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Application of Organic and Inorganic Fertilization on Growth Parameters of Wheat (*Triticum aestivum* L.) under Wheat Maize Cropping Sequence

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ABSTRACT

A long-term field experiment was conducted during rabi 2023–24 and 2024–25 at the Instructional Farm, Rajasthan College of Agriculture, Udaipur, to assess the effect of organic and inorganic fertilization on growth parameters of wheat (*Triticum aestivum* L.) under a maize–wheat cropping sequence. The trial, representing the 26th and 27th cropping cycles of the ongoing study initiated in 1997, comprised twelve nutrient management treatments laid out in a randomized block design with four replications. Growth parameters, namely plant height and dry matter accumulation (DMA), were significantly influenced by fertilization practices. Across years and pooled data, the integrated treatment of 100% NPK + FYM @ 10 t ha^{-1} (T) consistently recorded the maximum plant height (97.42 cm) and DMA (23.29 g $plant^{-1}$), showing a 78.7% and 75% increase, respectively, over the control. Treatments with higher fertilizer application (150% NPK, T_7) and combined FYM with NPK (T_7) were statistically at par with T_7, whereas control and nutrient-omission plots (100% NP, 100% N, and no fertilizer) recorded significantly lower values. The results highlight the superiority of integrated nutrient management in enhancing growth performance of wheat by improving nutrient availability and soil health. The findings reinforce the importance of combining organic and inorganic sources for sustainable productivity and long-term fertility management in cereal-based cropping systems.

Key words: *Organic fertilizers, Wheat, Wheat maize cropping sequence*

Introduction

Plant growth parameters such as plant height and dry matter accumulation are key indicators of nutrient uptake efficiency, physiological performance, and ultimate yield potential in wheat (*Triticum aestivum* L.). These traits are highly responsive to fertilization strategies, which regulate nutrient availability, soil organic matter turnover, and root development. Inorganic fertilizers provide readily available nutrients that enhance early vegetative growth and shoot elongation, but their continuous and sole application may lead to soil quality deterioration and imbalanced nutrient supply (Hati *et al*., 2007; Bandyopadhyay *et al*., 2010). On the other hand, organic manures release nutrients more gradually,

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improve soil structure, and enhance microbial activity, thereby sustaining biomass accumulation over longer growth periods (Bronick and Lal, 2005; Chivenge *et al*., 2011). Recent studies have demonstrated that integrated use of organic and inorganic fertilizers significantly increases plant height and total dry matter production compared to sole nutrient sources, mainly due to improved synchronization between nutrient release and crop demand (Ghosh *et al*., 2018; Zhang *et al*., 2024). Moreover, partial substitution of mineral nitrogen with organic inputs reduces nitrate leaching and enhances nutrient use efficiency, ensuring steady accumulation of biomass throughout the growing season (Regelink *et al*., 2015; Basche and DeLonge, 2019). Given the dual role of fertilization in sustaining soil health and improving crop performance, understanding the combined effect of organic and inorganic nutrient sources on growth parameters of wheat remains a crucial research priority.

Materials and Methods

Experimental Site and Background

The present investigation was carried out under the ongoing at the fixed experimental site located at Block B_2, Instructional Farm, Rajasthan College of Agriculture (RCA), Udaipur. This study represents the 26th and 27th cropping cycles of the maize-wheat system, which has been under continuous experimentation since its initiation during *kharif* 1997. The experimental site is situated in the South-Eastern part of Rajasthan, positioned at an elevation of 582.2 m above mean sea level, with geographical coordinates of 24°35′ N latitude and 73°42′ E longitude. The region is categorized under Agro-Climatic Zone IVa (Sub-Humid Southern Plain and Aravalli Hills) of Rajasthan.

Experimental Design and Crop Details

The field experiment was conducted during rabi seasons of 2023-24 and 2024-25 using wheat (*Triticum aestivum* L.) variety Raj 4037 as the test crop. A seed rate of 100 kg ha^{-1} was maintained. The layout of the experiment followed a Randomized Block Design (RBD) with 12 treatments replicated four times, resulting in a total of 48 plots. Each gross plot measured 20.0 m × 9.0 m (180 m²), while the net plot size was maintained at 19.0 m × 8.0 m (152 m²). Sowing was done with a row-to-row spacing of 22.5 cm. All agronomic operations were carried out uniformly across treatments as per recommended practices for wheat cultivation in the region.

Treatment Structure

The experimental treatments consisted of twelve nutrient management combinations involving inorganic fertilizers (NPK, NP, N), organic amendments (FYM), and biofertilizers, either alone or in different integrated forms. The treatments were as follows: T: 100% NPK, T: 100% NPK + Zn, T: 100% NPK + Zn + S, T: 100% NPK + S, T: 100% NPK + Biofertilizer, T: FYM @ 10 t ha^{-1} + 100% NPK (-NPK of FYM), T: 100% NPK + FYM @ 10 t ha^{-1}, T: FYM @ 20 t ha^{-1}, T: 150% NPK, T: 100% NP, T: 100% N and T: Control (no fertilizer or manure). These treatments have been continuously applied on the same plots since the initiation of the experiment in 1997, ensuring a true long-term evaluation of organic and inorganic fertilization effects under the maize-wheat cropping sequence.

Analysis of Parameters

Plant height was recorded at physiological maturity by measuring five representative plants from each net plot, from the soil surface to the tip of the main shoot (excluding awns), and the average value was taken for analysis. Above-ground biomass for dry matter accumulation was sampled from a 1.0 m² area in the central rows of each plot, oven-dried at 65 ± 2 °C to constant weight, and expressed in kg ha^{-1}. Data from four replications were analyzed using ANOVA for a randomized block design, and treatment means were compared at the 5% level of significance, following standard agronomic protocols (Gomez and Gomez, 1984).

Results and Discussion

The results of the present study clearly demonstrate that combined application of inorganic fertilizers with organic manures significantly enhanced plant height of wheat compared to sole or imbalanced fertilization. Across both years data (Table 1; Fig. 1), treatment T (100% NPK + FYM 10 t ha{1}) consistently produced the tallest plants, with values statistically comparable to T (150% NPK) and T (FYM 10 t + 100% NPK). These findings highlight the synergistic effect of integrating farmyard manure with mineral fertilizers, which ensures a steady nutrient supply throughout crop growth. Similar observa-

tions were reported by Hati *et al*. (2007), who found that long-term combined use of FYM and fertilizers improved soil organic carbon and structural properties, thereby favoring vegetative growth. The role of FYM in enhancing nutrient use efficiency, root proliferation, and water-holding capacity has been emphasized by Bronick and Lal (2005), and more recently by Zhang *et al*. (2024), who demonstrated that substituting 20% of chemical N with organic fertilizers increased wheat productivity under semi-arid conditions. In contrast, the control and imbalanced treatments (NP or N alone) consistently recorded the lowest plant heights, underscoring the negative effects of nutrient omission and imbalance, which restrict plant metabolism and photosynthetic activity (Bandyopadhyay *et al*., 2010; Ghosh *et al*., 2018). Thus, the superior performance of integrated treatments in the current study corroborates the importance of balanced and combined nutrient management in sustaining plant growth.A Perusal of data (Table 1; Fig. 1) shows that DMA was significantly influenced by fertilization practices. In 2023-24, values ranged from 13.29 g in control (T) to 23.25 g in T, reflecting a 75% increase over control. Treatments T (22.97 g) and T (20.06 g) were statistically at par with T. Treatments T (19.95 g) and T (20.38 g) also showed significant improvement compared to control and imbalanced fertilization. Lower values were recorded in T (17.96 g) and T (17.00 g), while FYM alone (15.43 g, T) remained superior to control but inferior to combined nutrient applications. In 2024-25, DMA followed the same trend, ranging from 13.11 g (control) to 23.33 g (T). Treatments T (23.00 g) and T (20.12 g) remained statistically at par with T, while significantly lower values were obtained in T (18.00 g), T (17.04 g), and T (15.47 g). The pooled data revealed that T consistently achieved the highest DMA (23.29 g), followed by T (22.98 g) and T (20.09 g). The lowest values were recorded in control (13.20 g). This pattern suggests that organic–inorganic combinations not only promote vegetative growth but also sustain biomass partitioning into above-ground tissues. The 75% increase in DMA over control highlights the crucial role of nutrient management in enhancing crop productivity. Earlier studies have established that organic manures improve microbial activity and nutrient mineraliza-

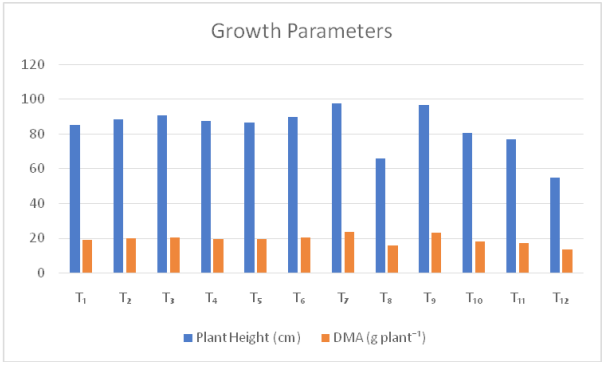

Fig. 1. Effect of organic and inorganic fertilization on Growth parameters of wheat under wheat maize cropping sequence

Table 1. Effect of organic and inorganic fertilization on Growth parameters of wheat under wheat maize cropping sequence

Treatments	Growth parameters					
	Plant Height (cm)			DMA (g plant^{-1})		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T_1: NPK	85.01	85.18	85.09	19.03	19.05	19.04
T_2: NPK + Zn	88.10	88.23	88.17	19.95	19.99	19.97
T_3: NPK + Zn + S	90.70	90.81	90.76	20.38	20.39	20.39
T_4: NPK + S	87.49	87.52	87.50	19.46	19.50	19.48
T_5: NPK + Bio	86.33	86.40	86.36	19.44	19.47	19.46
T_6: FYM 10 t + 100% NPK (- NPK of FYM)	89.60	89.66	89.63	20.06	20.12	20.09
T_7: NPK + FYM 10 t ha^{-1}	97.41	97.43	97.42	23.25	23.33	23.29
T_8: FYM 20 t ha^{-1}	65.80	65.88	65.84	15.43	15.47	15.45
T_9: 150% NPK	96.31	96.39	96.35	22.97	23.00	22.98
T_{10}: 100% NP	80.40	80.44	80.42	17.96	18.00	17.98
T_{11}: 100% N	76.90	76.91	76.91	17.00	17.04	17.02
T_{12}: Control	54.50	54.52	54.51	13.29	13.11	13.20
S.Em. +	2.131	2.185	1.425	0.512	0.513	0.339
C.D. (P= 0.05)	6.13	6.29	4.02	1.474	1.475	0.957

tion, leading to higher leaf area development and photosynthetic efficiency, which ultimately translate into greater biomass production (Chivenge *et al*., 2011; Regelink *et al*., 2015). The superiority of integrated fertilization over sole FYM (T) in our study indicates that mineral fertilizers are indispensable for meeting the immediate nutrient demand of wheat, while organics contribute to long-term soil fertility. This observation agrees with Basche and DeLonge (2019), who reported improved infiltration and water availability under organic inputs, but stressed that yield sustainability requires nutrient balance. Similarly, long-term trials in India have shown that combined FYM and NPK application enhances both dry matter production and grain yield in cereal-based systems (Ghosh *et al*., 2018). Therefore, the findings of the present investigation support the hypothesis that integrated nutrient management ensures better synchronization between nutrient release and crop demand, thereby maximizing plant growth and biomass accumulation in wheat.

Conclusion

The study clearly demonstrated that integrated application of inorganic fertilizers with farmyard manure (T: 100% NPK + FYM 10 t ha^{-1}) was most effective in enhancing plant height and dry matter accumulation of wheat, outperforming sole or imbalanced nutrient applications. Treatments with higher fertilizer levels (T: 150% NPK) and combined FYM with NPK (T) also produced comparable results, while control and nutrient-omission plots recorded the lowest values. These findings highlight that balanced and integrated nutrient management not only ensures adequate nutrient supply for optimal growth but also sustains biomass productivity across years. Adoption of such integrated fertilization strategies is therefore essential for improving wheat performance and maintaining long-term soil fertility under intensive cropping systems.

Conflict of Interest- None

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