11.7% observed in T1 and significantly more than the 10.3% in T6. Similarly, the iron concentration reached 4.5 mg/100g in organic wheat, compared to 3.7 mg/100g in the conventional system. Vitamin C levels also followed this trend, with T2 registering 1.24 mg/100g—considerably higher than other treatments. The superior nutritional profile of organically grown wheat may be ascribed to a balanced nutrient release from sources like vermicompost and neem cake, which are known to stimulate rhizosphere microbial biomass and enhance micronutrient solubilization [12].

Table 3: *Nutritional Composition of Wheat Grain under Each Nutrient Management Treatment*

Treatment	Protein (%)	Iron (mg/100g)	Copper (mg/100g)	Vitamin C (mg/100g)
T1	11.7	3.7	0.42	0.89
T2	13.1	4.5	0.49	1.24
T3	12.4	4.1	0.47	1.12
T4	12.1	4.0	0.45	1.05
T5	11.9	3.8	0.44	0.97
T6	10.3	3.3	0.40	0.76

On the other hand, carbohydrates, crude fat, and crude fiber contents did not vary significantly across treatments, suggesting these components are less sensitive to input types or that short-term soil fertility changes did not strongly affect their biosynthesis. Nonetheless, T3 and T4 integrated treatments exhibited a modest improvement in nutrient parameters, indicating that partial incorporation of organic matter alongside conventional inputs can enhance grain quality without compromising yield. These findings are consistent with earlier reports by Ramesh et al. who noted nutritional improvements in organically managed cereal crops [11].

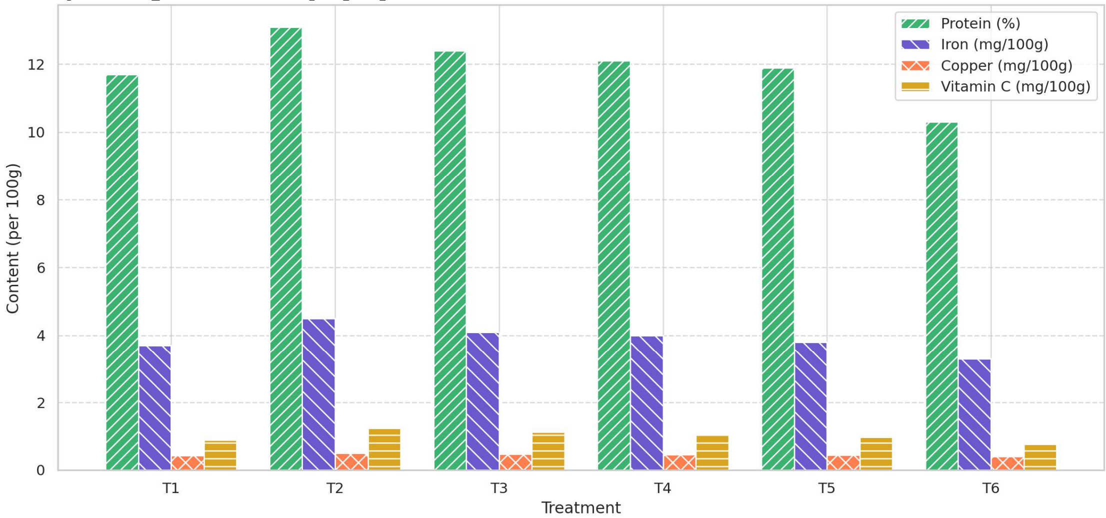

Figure 5*: Comparison of Protein Content and Micronutrients (Fe, Cu, Vitamin C) Across Treatments*

The integrated assessment of yield performance and nutritional attributes among the six nutrient management treatments revealed critical insights into the agro-ecological adaptability and functional outcomes of each approach. The conventional treatment (T1), characterized by the use of synthetic fertilizers such as urea, DAP, and MOP, consistently recorded superior grain and straw yields. This enhancement is largely attributed to the immediate availability of nutrients, particularly nitrogen, which facilitated robust vegetative growth and reproductive development in wheat (*Triticum aestivum* L., HD-2189) [12].

Conversely, the organic treatment (T2), comprising farmyard manure, vermicompost, and neem cake, significantly improved the nutritional quality of the wheat grains, especially in terms of protein content, micronutrients like iron and copper, and vitamin C levels. The improved nutritional profile in organic systems is attributed to enhanced microbial activity, better organic matter content, and efficient nutrient cycling. However, a noticeable trade-off was evident as the grain and straw yields in T2 lagged behind conventional and integrated systems, likely due to the slower nutrient mineralization and release from organic sources [13].

Integrated treatments, particularly T3 (75% organic + 25% conventional) and T4 (50% organic + 50% conventional), exhibited a balanced performance by achieving moderately high yields along with improved grain nutritional content. These results underscore the viability of integrated nutrient management systems in achieving dual goals: sustaining crop productivity while enriching grain quality [20]. Such an approach not only leverages the benefits of rapid nutrient uptake from chemical sources but also promotes soil health and biological activity facilitated by organic amendments. This integrated strategy appears particularly suitable for Indian agro-ecological zones where resource optimization and sustainable practices are increasingly necessary for food security and environmental conservation [14].

CONCLUSION

The present investigation comparing organic, conventional, and integrated nutrient management systems in wheat (*Triticum aestivum* L., HD-2189) cultivation highlights a clear distinction between productivity and nutritional quality outcomes. Conventional farming (T1), reliant on synthetic inputs, resulted in the highest grain and straw yields due to rapid nutrient availability and uptake. In contrast, organic treatment (T2) significantly enhanced the nutritional composition of wheat grains, particularly increasing protein, iron, and vitamin C content. However, this improvement came at the cost of reduced yield, likely due to slower nutrient mineralization from organic sources. The integrated treatments, especially T3 (75% organic + 25% conventional) and T4 (50% organic + 50% conventional), demonstrated an optimal compromise between the two extremes. These treatments delivered satisfactory yield performance while also preserving or enhancing grain nutritional quality, making them suitable candidates for sustainable agricultural practices. Thus, integrated nutrient management emerges as a promising approach for balancing productivity and nutritional outcomes in wheat farming, particularly in the Indian context where soil health and food quality are of growing concern. Future research should focus on long-term field trials incorporating microbial diversity and soil health indicators to validate the ecological sustainability of these integrated systems.

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