International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 11s,2025
https://theaspd.com/index.php

Impact of Integrated Nutrient Management and Sowing Dates on Wheat (*Triticum aestivum* L.)

Ajit Kumar[1],Bhupesh Kumar Mishra[2]
[1]Master Student, Maharishi School of Science & Humanities, Maharishi University of Information Technology, Lucknow
[2]Assistant Professor, Maharishi School of Science & Humanities, Maharishi University of Information Technology, Lucknow, mbhupesh14@gmail.com

Abstract
A field experiment was conducted during the Rabi season of 2024–25 to evaluate the "Impact of Integrated Nutrient Management and Sowing Dates on Wheat (Triticum aestivum L.)." The experiment comprised three sowing dates—5th November, 15th November, and 5th December—and five integrated nutrient management (INM) practices: (1) 100% recommended dose of fertilizers (RDF) through inorganic sources, (2) 75% recommended dose of nitrogen (RDN) through inorganic fertilizers + 25% nitrogen (N) through farmyard manure (FYM), (3) 75% RDN through inorganic fertilizers + 25% N through vermicompost + $ZnSO_4$ @ 25 kg ha $^{-1}$ + sulphur @ 40 kg ha $^{-1}$, (4) 75% RDN + 25% N through vermicompost + $ZnSO_4$ @ 25 kg ha $^{-1}$, and (5) 75% RDN through inorganic fertilizers + 25% N through poultry manure. Wheat sown on 15th November recorded the highest values for plant height, number of tillers per m^2, dry matter accumulation (g/m row), yield-attributing parameters (such as grain and straw yield), compared to the 5th December sowing. However, these values were statistically at par with those recorded under the 5th November sowing, indicating that early to mid-November is the optimal window for wheat sowing under the given agro-climatic conditions.
Keywords: *Wheat, integrated nutrient management, dates of sowing*

INTRODUCTION

Wheat (*Triticum aestivum* L.) remains one of the most essential staple food crops worldwide, playing a vital role in global food security. Native to Southwest Asia, it is often referred to as the "King of Cereals" due to its wide adaptability, vast cultivation area, and high consumption rates. As of 2025, wheat is cultivated in more than 45 countries, with China (138 million tonnes), India (108 million tonnes), and Russia (104 million tonnes) leading in production, followed by the United States and France. In India, wheat contributes nearly 35% of total cereal production, forming the backbone of diets in northern and central regions. It is a primary ingredient in commonly consumed foods like bread, pasta, biscuits, cakes, sweets, and chapatis.Over the last two decades, increased use of synthetic fertilizers has helped achieve significant gains in wheat productivity. However, the over-dependence on chemical inputs has raised concerns about soil health degradation, declining factor productivity, and environmental pollution. According to recent reports (IJOEAR, 2024), prolonged exclusive use of chemical fertilizers leads to nutrient imbalance, reduced soil microbial activity, and a decline in organic carbon content, ultimately affecting wheat yields and soil sustainability.Research by Sheoran et al. (2017) indicated that organic manures alone cannot fully meet wheat's nutrient demands. However, newer studies (e.g., Jat et al., 2025) emphasize that integrating organic and inorganic sources enhances nutrient efficiency, sustains soil fertility, and improves crop performance. This approach, known as Integrated Nutrient Management (INM), involves the combined use of organic manures (like FYM, vermicompost, poultry manure), inorganic fertilizers, and bio-fertilizers to optimize nutrient availability, reduce chemical dependency, and promote environmental safety.INM not only ensures a balanced nutrient supply throughout the crop growth stages but also improves soil structure, microbial diversity, and moisture retention. This integrated approach is now widely recommended under sustainable agriculture frameworks aimed at mitigating climate stress and enhancing input-use efficiency.Apart from nutrient management, sowing date plays a pivotal role in wheat productivity. Wheat is highly sensitive to sowing time, and any delay can adversely affect germination, tillering, spike development, and grain filling. Under delayed sowing, wheat often encounters terminal heat stress during anthesis and grain-filling stages, resulting in reduced grain number, size, and quality.

Recent findings by Pathania et al. (2024) revealed that delayed sowing from October 20 to December 20 led to a 0.6–7.7% reduction in growing degree days (GDD), shortening the wheat crop's phenological duration. This reduction translated into a 50–62% decrease in grain yield, due to the diminished time for key growth stages. Similar outcomes were reported in a 2024 study by Yi Hong et al., which highlighted genetic differences in grain size and yield stability under delayed sowing conditions. These findings support the critical importance of timely sowing (ideally between 5–20 November) for optimizing physiological development and yield under favorable temperature regimes.Wheat thrives best at temperatures ranging from 15°C to 25°C, though it can tolerate a minimum of 3–4°C during early growth and a maximum of 30–32°C in later stages. However, exposure to temperatures above 28°C during anthesis or grain filling can significantly disrupt photosynthesis, reduce grain weight, and lead to substantial yield penalties. With climate variability and rising mean temperatures becoming more frequent, the adoption of climate-smart agronomic practices—such as INM and optimal sowing windows—has become increasingly vital.Thus, combining Integrated Nutrient Management with appropriate sowing dates emerges as a practical and effective strategy to improve wheat yield, maintain soil fertility, and support sustainable food production under changing agro-climatic conditions.

MATERIALS AND METHODS

A field experiment was conducted during the Rabi season of 2024–2025 at the Agronomy Research Farm of Maharshi University of Information Technology, Lucknow. The aim was to study the impact of integrated nutrient management and sowing dates on the growth and yield of wheat (*Triticum aestivum* L.). The experiment was laid out in a Factorial Randomized Block Design (F-RBD) with three replications, comprising two factors: three dates of sowing and five integrated nutrient management (INM) treatments. The three sowing dates were S1 – 5th November, S2 – 15th November, and S3 – 5th December. The five INM treatments were as follows: T1 – 100% Recommended Dose of Fertilizer (RDF) through inorganic sources; T2 – 75% Recommended Dose of Nitrogen (RDN) through inorganic fertilizers + 25% N through Farm Yard Manure (FYM); T3 – 75% RDN + 25% N through Vermicompost + Zinc Sulphate ($ZnSO_4$) @ 25 kg ha^{-1} + Sulphur @ 40 kg ha^{-1}; T4 – 75% RDN through inorganic fertilizers + 25% N through Vermicompost; and T5 – 75% RDN through inorganic fertilizers + 25% N through Poultry Manure. The experimental field was prepared using a tractor-drawn cultivator followed by disc harrowing. Weeds and crop residues were removed to ensure a clean seedbed. All organic manures and basal doses of phosphorus and potash were applied one day before sowing, and the materials were incorporated thoroughly into the soil on a plot-wise basis. The wheat variety 'HD-2967' was used for the experiment and was manually sown in rows spaced 22.5 cm apart. Sowing dates and fertilizer applications were as per treatment allocations. Nitrogen was applied in three equal splits: one-third as basal, one-third at the crown root initiation stage (approximately 21 days after sowing), and the remaining one-third at the heading stage. All recommended agronomic practices were followed uniformly throughout the experimental period. Observations on growth parameters (such as plant height, tiller count, and dry matter accumulation), yield attributes (including number of spikes per square meter, grains per spike, 1000-grain weight), and final grain and straw yield were recorded using standard procedures. For nutrient uptake analysis, plant samples were collected at harvest, dried, ground, and analyzed for nitrogen, phosphorus, and potassium content using standard chemical methods. The uptake of nutrients was calculated using the following formula: Nutrient uptake (kg ha^{-1}) = [Nutrient concentration (%) × Dry matter yield (kg ha^{-1})] / 100

RESULTS AND DISCUSSION

Effect on Crop Growth Parameters

Important growth-attributing characteristics include plant height, number of tillers per m^2, dry matter accumulation, leaf area index, and chlorophyll content. Among the sowing dates, 15th November recorded significantly superior values for number of tillers per m^2, dry matter accumulation (g/m row), and chlorophyll content at 90 days after sowing (DAS) compared to the 5th December sowing. However, these values were statistically at par with those observed under the 5th November sowing, indicating that early to mid-November sowing is optimal under the given conditions.

Plant growth, which reflects the increase in size, volume, and biomass of plant cells, is one of the most crucial physiological traits. It is significantly influenced by the date of sowing, which directly affects the duration and efficiency of each phenological stage. Late sowing (e.g., 5th December) shortens the crop duration, reducing the time available for growth and development.

Wheat sown on 15th November exhibited the highest plant height, number of tillers per m^2, and dry matter accumulation per plant. Among the nutrient treatments, T_3 (75% RDN + 25% N through vermicompost + $ZnSO_4$ @ 25 kg ha^{-1} + sulphur @ 40 kg ha^{-1}) recorded the maximum values for plant height, number of tillers per m^2, and dry matter accumulation.

The improved growth characteristics under T_3 may be attributed to the balanced and sustained release of nutrients, minimizing nutrient limitations throughout the crop cycle. In contrast, treatments using FYM as a partial nutrient source may have experienced delayed nutrient availability, which could have limited early growth. Effect on Yield Parameters- Sowing wheat on 15th November (S_2) resulted in the highest grain and straw yields, outperforming both early sowing (5th November - S_1) and late sowing (5th December - S_3). The improved yield under S_2 can be attributed to favorable soil moisture, temperature conditions, and optimal resource availability that enhanced vegetative growth, leading to better reproductive success. This was evident from the increased number of tillers, longer ear heads, and greater number of grains per ear. Among the integrated nutrient management treatments, N_3 (75% RDN + 25% N through vermicompost + $ZnSO_4$ @ 25 kg ha^{-1} + sulphur @ 40 kg ha^{-1}) recorded the highest grain and straw yields. This superior performance was likely due to the balanced and sustained nutrient supply throughout the crop growth stages, promoting enhanced net photosynthesis, dry matter accumulation, and ultimately higher yield-attributing parameters. The results indicate that the combined application of organic and inorganic nutrient sources, particularly in N_3, effectively supported plant growth and yield formation. The consistent performance of this treatment across parameters validates the potential of integrated nutrient management in improving wheat productivity.

Table 4.1:" Impact of Integrated Nutrient Management and Sowing Dates on Wheat (Triticum aestivum L)"

	Plant height (cm)			
Treatment	30 DAS	60 DAS	90 DAS	At harvest
Year	2024	2024	2024	2024
Date of sowing				
05-Nov	27.85	55.67	73.05	81.43
15-Nov	32.12	62.71	81.63	91.26
05-Dec	21.67	45.91	58.47	65.34
SEm±	1.151	1.777	3.098	3.309
CD (p =0.05)	4.52	6.98	12.16	12.99
Integrated Nutrient Management				
100% RDN (Recommended Dose of Nitrogen) through inorganic fertilizer	25.15	51.30	68.10	76.20
75%RDNthrough inorganic fertilizer +25%N through FYM	26.95	53.95	70.40	78.70
75% RDN+25% N through Vermicompost + ZnSO4 @ 25 kg + Sulphur @ 40 kg ha-1	28.50	57.20	73.80	82.45
75% RDN+25% N through Vermicompost+ ZnSO4 @ 25 kg ha-1	27.30	55.20	71.10	79.55
75% RDN through inorganic fertilizer + 25% N through Poultry manure	27.10	54.95	71.00	79.40
SEm±	0.19	0.33	0.067	0.057

CD (p =0.05)	0.55	0.96	0.2	0.17

Table 4.2: Impact of Integrated Nutrient Management and date of sowing on the number of tillers/m2 of wheat

	Number of tillers/m^2 of wheat			
Treatment	30 DAS	60 DAS	90 DAS	At harvest
Year	2024	2024	2024	2024
Date of sowing				
05-Nov	266.4	539.55	557.35	576.22
15-Nov	297.12	601.22	621.55	645.14
05-Dec	211.88	432.2	450.41	465.78
SEm±	9.85	19.33	17.45	21.12
CD (p =0.05)	39.2	77.1	69.8	84.55
Integrated Nutrient Management				
100% RDN (Recommended Dose of Nitrogen) through inorganic fertilizer	246.24	503.12	521.4	540.1
75% RDN through inorganic fertilizer + 25% N through FYM	255.01	520.05	539.24	558.2
75% RDN+25% N through Vermicompost + ZnSO4 @ 25 kg + Sulphur @ 40 kg ha-1	268.3	545.41	566.7	585.99
75% RDN+25% N through Vermicompost + ZnSO4 @ 25 kg ha-1	259.18	525.1	544.55	563.62
75% RDN through inorganic fertilizer + 25% N through Poultry manure	257.77	522.25	541.48	561.01
SEm±	0.28	0.51	0.48	0.36
CD (p =0.05)	0.82	1.51	1.45	1.08

Table 4.3: Impact of Integrated Nutrient Management and dates of sowing on dry matter accumulation (g/m row length) of wheat

Treatment	Dry matter accumulation (g/m row length)			
	30 DAS	60 DAS	90 DAS	At harvest
	2024-25	2024-25	2024-25	2024-25
Date of sowing				
5 November	36.12	109.25	270.90	447.62
15 November	37.44	114.40	282.82	466.85
5 December	29.45	89.78	222.85	367.21
SEm±	1.65	5.20	13.11	21.85
CD(*p*=0.05)	6.48	20.45	51.98	85.32
Integrated Nutrient Management				
100% RDN (Recommended Dose of Nitrogen) through inorganic fertilizer	26.81	82.03	203.65	337.47
75%RDNthrough inorganic fertilizer+25%N through FYM	30.05	91.83	227.68	377.52

75% RDN+25% N through Vermicompost + ZnSO4 @ 25 kg + Sulphur @ 40 kg ha-1	43.15	132.04	327.81	543.22
75%RDNthrough inorganic fertilizer+25%N throughVermi-compost	36.11	110.50	274.32	454.59
75%RDNthrough inorganic fertilizer+25%N through Poultry manure	33.15	101.36	251.40	416.77
SEm±	0.966	3.035	7.681	12.617
CD(*p*=0.05)	2.82	8.86	22.42	36.83

Table 4.4: Impact of Integrated Nutrient Management and dates of sowing on yield attributes of wheat.

Treatment	Number of ears/m^2	Ear length (cm)	Number of grains/ears	Number of unfilled spikelets/ears	Test weight (g)
	2024-25	2024-25	2024-25	2024-25	2024-25
Date of Sowing					
05-Nov	584.20	5.65	27.91	4.75	35.42
15-Nov	602.55	5.84	28.88	4.20	36.58
05-Dec	481.45	4.33	21.30	5.49	27.18
SEm±	8.20	0.165	0.79	0.145	1.02
CD(*p*=0.05)	32.40	0.64	3.12	0.57	3.98
Integrated Nutrient Management					
100% RDN (Recommended Dose of Nitrogen) through inorganic fertilizer	500.40	3.78	18.62	6.89	23.66
75%RDNthrough inorganic fertilizer +25%N throughFYM	526.25	4.70	23.20	5.64	29.40
75% RDN+25% N through Vermicompost + ZnSO4 @ 25 kg + Sulphur @ 40 kg ha-1	614.80	6.60	32.45	2.78	41.24
75%RDNthrough inorganic fertilizer +25%N through Vermi-compost	587.50	5.77	28.42	3.90	36.12
75%RDNthrough inorganic fertilizer +25%N through Poultry manure	553.20	5.58	27.30	4.70	34.92
SEm±	7.65	0.232	1.15	0.155	1.48
CD(*p*=0.05)	22.30	0.68	3.34	0.45	4.25

Table 4.5: Impact of Integrated Nutrient Management and date of sowing on grain yield, straw yield, and harvest index of wheat

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)
	2024-25	2024-25	2024-25	2024-25
Date of Sowing				
05-Nov	3580.42	5639.80	9220.22	38.82
15-Nov	3681.14	5642.50	9323.64	39.45

05-Dec	3272.15	5070.80	8342.95	39.22
SEm±	9.55	17.40	26.50	0.045
CD(p=0.05)	37.60	68.45	104.20	0.17
Integrated Nutrient Management				
100% RDN (Recommended Dose of Nitrogen) through inorganic fertilizer	3055.70	4879.20	7934.90	38.50
75%RDNthroughinorganic fertilizer+25%Nthrough FYM	3110.10	4899.30	8009.40	38.83
75% RDN+25% N through Vermicompost + ZnSO4 @ 25 kg + Sulphur @ 40 kg ha-1	3962.80	5981.35	9944.15	39.85
75%RDNthroughinorganic fertilizer+25%NthroughVermi-compost	3775.20	5803.00	9578.20	39.42
75% RDN through inorganic fertilizer + 25% N through Poultry manure	3658.70	5687.90	9346.60	39.13
SEm±	15.00	14.30	25.20	0.09
CD(p=0.05)	43.80	41.50	74.10	0.26

Fig. 4.1:" Impact of Integrated Nutrient Management and Sowing Dates on Wheat (Triticum aestivum L)"

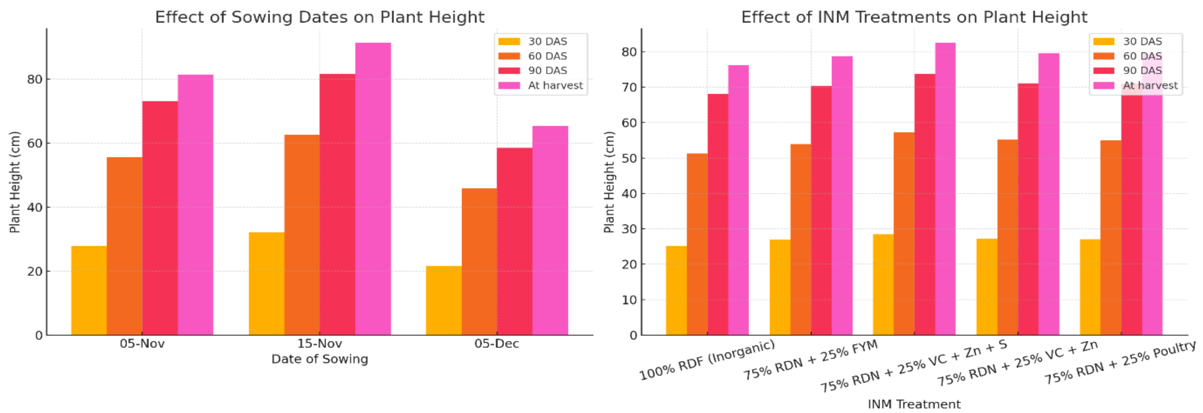


Fig. 4.2: Impact of Integrated Nutrient Management and date of sowing on the number of tillers/m2 of wheat

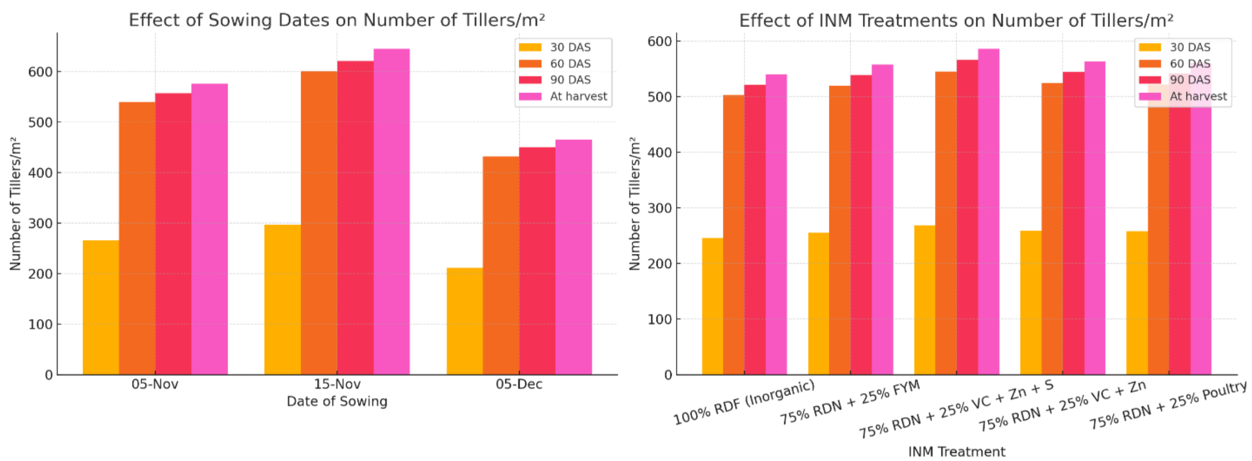


Fig. 4.3: Impact of Integrated Nutrient Management and dates of sowing on dry matter accumulation (g/m row length) of wheat

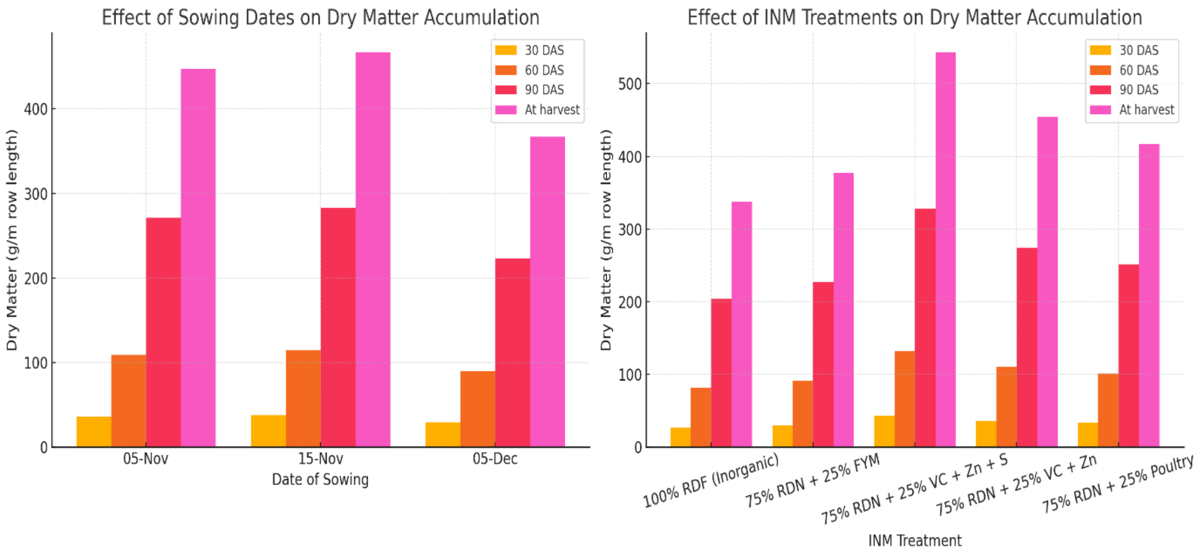
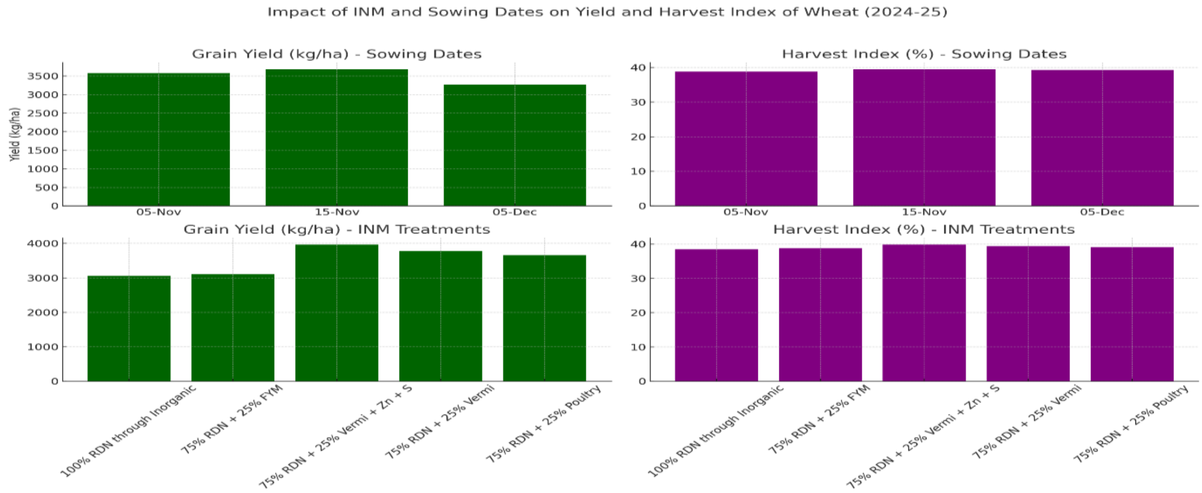


Fig 4.4: Impact of Integrated Nutrient Management and dates of sowing on yield attributes of wheat.

Table 4.5: Impact of Integrated Nutrient Management and date of sowing on grain yield, straw yield, and harvest index of wheat



REFERENCES

1. **Kaur, C., Kumar, S., & Singh, K. (2024)**. *Effect of integrated nutrient management on growth and yield of wheat (Triticum aestivum L.) under the system of wheat intensification.* Journal of Cereal Research, 15(2). Evaluated 11 INM treatments under a system of wheat intensification. Found best growth, yield, LAI, tillers, and dry matter with 75% RDF + FYM + vermicompost + biofertilizers
2. **Tiwari, H. N., Singh, D. K., Singh, S., Singh, G., & Yadav, D. (2025)**. *Effect of integrated nutrient management (INM) on growth and yield of wheat crop (Triticum aestivum L.).* Agronomy Journals, 8(1). In Lucknow, found that 125% RDF (all inorganic) recorded the highest grains/spike, test weight, grain & straw yield
3. **Jatin, I. S., Behl, R. K., Sharma, P. K., Saini, M., & Mwanika, B. (2024)**. *Effect of integrated nutrient management on growth, yield attributes, and yield of black wheat under late sown conditions.* Agronomy Journals, 7(6). Under late sowing, 100% RDN + vermicompost + Azotobacter + Hairamine spray yielded the best plant height, dry matter, tillering, and yield (40.92 q/ha)
4. **Tiwari, H., Naresh, R. K., Singh, P. K., Kumar, Y., Purushottam, & Vivek (2023)**. *Effect of Integrated Nutrient Management on Growth and Productivity in Typic Ustochrepts (W. U.P., India).* Int. J. Plant & Soil Science, 35(11):129–142. The optimal INM (50% N via vermicompost + FYM, bio-stimulants) significantly improved physiological traits, biomass, and yielded 47.5 kg/ha
5. **Bhagat, R. K., Sahu, M., Narayan, D., & Dhurve, R. (2023)**. *Influence of Different Sowing Dates and Nutrient Management on Dry Matter Accumulation and Grain Yield.* Int. J. Plant & Soil Science, 35(21):751–757. Split-plot trial; best results on 5 Nov sowing + 150% RFD + FYM 15 t/ha + growth regulators—boosted dry matter, CGR, RGR, yield components
6. **Pravesh Kumar, Dheer, V., Kumar, P., et al. (2024)**. *Effect of Irrigation Scheduling and Different Sowing Dates on Growth and Yield of Wheat.* Int. J. Environ. & Climate Change, 14(1):155–161. Found the highest shoot density, height, biomass, and yield on 15 Nov sowing with 1.0 IW/CPE irrigation scheduling
7. **Dhiman Mukherjee (2024)**. *Enhancement of wheat productivity through variation in sowing time and nutrient management with growth regulators.* Annals of Agricultural Research, 45(4):351–356. Four sowing dates × nutrient treatments: best grain yield (15 Nov, 48.39 q/ha) with 150% RFD + FYM + growth regulators
8. **Kumawat, R. K., Tiwari, G., Ramakrishnan, R. S., et al. (2023)**. *Sowing Time, Plant Growth Regulators, and Their Application Scheduling Affect Quality Traits of Wheat.* Int. J. Plant & Soil Science, 35(18):121–126. Studied sowing and PGR sprays: normal (Nov) sowing + salicylic acid spray improved seed quality traits significantly
9. **Nadia, Amanullah, Arif, & Muhammad D. (2023)**. *Improvement in Wheat Productivity with Integrated Management of Beneficial Microbes along with Organic and Inorganic Phosphorus Sources.* Agriculture, 13(6):1118. Combining organic & inorganic P-fertilizers with PSB improved grains/spike (+23.9%), yield (+40.9%), and biological yield (+17%) over the control
10. **Hussain, K., Hakki, E. E., Ilyas, A., et al. (2024)**. *Role of Nitrogen Fertilization and Sowing Date in Productivity & Climate Change Adaptation Forecast in Rice–Wheat Cropping System.* Nitrogen, 5(4):977–991. Modeled N-rate × sowing date under climate scenarios; early sowing + N-timing improved yield and resilience to climate variability