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Optimization of sowing time and nutrient management for enhancing yield parameters of wheat production

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Abstract

A field experiment entitled “Optimization of Sowing Time and Nutrient Management for Enhancing Wheat Production” was conducted during the Rabi season of 2025–26 at the research farm of the Department of Agronomy, Faculty of Agricultural Sciences and Allied Industries, Rama University. The study aimed to evaluate the influence of different sowing dates and nutrient management practices on yield attributes, yield, and harvest index of wheat under subtropical climatic conditions of Uttar Pradesh.

The experiment comprised three sowing dates, viz., D₁ (04 December), D₂ (19 December), and D₃ (03 January), along with four nutrient management treatments, namely N₁ (100% recommended dose of fertilizers), N₂ (100% RDF + mycorrhiza @ 5 kg ha⁻¹), N₃ (75% RDF + mycorrhiza @ 5 kg ha⁻¹ + farmyard manure @ 10 t ha⁻¹), and N₄ (control). The experiment was laid out in a factorial randomized block design with three replications. Observations were recorded on number of ears plant⁻¹, number of grains ear⁻¹, 1000-grain weight, straw yield, biological yield, and harvest index.

The results indicated that sowing time and nutrient management significantly influenced the yield parameters of wheat. Among the sowing dates, D₃ (03 January sowing) produced superior yield attributes, including higher number of ears plant⁻¹, grains ear⁻¹, and test weight, which ultimately resulted in increased straw yield and biological yield. Delayed sowing under favorable temperature conditions during reproductive stages contributed to better grain development and assimilate partitioning.

Among nutrient management practices, treatment N₃ (75% RDF + mycorrhiza + FYM) recorded the best performance in terms of yield attributes and yield. The integrated application of inorganic fertilizers, organic manure, and biofertilizer improved nutrient availability, root growth, and soil health, thereby enhancing crop productivity. The control treatment recorded the lowest values for all parameters. Harvest index was also positively affected by integrated nutrient management practices.

Overall, the study revealed that appropriate sowing time combined with integrated nutrient management can effectively improve wheat productivity and yield sustainability under subtropical agro-climatic conditions.

Keywords: Wheat, mycorrhiza, farmyard manure, integrated nutrient management, sowing dates, water use efficiency

Introduction

Wheat is one of the most widely cultivated cereal crops in the world and is a member of the Poaceae family. It is considered a staple food for millions of people and plays a crucial role in ensuring global food and nutritional security. Wheat grains are an important source of carbohydrates, proteins, vitamins, and essential minerals required for human health. Due to its high nutritional value, adaptability to diverse climatic conditions, and wide range of uses in food products, wheat has gained immense agricultural and economic importance across the globe.

At the international level, wheat occupies a significant position among cereal crops with respect to both cultivated area and total production. Countries such as China, India, Russia, and the United States are among the leading producers of wheat. In India, wheat is the second most important food grain crop after rice and forms a major component of the daily diet of the population. It contributes substantially to the country's food grain reserves and supports the livelihood of millions of farmers. The increasing demand for wheat due to rapid population growth highlights the need for improving its productivity and sustainability.

The productivity of wheat is strongly influenced by several agronomic and environmental factors,

among which sowing time is one of the most critical. Proper sowing at the recommended time allows the crop to utilize favorable temperature, sunlight, and moisture conditions during different growth stages. Timely sown wheat generally exhibits better germination, tillering, vegetative growth, and grain development. On the other hand, delayed sowing often exposes the crop to unfavorable climatic conditions, particularly high temperature stress during flowering and grain filling stages. This condition, commonly referred to as terminal heat stress, reduces the duration of grain filling and adversely affects grain size, grain weight, and overall yield. Therefore, selection of an optimum sowing date is essential for achieving higher productivity and efficient crop growth.

Nutrient management also plays a vital role in the growth and development of wheat. Wheat requires an adequate and balanced supply of essential nutrients for proper physiological and biochemical processes. Continuous cultivation and excessive dependence on chemical fertilizers alone may lead to nutrient imbalance and deterioration of soil health over time. Integrated nutrient management, which combines inorganic fertilizers with organic manures and biofertilizers, has emerged as an effective approach for maintaining soil fertility and sustaining crop productivity. The application of farmyard manure improves soil structure, moisture retention, and microbial activity, while biofertilizers such as mycorrhiza enhance nutrient uptake, particularly phosphorus and micronutrients. Combined use of these nutrient sources improves nutrient use efficiency and promotes healthy crop growth.

Water availability is another major factor affecting wheat production, especially under changing climatic conditions and increasing pressure on water resources. Efficient use of available water has become an important objective in modern agriculture. Appropriate sowing time and balanced nutrient management help improve water use efficiency by encouraging better root growth, nutrient absorption, and moisture utilization. These practices not only increase crop productivity but also contribute to sustainable agricultural production under limited water conditions. Hence, optimizing sowing time along with integrated nutrient management is essential for improving wheat yield, resource use efficiency, and long-term soil health.

Materials and Methods

The field experiment entitled “Optimization of Sowing Time and Nutrient Management for Enhancing Wheat Production” was conducted during the Rabi season of 2025–26 at the research farm of the Department of Agronomy, Faculty of Agricultural Sciences and Allied Industries, Rama University, located in Kanpur, Uttar Pradesh.

Geographically, the experimental site is situated at 26.449923° North latitude and 80.331874° East longitude in the central-western region of Uttar Pradesh, at an elevation of approximately 567 meters above mean sea level. The region experiences a subtropical climate characterized by hot summers, cool winters, and moderate rainfall, which is suitable for wheat cultivation.

Experimental Materials

The experimental material used in the present investigation consisted of Wheat seeds of a recommended variety suitable for the agro-climatic conditions of the region. Other materials used in the study included chemical fertilizers, biofertilizer (mycorrhiza), farmyard manure (FYM), irrigation facilities, and standard field equipment required for crop management and data recording.

The crop was raised under recommended agronomic practices to evaluate the influence of different sowing dates and nutrient

management treatments on growth, physiological performance, yield attributes, grain yield, and water use efficiency of Wheat.

Results and Discussion

Yields Parameters

The present investigation revealed that sowing dates and nutrient management practices significantly influenced the yield attributes and productivity of wheat. The data indicated considerable variation in the number of ears per plant, grains per ear, 1000-grain weight, straw yield, biological yield, and harvest index under different treatments. Proper synchronization of sowing time with suitable nutrient management practices created favourable conditions for crop growth and reproductive development, thereby enhancing yield performance.

Number of Ears plant⁻¹

The number of ears plant⁻¹ was significantly influenced by different sowing dates and nutrient management practices in wheat. Among the sowing dates, D3 (03 January sowing) recorded the maximum number of ears plant⁻¹, whereas the lowest value was observed under D1 (04 December sowing). Favorable climatic conditions under D3 possibly enhanced tillering and spike development. In nutrient management treatments, N3 (75% RDF + Mycorrhiza + FYM) produced the highest number of ears plant⁻¹, while the control treatment recorded the minimum value. Integrated nutrient management improved soil fertility, nutrient availability, root growth, and vegetative development, thereby increasing productive tillers and ear formation in wheat crop Kumar *et al.* (2020) ^[1].

Number of Grains Ear⁻¹

The number of grains ear⁻¹ was significantly affected by sowing dates and nutrient management practices in wheat. Among different sowing dates, D3 (03 January sowing) recorded the highest number of grains ear⁻¹, while the lowest value was observed under D1 (04 December sowing). Favorable environmental conditions during flowering and grain filling stages under D3 may have improved pollination and grain setting. In nutrient management treatments, N3 (75% RDF + Mycorrhiza + FYM) produced the maximum grains ear⁻¹, whereas the control treatment recorded the minimum value. Integrated nutrient management enhanced nutrient uptake, photosynthetic activity, and assimilate translocation, resulting in improved grain development and higher grain formation in wheat Sharma *et al.* (2020) ^[2].

1000-grain weight

The 1000-grain weight was significantly influenced by sowing dates and nutrient management practices in wheat. Among different sowing dates, D3 (03 January sowing) recorded the highest test weight, while the lowest value was observed under D1 (04 December sowing). Favorable climatic conditions during grain filling under D3 might have enhanced carbohydrate accumulation in grains. In nutrient management treatments, N3 (75% RDF + Mycorrhiza + FYM) recorded the maximum 1000-grain weight, whereas the control treatment showed the minimum value. The improvement in grain weight under integrated nutrient management may be attributed to balanced nutrient supply, improved photosynthesis, better nutrient uptake, and efficient translocation of assimilates towards developing grains Yadav *et al.* (2020) ^[3].

Straw yield

The data on straw yield indicated that both sowing dates and

nutrient management practices significantly influenced straw production in wheat. Among sowing dates, D₃ recorded the highest straw yield (61.10 q ha⁻¹), followed by D₂ (56.83 q ha⁻¹), while the lowest yield was observed under D₁ (53.17 q ha⁻¹). Improved environmental conditions and better vegetative growth under D₃ might have enhanced biomass accumulation. In nutrient management treatments, N₃ produced the maximum straw yield (73.17 q ha⁻¹), followed by N₂ (68.60 q ha⁻¹) and N₁ (64.83 q ha⁻¹), whereas the control treatment recorded the minimum yield (46.17 q ha⁻¹).

Biological yield

The biological yield of wheat was significantly influenced by sowing dates and nutrient management practices. Among different sowing dates, D₃ (03 January) recorded the highest biological yield (108.20 q ha⁻¹), followed by D₂ (100.67 q ha⁻¹), while the lowest yield was observed under D₁ (93.77 q ha⁻¹). Better growth and dry matter accumulation under favorable

climatic conditions might have enhanced biomass production. In nutrient management treatments, N₃ recorded the maximum biological yield (130.00 q ha⁻¹), followed by N₂ (121.70 q ha⁻¹) and N₁ (114.83 q ha⁻¹), whereas the control treatment produced the minimum yield (80.31 q ha⁻¹).

Harvest Index

Harvest index was slightly affected by sowing dates and nutrient management practices. Among sowing dates, D₂ (19 December) recorded the highest harvest index (43.60%), closely followed by D₃ (43.59%) and D₁ (43.36%). The minor variation among sowing dates indicates balanced partitioning of dry matter between grain and straw yield. Under nutrient management treatments, N₁ recorded the highest harvest index (43.55%), followed by N₂ (41.61%) and N₃ (41.41%), while the lowest value was observed in the control treatment (40.89%). Improved nutrient availability might have enhanced crop growth and yield distribution.

Table 1: Effect of sowing dates and nutrient management practices on yield attributes of wheat

Treatments	Number of Ears plant ⁻¹	Number of Grains Ear ⁻¹	Weight of 1000 grains
A. Date of sowing			
D1-04 December	3.50	33.00	36.77
D2-19 December	3.80	36.00	38.23
D3-03 January	4.20	39.00	39.77
S.E(d)	0.02	0.20	0.05
CD (P=0.05)	0.06	0.61	0.16
B. Nutrient Management			
N1 -(100% RDF)	4.60	43.00	41.23
N2-100% RDF Mycorrhiza 5 kg/ha	4.90	46.00	42.77
N3-75% RDF + Mycorrhiza 5 kg/ha + FYM 10 t/ha	5.30	49.00	44.23
N4- 100% Control	2.80	28.00	34.23
S.E(d)	0.02	0.20	0.05
CD (P=0.05)	0.06	0.61	0.16

Table 2: Effect of sowing dates and nutrient management practices on straw yield, biological yield and harvest index of wheat

Treatments	Straw yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)	Harvest Index (%)
A. Date of sowing			
D1-04 December	53.17	93.77	43.36
D2-19 December	56.83	100.67	43.60
D3-03 January	61.10	108.20	43.59
SE (d)	0.13	0.21	0.04
CD (P=0.05)	0.40	0.63	0.13
B. Nutrient Management			
N1 -(100% RDF)	64.83	114.83	43.55
N2-100% RDF Mycorrhiza 5 kg/ha	68.60	121.70	41.61
N3-75% RDF + Mycorrhiza 5 kg/ha + FYM 10 t/ha	73.17	130.00	41.41
N4- 100% Control	46.17	80.31	40.89
SE (d)	0.13	0.21	0.04
CD (P=0.05)	0.40	0.63	0.13

Conclusion

The present investigation demonstrated that sowing time and nutrient management practices had a significant effect on the yield and productivity of wheat. Among the different sowing dates, D₃ (03 January sowing) consistently produced superior performance in terms of ears plant⁻¹, grains ear⁻¹, 1000-grain weight, straw yield, and biological yield. Favorable climatic conditions during vegetative and reproductive stages under this sowing date might have enhanced crop growth and yield formation.

Among nutrient management treatments, N₃ (75% RDF + Mycorrhiza 5 kg ha⁻¹ + FYM 10 t ha⁻¹) recorded the highest values for most yield parameters and biomass production. The integrated application of inorganic fertilizers, biofertilizer, and

organic manure improved nutrient availability, soil health, and plant growth, resulting in better yield performance.

Therefore, the combination of January sowing with integrated nutrient management can be considered an effective approach for improving wheat productivity and sustaining soil fertility under the agro-climatic conditions of Kanpur, Uttar Pradesh.

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