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Influence of Organic Fertilizers and Nitrogen on the Growth and Yield of Wheat (*Triticum aestivum* L.)

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ABSTRACT

Background: The integration of organic fertilizers with nitrogen-based fertilizers creates a synergistic effect that enhances wheat growth, yield and grain quality within a sustainable agricultural framework.

Methods: The experimentation was executed at the Research Farm, Division of Agronomy, Lovely Professional University, during the *rabi* seasons of 2023-2024 and 2024-2025, evaluating the effects of organic fertilizers and nitrogen on wheat growth and yield. The research was conducted using a split-plot design with three replications. The treatment comprised five main plots, *viz*., M_1: Control, M_2: 10 t/ha FYM, M_3: 15 t/ha FYM, M_4: 5 t/ha Poultry Manure and M_5: 7.5 t/ha Poultry Manure and three sub-plot *viz*., N_1: 100% RDN, N_2: 50% RDN + Two spray of nano urea (at tillering and booting stages) and N_3: 75% RDN + one spray of nano urea (at booting stages).

Result: The analysis highlighted that among the application of organic manures, 7.5 t ha poultry manures (M_5) notably observed the highest growth parameters like plant height (104.25 cm), dry matter accumulation (258.10 g/m row length) and leaf area index (4.86) succeeded by plant height (103.64 cm), dry matter accumulation (257.50 g/m row length) and leaf area index (4.81) on 15 t/ha FYM (M_3) of the wheat which the resulted values were statistically at par. In a similar vein, it was observed that varying levels of nitrogen application had a pronounced and significant influence on the growth parameters of wheat crops *viz.,* plant height (102.08 cm), dry matter accumulation (235.10 g/m row length) and leaf area index (4.65), all of which were achieved under the nitrogen treatment, 100% RDN (N_1). Furthermore, the yield attributes and yield as effective tillers of 228.39, grains per spikelet of 47.39, test weight of 43.41 g, grain yield of 55.67 q/ha, a straw yield of 73.65 q/ha, a biological yield of 129.32 q/ha and harvest index of 43.04% were obtained from 7.5 t ha poultry manures (M_5) followed by effective tillers of 227.94, grains per spikelet of 47.09, test weight of 42.97 g, grain yield of 55.09 q/ha, a straw yield of 73.27 q/ha, a biological yield of 128.36 q/ha and harvest index of 42.91% from 15 t/ha FYM (M_3) when juxtaposed with the outcomes observed from other treatments administered during the study. However, these values were statistically comparable with 7.5 t/ha poultry manures (M5). Among the various nitrogen levels employed in the study, the highest yield attributes and yield such as effective tillers of 222.57, grains per spikelet of 46.39, test weight of 41.46 g, grain yield of 51.59 q/ha, a straw yield of 69.83 q ha, a biological yield of 121.42 q/ha and harvest index of 42.43% were recorded under the 100% RDN (N_1).

Key words: Growth, Nano urea, Nitrogen, Organic manures, Wheat, Yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the predominant cereal food crop cultivated in India and worldwide. Following rice as the most important cereal crop in India in terms of both productivity and output, it is the second-most significant cereal crop in India (Ramadas *et al*., 2019). The overall wheat harvest soared to an impressive 117.5 million tonnes, marking a historic peak and a 3.7% rise from last year's total of 113.3 million tonnes. Cultivated land spanned roughly 32 million hectares, while the average yield reached an impressive 3.56 tonnes per hectare, setting yet another remarkable milestone. The leading states in wheat production were Uttar Pradesh (36.05 million tonnes), Madhya Pradesh (23.03 million tonnes), Punjab (18.09 million tonnes), Haryana (11.42 million tonnes) and Rajasthan. These five regions produced the majority of the country's total wheat yield, highlighting their importance in India's wheat economy.

Wheat, a globally significant staple crop, has several production challenges that affect its yield. Insufficient information and awareness have led farmers to be misled into applying excessive amounts of nitrogen through fertilizers (Ullah *et al*., 2018) to prevent nitrogen deficiency, while simultaneously improving crop yield and quality (Peng *et al*., 2011). Farmers often supply nitrogen to the soil by broadcasting or top-dressing urea, but much of it is lost through leaching, volatilisation and denitrification, reducing nitrogen use efficiency. Foliar nitrogen sprays, particularly nano-fertilizer formulations, have shown improved absorption

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and efficiency in wheat and other cereals (Jithendar *et al*., 2024). Crops use only 20-50% of the nitrogen fertiliser supplied directly to the soil, with the remaining amount lost due to denitrification and leaching. Consequently, steps must be taken to lessen the impact of these losses. An efficient way to increase crop nitrogen availability is through foliar nitrogen spraying. The use of nitrogen foliar treatments, particularly during the tillering stage, has been shown to significantly increase grain yield. Nitrogen foliar sprays are effective in improving growth and production (Yadav *et al*., 2023). The excessive use of synthetic fertilisers and intensive farming practices, together with inadequate organic recycling, has resulted in diminished soil fertility. This reduction poses a challenge to sustaining wheat production over the long term (Meena *et al*., 2023; Patel *et al*., 2022). Considering the current international energy crisis, the rising costs of chemical fertilizers and the declining state of soil, organic manure is gaining prominence as a sustainable tool for crop production. Therefore, the appropriate application of both organic and inorganic fertilisers has become indispensable in this endeavour to enhance crop yields while preserving soil health (Singh *et al*., 2017; Ankush *et al*., 2020). Incorporating organic manure with nitrogen application has proved to be a successful technique for boosting wheat production and addressing soil health concerns (Rashid *et al*., 2024). Organic manures provide essential nutrients, enhancing soil organic carbon (SOC) levels by up to 11% when applied appropriately (Sheoran *et al*., 2025). Two physical soil properties that serve as indicators of soil health-microbial diversity and cation exchange capacity-are enhanced by composting and other organic material treatments, which in turn improve soil structure (Edlinger *et al*., 2025; Sathiyapriya *et al*., 2024). Soil health and nutrient cycling are influenced by microorganisms, which are encouraged by organic inputs (Sathiyapriya *et al*., 2024).

MATERIALS AND METHODS

Location and climate

The experiment was conducted over two years at Lovely Professional University's Research Farm, School of Agriculture, Phagwara, Punjab, India, during the *Rabi* seasons 2023-2024 and 2024-2025. The experimental site is located in the Trans-Gangetic Plains. It is located geographically at 31°13′27″N latitude and 75°46′24″E longitude with an elevation of 245 m above sea level. The climate is semi-arid and subtropical, with scorching summers and freezing winters. An average annual rainfall of 500-800 mm is primarily experienced during the monsoon season (July-September).

Experimental details

The wheat crop was sown during the *Rabi* seasons following standard agronomic practices recommended for the region. The field was prepared with two cross harrowings followed by planking to achieve a fine tilth. Certified seed of wheat was manually drilled in rows spaced 20 cm apart at the recommended seed rate. Irrigations were applied at critical stages-crown root initiation, tillering, jointing, booting and grain filling-while timely weeding and plant protection measures were carried out to maintain uniform crop growth.

The experiment included five organic manure treatments (Control, 10 t ha^{-1} FYM, 15 t ha^{-1} FYM, 5 t ha^{-1} poultry manure and 7.5 t ha^{-1} poultry manure) as main plots and three nitrogen levels (100% RDN, 50% RDN + two foliar nano urea sprays and 75% RDN + one foliar nano urea spray) as sub-plots. Organic manures were incorporated into the soil before sowing, while nitrogen was applied as per treatment through basal soil application and foliar nano-urea sprays at tillering and booting stages.

Data collection and analysis

Grain yield and straw yield

From each experimental plot, the net plot area measuring 5 m × 3 m (15 m^2) was harvested and the produce was sun-dried for 3-4 days. The dried material was then threshed using a mechanical thresher, followed by careful cleaning of the grains. The cleaned grain was weighed and the yield was expressed in quintals per hectare (q/ha). The total biological yield (grain + straw) obtained from the net plot was recorded and the straw yield was calculated by subtracting the grain yield from the biological yield, also expressed in q/ha.

Harvest index (per cent)

The harvest index, expressed as a percentage, was calculated as the ratio of economic yield to biological yield, using the formula proposed by Donald and Hamblin (1976). Harvest index calibration continues to be widely applied in recent studies for yield estimation, crop modelling and remote-sensing-based assessments (Chen *et al*., 2025).

$$\text{Harvest index (\%)} = \frac{\text{Economical yield (q/ha)}}{\text{Biological yield (q/ha)}} \times 100$$

Statistical analysis

The statistical data analysis was performed using the OPSTAT software. An analysis of variance (ANOVA) was carried out and a significance level of 5% was used for all data. The critical difference (CD) and standard error of the mean (SEM ±) were employed to compare treatment effects at the 5% level of significance. The split-plot ANOVA also enabled assessment of the main effects of organic manures (main plots) and nitrogen levels (subplots), as well as their interaction (M × N), thereby determining whether nitrogen responses varied across manure treatments. Furthermore, the effectiveness of soil-applied nitrogen (100% RDN) versus foliar-applied nitrogen (nano-urea sprays) was compared by analysing treatment differences

in growth attributes, yield components and final grain and straw yields using the CD at the 5% level.

RESULTS AND DISCUSSION

Growth parameters

Empirical studies conducted in the farm field have established a methodological basis for evaluating the response of critical agronomic growth metrics to various agronomic interventions within genuine environmental settings. The significance of organic fertilizers and nitrogen applications was investigated in key plant characteristics, specifically plant height, biomass accumulation, leaf area index, root shoot ratio and tiller quantity. According to Fig 1, the outcomes indicated that both organic manures and nitrogen fertilization significantly influenced the growth parameters of wheat; specifically, plant height demonstrated a consistent increase with higher manure applications, attaining the maximum measurement in 7.5 tons/ha poultry manure (M_5) reaching 104.25 cm, which is a 16% rise compared to the control (M_1) (89.88 cm) and 15 tons/ha FYM (M_3) reaching 103.64 cm which is statistically at par. In terms of nitrogen treatments, the tallest plants were achieved at 100% RDN (N_1), measuring 102.08 cm. These results were corroborated by Khaleeq *et al*. (2025), Brijendra *et al*. (2024) and Kavinder *et al*. (2019). The utilization of organic manure significantly improved dry matter accumulation, with 7.5 tons/ha poultry manure (M_5) achieved 258.10 g/m row length, reflecting a 10.2% increase compared to the control (M_1) (219.39 g/m row length) and 15 tons/ha FYM (M_3) with 257.50 g/m row length exhibiting statistically at par; moreover, among the nitrogen treatments, the 100% RDN (N_1) reached 240.27 g/m row length. Similar findings were supported by Nautiyal *et al*. (2024); Niel (2021) and Alamzeb *et al*. (2017) The Leaf Area Index (LAI) increased from 4.08 in the control (M_1) to 4.86 in 7.5 tons/ha poultry manure (M_5), indicating a 19.1% improvement, with 4.81 in 15 tons/ha FYM (M_3) exhibiting comparable statistical outcomes. The nitrogen treatment at 100% RDN (N_1) resulted in the highest LAI, with a value of 4.65. Similar findings were reported by Fallah *et al*. (2025); Upadhyay *et al*. (2024); Katyar *et al*. (2024); Yadav *et al*. (2025). The interaction effect (M × N) was found to be non-significant for plant height, dry matter accumulation and leaf area index.

Yield attributes

In accordance with Fig 2, the number of effective tillers experienced a notable increase, rising from a baseline measurement of 205.94 in the control (M_1) to an impressive 228.39 in the treatment denoted as 7.5 tons/ha poultry manure (M_5), which represents an increase of approximately 11% and 227.94 in 15 tons/ha FYM (M_3) which were found statistically at par whereas 100% RDN (N_1) showed 222.57 as the highest as compared to other nitrogen treatments. Similar results were obtained by Yang *et al*. (2019) Katyar *et al*. (2024) and Ding *et al*. (2021). In addition to this, the quantity of grains per spike demonstrated a remarkable elevation of 20.3%, escalating from a count of 39.4 in the control (M_1) to a significantly higher figure of 47.39 in the 7.5 tons/ha poultry manure (M_5) treatment and 15 tons/ha FYM (M_3) with 47.09, which was statistically at par. The highest value was observed on 100% RDN (N_1) with 46.39. Comparable discoveries were corroborated by Ali *et al*. (2022) Khaliq *et al*. (2024) and Yertayeva *et al*. (2025).

Test weight (g)

According to the detailed information presented in Table 1, the evaluation of test weight revealed an impressive and noteworthy increase of 19.3%, which marked a significant rise from the initial measurement of 36.41 g recorded in the control group (M_1) to a remarkable 43.41 g observed with the application of 7.5 t ha^{-1} of poultry manure (M_5), highlighting the positive impact of organic amendments on crop performance. In a similar vein, the treatment that involved the application of 15 t ha^{-1} FYM (M_3) achieved a comparable measurement of 42.97 g, which, upon

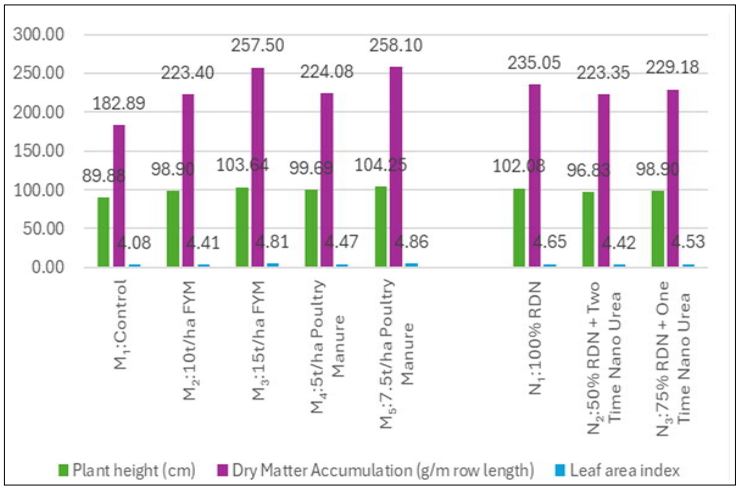


Fig 1: Influence of organic fertilizers and nitrogen on the growth attributes of wheat (Pooled data of 2 years).

statistical analysis, was found to be at par with the results obtained from M_5, thus affirming the effectiveness of both types of manure in enhancing test weight. Furthermore, when examining the various nitrogen levels applied to the crops, it was noted that the treatment utilizing 100% RDN (N_1) yielded the highest recorded test weight at an impressive value of 41.46 g, underscoring the critical role of nitrogen in promoting optimal plant growth and development. Comparable data were supported Choudhary *et al*. (2022), Kantwa *et al*. (2025) and Yertayeva *et al*. (2025).

Grain yield (q/ha)

As indicated in Table 1, the increase in grain yield was found to be remarkably significant, rising by an impressive 34% when utilizing M_5 organic manure, which resulted in an elevation of the yield from 41.52 q ha in the control(M_1) to a noteworthy 55.67 q/ha of 7.5 tons/ha poultry manure (M_5) and 15 tons/ha FYM (M_3) with 55.09 q/ha. At the same time, these two treatments were found to be statistically equivalent. Additionally, it was observed that the application of 100% RDN (N_1) led to a substantial increase of 51.59 q/ha. Comparable data were validated by Kaur and Verma. (2016); Dhaliwal *et al*. (2023); Hekmat *et al*. (2023) and Khatua *et al*. (2025).

Straw yield (q/ha)

Based on the comprehensive data detailed in Table 1, The significant and noteworthy enhancement in straw yield was observed at an impressive 21.6% with the implementation of the innovative 7.5 tons/ha poultry manure (M_5) treatment, with statistically comparable yield with 73.27q/ha on 15 tons/ha FYM (M_3), leading to an exceptional yield of 73.65 q/ha in contrast to the control (M_1) yield of only 60.53 q/ha. Concurrently, a significant advancement of 69.83 q/ha in yield was achieved through the application of 100% RDN (N_1) fertilization. Similar findings were validated by Das *et al*. (2024) PP *et al*. (2024); Kumar *et al*. (2024) and Shakar *et al*. (2024).

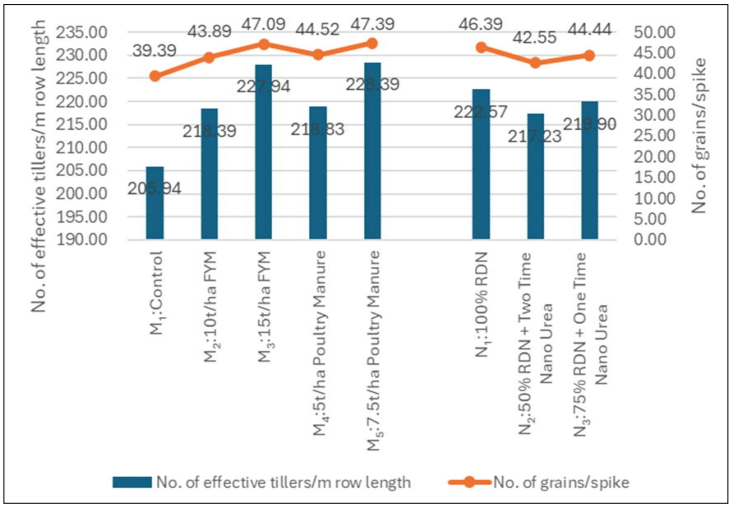


Fig 2: Influence of organic manures and nitrogen on effective tillers and spike of wheat (Pooled data of 2 years).

Table 1: Influence of organic manures and nitrogen on the yield of wheat. (Pooled data of 2 years)

Treatments	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
	Pooled data (2023-2025)				
Organic manures					
M_1: Control	36.41	41.52	60.31	101.83	40.58
M_2: 10 t/ha FYM	39.38	48.20	66.88	115.08	41.85
M_3: 15 t/ha FYM	42.97	55.09	73.27	128.36	42.91
M_4: 5 t/ha Poultry manure	39.90	48.77	67.22	115.99	42.04
M_5: 7.5 t/ha Poultry manure	43.41	55.67	73.65	129.32	43.04
SEm±	0.33	0.28	0.29	0.55	0.07
CD (P=0.05)	0.98	0.85	0.88	1.65	NS
Nitrogen					
N_1: 100% RDN	41.46	51.59	69.83	121.42	42.43
N_2: 50% RDN + Two time nano urea	39.40	47.98	66.50	114.48	41.70
N_3: 75% RDN + One time nano urea	40.39	49.98	68.47	118.45	42.12
SEm±	0.28	0.27	0.27	0.54	0.09
CD (P=0.05)	0.85	0.81	0.82	1.61	NS

Biological yield (q ha)

According to the thorough data outlined in Table 1, the total biological yield, which includes both grain and straw output, showed an impressive increase of 27% when 7.5 tons/ha poultry manure (M_5) was applied, ultimately achieving an outstanding figure of 129.32 q/ha, in stark contrast to the control group that recorded a yield of merely 101.05 q/ha. Furthermore, it was observed that the application of 15 tons/ha FYM (M_3) resulted 128.36 q/ha which is statistically at par with 7.5 tons/ha poultry manure (M_5). The nitrogen fertilization resulted in a substantial enhancement of the biological yield, yielding 121.42 q/ha when 100% RDN (N_1) was administered. This compelling data underscores the significant impact of both M_5 manure and nitrogen fertilization on agricultural productivity, highlighting their essential roles in optimizing crop yields. These observations were endorsed by Shakar *et al*. (2024), Ali *et al.* (2022), Singh *et al*. (2023) and Kumar *et al*. (2024).

Harvest index (%)

As delineated in Table 1, the harvest index (HI), which is a critical measure of the efficiency of crop production, exhibited a noteworthy increase of 6.1% when utilizing 7.5 tons/ha poultry manure (M_5), resulting in a percentage of 43.04% in comparison to the control group, which stood at 40.58%. Also the application of 15 tons/ha FYM (M_3) was observed with 42.91% and resulted statistically at par with 7.5 tons/ha poultry manure (M_5), while additionally, it also demonstrated a substantial increment subjected to comprehensive 100% RDN (N_1) with 42.43%. These observations were substantiated by Yertayeva *et al*. (2025) and Ali *et al*. (2022).

CONCLUSION

The combination of organic manures and nitrogen fertilisers considerably increased wheat growth and production. Using 7.5 t ha^{-1} of poultry manure and 100% RDN resulted in optimal plant growth, yield components, grain yield, straw yield and harvest index. Improvements were from 10-40% over control, demonstrating the efficacy of coordinated nutrition treatment. These findings show that balanced organic and inorganic fertilisation enhances nutrient availability, nitrogen usage efficiency and soil health while lowering reliance on chemical fertilisers. As a result, comprehensive nutrient management is advised for sustainable wheat production under similar agro-ecological situations.

Disclaimers

The opinions and conclusions articulated within this article are exclusively those of the authors and do not necessarily reflect the perspectives of their associated institutions. The authors bear responsibility for the precision and thoroughness of the information provided; however, they disclaim any liability for any direct or indirect losses that may arise from the utilization of this content.

Informed consent

Lovely Professional University, Punjab sanctioned all experimental methodologies and handling protocols.

Conflict of interest

The authors affirm that there are no conflicts of interest in relation to the publication of this article. Furthermore, no financial support or sponsorship has influenced the study's design, data collection, analysis, decision to publish, or manuscript preparation.

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