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Effect of integrated nutrient management on growth, yield attributes and yield of black wheat (*Triticum aestivum* L.) under late sown condition

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Abstract
Wheat (*Triticum aestivum* L.) cultivation under late-sown conditions faces challenges that affect growth and yield. This study aimed to evaluate the efficacy of integrated nutrient management (INM) on the growth, yield attributes and yield of black wheat. A field experiment was conducted during the *Rabi* season 2022-23 at Maharishi Markandeshwar (Deemed to be University), the experiment utilized a randomized complete randomized block design with eight treatments, including various combinations of urea, vermicompost, Hairamine spray and *Azotobacter*. Among these, treatments T_6 (100% RDN through urea + Hairamine spray) emerged as the most effective, showcasing superior plant height, increased dry matter accumulation, prolific tillering and robust yield attributes. Notably, treatment T_6 exhibited the highest grain yield at 40.92 q/ha, surpassing other treatments significantly. These findings underscored the potential of tailored INM strategies, particularly T_6, in optimizing black wheat productivity under challenging late-sown conditions, thereby supporting sustainable agricultural practices and food security.

Keywords: Integrated nutrient management, late-sown, black wheat, Hairamine, *Azotobacter*, sustainable agriculture

1. Introduction
Wheat (*Triticum aestivum* L.) is a major cereal crop globally and serves as a staple food for a large portion of the world's population (Sahu *et al*., 2020) [12]. In 2023-24, global wheat production reached approximately 790 million metric tons, covering an area of about 216 million hectares, with an average productivity of 3.65 tons per hectare (FAO, 2024) [5]. In India, wheat production reached 114 million metric tons, cultivated over 31.3 million hectares, resulting in a productivity of 3.64 tons per hectare (Ministry of Agriculture and Farmers Welfare, 2024). Specifically, in Haryana, wheat production was recorded at 11.06 million metric tons from an area of 2.5 million hectares, with a productivity of 4.42 tons per hectare (CEIC, 2024) [1].

Black wheat has gained attention for its unique nutritional properties and potential health benefits (Dhua *et al*., 2021) [4]. Black wheat is high in anthocyanins, a type of flavonoid with powerful antioxidant properties (Sharma *et al*., 2020) [14]. Black wheat contains higher levels of dietary fiber, proteins, vitamins and minerals compared to traditional wheat varieties (Padhy *et al*., 2019) [9]. Additionally, the continuous demand for higher yields and improved nutritional quality necessitates ongoing research and innovation in wheat agronomic practices (Yadav *et al*., 2020) [17]. By implementing advanced INM practices, farmers can reduce the use of chemical fertilizers, resulting in lower human and environmental costs (Chauhan *et al*., 2024) [2]. Black wheat plant growth and grain yield attributes are differently affected by both inorganic fertilizer, organic manure (vermicompost), Bio stimulant (Hairamine) and biofertilizer (*Azotobacter*). The widespread adoption of black wheat faces several challenges, including agronomic issues related to its cultivation and the need for more comprehensive studies on its health impacts (Salim and Raza 2020) [13]. By examining current challenges and potential solutions, this study seeks to contribute to the advancement of sustainable black wheat production and to enhance its role in global food security.

2. Methods and Materials

The field experiment titled "Effect of integrated nutrient management on growth, yield attributes and yield of black wheat (*Triticum aestivum* L.) under late sown condition" was conducted during the *Rabi* season of 2022–23 at the research farm of Maharishi Markandeshwar (Deemed to be University) Mullana, Ambala. The experiment utilized randomized complete block design (RBD) included eight treatments with three replications. Treatments varied in nutrient management strategies: T_1 (Control), T_2 (100% RDN through urea), T_3 (75% RDN through urea + 25% through vermicompost), T_4 (50% RDN through urea + 50% through vermicompost), T_5 (75% RDN through urea + 25% through Hairamine spray), T_6 (100% RDN through urea + Hairamine spray), T_7 (75% RDN through urea + *Azotobacter*) and T_8 (100% RDN through urea + *Azotobacter*). Data were recorded for growth parameters, yield attributes and yield. Growth parameters included plant height, dry matter accumulation and number of tillers per meter row length at 30, 60, 90 and 120 days after sowing (DAS) and at harvest. Yield attributes recorded were the number of effective tillers per meter row length, spike length, number of spikelets per spike, number of grains per ear, test weight (g), grain yield (kg/ha), straw yield (kg/ha), biological yield (kg/ha) and harvest index (%). The experimental data were statistically analysed using ANOVA and the significance of treatment effects was determined using the 'F' test, with differences between means compared using critical differences (CD).

3. Results

3.1 Effect of integrated nutrient management on growth parameters of black wheat

The data for black wheat across various growth stages revealed significant differences in plant height, dry matter accumulation and tillers per meter row length, emphasizing the impact of different fertilization strategies and presented in Table 1. T_6 (100% RDN through urea + Hairamine spray) and T_8 (100% RDN through urea + *Azotobacter*) consistently outperformed the control (T_1) and other treatments. At 30 DAS, T_8 exhibited the tallest plants at 23.71 cm, a 66.7% increase over T_1, while T_6 led by 60 DAS with 44.64 cm, 62.2% taller than T_1. This trend continued at 90 DAS and 120 DAS, with T_6 maintaining the highest growth at 81.66 cm and 100.21 cm, respectively. In terms of dry matter accumulation, T_6 leading at harvest with 188.33 g/mrl, significantly surpassing T_1's 126.14 g/mrl. For tillers per meter row length, at 30 DAS, T_2 and T_8 had shown increases of 37.44 tillers/mrl (37.7% higher than T_1's 27.21 tillers/mrl), while T_6 had shown 37.44 tillers/mrl (37.7% higher). By 60 DAS, T_6 had exhibited the highest number of tillers with 61.81 tillers/mrl (25.4% higher than T_1's 49.30 tillers/mrl), followed by T_8 at 59.57 tillers/mrl (21.1% higher) and T_2 at 58.75 tillers/mrl (19.2% higher). At 90 DAS and 120 DAS, T_6 consistently maintained the highest tiller count with 66.72 tillers/mrl (22.3% and 23.7% higher than T_1's 54.59 tillers/mrl and 53.65 tillers/mrl, respectively), followed by T_8 and T_2, which also showed significant increases.

3.2 Effect of integrated nutrient management on yield attributes of black wheat

The data displayed in Table 2 revealed significant variations in black wheat productivity among different fertilization strategies. Treatments T_6 (100% RDN through urea + Hairamine spray) and T_8 (100% RDN through urea + *Azotobacter*) consistently outperformed the control (T_1) in effective tillers per meter row length, spikelets per spike, grains per spike, spike length and test weight. T_6 led with 63.31 tillers/mrl (24.7% higher than T_1), 19.24 spikelets per spike (32.2% higher), 38.47 grains per spike (32.1% higher) and a spike length of 10.72 cm (63.1% higher). T_8 also showed significant improvements with 61.60 tillers/mrl (21.4% higher), 18.31 spikelets per spike (25.7% higher), 36.60 grains per spike and a spike length of 10.12 cm. Test weights for T_6, T_8 and T_2 were 37.37 grams, 36.85 grams and 36.34 grams, respectively, compared to T_1's 32.67 grams. T_5 and T_3 also showed notable test weights of 35.49 grams and 34.65 grams.

3.3 Effect of integrated nutrient management on grain yield (q/ha), Straw yield(q/ha), biological yield (q/ha) and harvest index (%) of black wheat

The data for black wheat across various treatments highlighted significant differences in grain yield, straw yield, biological yield and harvest index influenced by different fertilization strategies and presented in Table 2. T_6 (100% RDN through urea + Hairamine spray) and T_8 (100% RDN through urea + *Azotobacter*) were top performers, with grain yields of 40.92 q/ha and 38.86 q/ha, respectively, marking increases of 65.7% and 57.4% over the control (T_1) at 24.70 q/ha. T_2 (100% RDN through urea) also performed strongly with a yield of 38.20 q/ha, a 54.6% increase. T_3 (75% RDN through urea + 25% vermicompost) and T_4 (50% RDN through urea + 50% vermicompost) yielded 34.01 q/ha and 33.24 q/ha, respectively, while T_5 (75% RDN through urea + 25% Hairamine spray) achieved 36.07 q/ha and T_7 (75% RDN through urea + *Azotobacter*) yielded 31.15 q/ha. For straw yield, T_6 led with 53.20 q/ha, a 39.0% increase over T_1's 38.28 q/ha, followed by T_8 at 51.69 q/ha and T_2 at 51.20 q/ha. T_5, T_3 and T_4 showed notable increases as well. In biological yield, T_6 recorded the highest at 94.12 q/ha, a 49.1% increase over T_1's 62.99 q/ha, with T_8 and T_2 also showing substantial gains. The harvest index data indicated T_6 had the highest efficiency at 43.47%, followed by T_8 at 42.91% and T_2 at 42.73%, with other treatments showing balanced allocation between grain and biomass production.

4. Discussion

The growth parameters and yield attributes of black wheat varied significantly across different fertilization treatments, highlighting the impact of nutrient management strategies on productivity. T_6 (100% RDN through urea + Hairamine spray) achieved the highest plant height, dry matter accumulation and tiller number due to enhanced nutrient uptake and improved photosynthesis and metabolic activity from Hairamine spray. T_6 achieved the highest numbers of effective tillers, spikelets per spike, grains per spike, spike length and test weight, leading to superior grain and straw yields. T_6's improved yield attributes can be attributed to the synergistic effects of Hairamine spray, optimizing nutrient uptake and metabolic activity. These results aligned with studies by Kumar *et al*. (2020) [6], Shekhar *et al*. (2021) [15], Patyal *et al*. (2022) [10] and Singh *et al*. (2023) [16]. T_8 (100% RDN through urea + *Azotobacter*) and T_2 (100% RDN through urea) also exhibited remarkable growth and high grain yield emphasizing nitrogen's essential role in vegetative development. Similar findings have been reported by Rouphael *et al*. (2020) [11], Choudhary *et al*. (2022) [3] and Mohan *et al*. (2024) [8].

Table 1: Effect of integrated nutrient management on growth parameters of black wheat

		Plant Height (cm)					Dry matter accumulation (g/mrl)					Tillers per meter row length			
Tr. No.	**Treatments**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**120 DAS**
T_1	Control (No Fertilizer)	14.23	27.52	60.41	78.31	79.56	3.25	26.76	59.25	120.93	126.14	27.21	49.3	54.59	53.65
T_2	100% RDN through urea	21.93	42.59	78.81	97.65	98.54	8.62	41.52	82.49	173.24	178.12	37.44	58.75	63.68	62.64
T_3	75% RDN through urea + 25% from vermicompost	20.11	38.92	73.85	92.35	93.27	7.32	36.19	73.06	157.61	162.64	34.43	55.65	60.5	59.51
T_4	50% RDN through urea + 50 % from vermicompost	18.76	37.35	71.32	89.78	90.57	6.04	35.53	72.53	156.62	162.25	32.38	54.22	58.38	57.1
T_5	75% RDN through urea + 25% Hairamine spray (3 doses)	16.02	40.53	76.32	95.09	96.08	5.26	38.89	77.63	167.34	172.45	30.04	57.24	62.16	61.02
T_6	100% RDN through urea + Hairamine spray (3 doses)	21.93	44.64	81.66	100.21	101.75	8.62	44.72	87.26	183.26	188.33	37.44	61.81	66.72	65.91
T_7	75% RDN through urea + *Azotobacter*	17.38	35.46	68.96	87.12	88.02	5.87	32.34	67.84	150.46	155.21	31.21	51.85	56.73	56.38
T_8	100% RDN through urea+ *Azotobacter*	23.71	43.73	79.41	99.45	100.38	8.92	42.02	83.85	176.1	181.62	38.86	59.57	64.55	63.83
C.D. at 5%		1.25	1.55	2.3	2.55	2.43	1.25	2.4	4.04	5.31	5.59	1.05	1.3	1.43	1.49
SEm ±		0.41	0.51	0.75	0.83	0.79	0.41	0.78	1.32	1.73	1.82	0.34	0.42	0.47	0.49

Table 2: Effect of integrated nutrient management on yield attributes and yield of black wheat.

		Yield attributes and yield								
Tr. No.	**Treatments**	**No. of Effective tiller/mrl**	**Spikelets per spike (No.)**	**Grains per spike (No.)**	**Spike length (cm)**	**Test weight (g)**	**Grain yield (q/ha)**	**Straw yield (q/ha)**	**Biological yield (q/ha)**	**Harvest index (%)**
T_1	Control (No Fertilizer)	50.74	14.55	29.1	6.57	32.67	24.7	38.28	62.99	39.21
T_2	100% RDN through urea	60.54	18.15	36.3	9.95	36.34	38.2	51.2	89.4	42.73
T_3	75% RDN through urea + 25% from vermicompost	58.23	17.25	34.5	8.49	34.65	34.01	47.27	81.28	41.84
T_4	50% RDN through urea + 50 % from vermicompost	56.94	17.1	34.2	7.75	34.42	33.24	47.86	81.1	40.98
T_5	75% RDN through urea + 25% Hairamine spray (3 doses)	58.74	17.51	35.02	9.23	35.49	36.07	50.06	86.14	41.87
T_6	100% RDN through urea + Hairamine spray (3 doses)	63.31	19.24	38.47	10.72	37.37	40.92	53.2	94.12	43.47
T_7	75% RDN through urea + *Azotobacter*	56.04	16.54	33.07	7.58	33.55	31.15	46.41	77.56	40.16
T_8	100% RDN through urea + *Azotobacter*	61.6	18.31	36.6	10.12	36.85	38.86	51.69	90.55	42.91
C.D. at 5%		1.52	1.12	1.2	0.68	0.81	2.03	2.51	4.53	0.046
SEm ±		0.75	0.41	0.47	0.22	0.21	0.66	0.82	1.48	0.015

5. Conclusion

The study conclusively demonstrates that optimizing fertilization strategies, particularly through the integration of higher nitrogen inputs and organic supplements like Hairamine spray and *Azotobacter*, significantly enhances the growth parameters and yield attributes of black wheat. Treatments such as T_6 (100% RDN through urea + Hairamine spray) and T_8 (100% RDN through urea + *Azotobacter*) consistently outperformed others, showcasing remarkable improvements in plant height, dry matter accumulation, tiller number and overall yield. By adopting these optimized nutrient management practices, farmers can achieve superior yield outcomes and contribute to sustainable and resilient agricultural systems.

6. References

1. CEIC Data. Haryana wheat production 2023-24. https://www.ceicdata.com/en/india/haryana-wheat-production-2024
2. Chauhan J, Pandey S, Rawat A, Chauhan A, Bhatt P. Effect of INM on Growth Indices, Yield Attributes, Yield and Economics of Wheat (Triticum aestivum L. emend. Fiori & Paol.). Journal of Experimental Agriculture International. 2024;46(6):733-739.
3. Choudhary L, Singh KN, Gangwar K, Sachan R. Effect of FYM and Inorganic fertilizers on growth performance, yield components and yield of wheat (*Triticum aestivum* L.) under Indo-Gangetic plain of Uttar Pradesh. The Pharma Innovation Journal. 2022;11(4):1476-1479.
4. Dhua S, Kumar K, Kumar Y, Singh L, Sharanagat VS. Composition, characteristics and health promising prospects of black wheat: A review. Trends in food science & technology. 2021;112:780-794.
5. Food and Agriculture Organization. Global wheat production statistics 2023-24. Retrieved from http://www.fao.org/wheat-statistics-2024
6. Kumar A, Tiwari US, Kumar V, Kumar N, Yadav AK. Assessment of the integrated nutrient management effects on yield attributes and yield of wheat cv. PBW-550. Plant Archives. 2020;20(2):282-285.
7. Ministry of Agriculture & Farmers Welfare. India wheat production report 2023-24. Government of India. Retrieved from http://www.agriculture.gov.in/wheat-production-2024
8. Mohan J, Singh I, Behl RK, Sharma PK, Bharti B, Arya R, *et al*. Effect of Hairamin and Fertilizer Application on Grain Yield and Its Attributes in Wheat (*Triticum aestivum* L.) Varieties. Asian Journal of Soil Science and Plant Nutrition. 2024;10(1):389-396.
9. Padhy AK, Kaur P, Singh S, Kashyap L, Sharma A. Colored wheat and derived products: Key to global nutritional security. Critical Reviews in Food Science and Nutrition. 2024;64(7):1894-1910.
10. Patyal A, Shekhar C, Sachan R, Kumar D, Yadav A, Kumar G. Effect of integrated nutrient management (INM) on growth parameters and yield of wheat (*Triticum aestivum* L.). International Journal of Plant and Soil Science. 2022;34(22):962-967.
11. Rouphael Y, Colla G. Toward a sustainable agriculture through plant bio stimulants. Agronomy. 2020;10(10):1461.
12. Sahu A, Nahatkar S, Kolar P. Variability and growth in production of wheat in India. Economic Affairs. 2020;65(2):255-260.
13. Salim N, Raza A. Nutrient use efficiency (NUE) for sustainable wheat production: a review. Journal of Plant Nutrition. 2020;43(2):297-315.
14. Sharma N, Tiwari V, Vats S, Kumari A, Chunduri V, Kaur S, *et al*. Evaluation of anthocyanin content, antioxidant potential and antimicrobial activity of black, purple and blue colored wheat flour and wheat-grass juice against common human pathogens. Molecules. 2020;25(24):5785.
15. Shekhar C, Nand V, Kumar R, Kumar N, Diwakar SK, Kumar G, *et al*. Effect of integrated nutrient management practices on yield attributes, yield and economics of timely sown wheat (*Triticum aestivum* L.). The Pharma Innovation Journal. 2021;10(7):1276-1279.
16. Singh D, Yadav A, Tiwari H, Singh AK, Singh S, Yadav RK, *et al*. Nitrogen Management through Nano Urea and Conventional Urea and its Effect on Wheat (*Triticum aestivum* L.) Growth and Yield. International Journal of Plant and Soil Science. 2023;35(18):1466-1473.
17. Yadav D, Shivay YS, Singh YV, Sharma VK, Bhatia A. Enhancing nutrient translocation, yields and water productivity of wheat under rice–wheat cropping system through zinc nutrition and residual effect of green manuring. Journal of Plant Nutrition. 2020;43(19):2845-2856.