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Performances of wheat (*Triticum aestivum* L.) varieties at different levels of nitrogen under late sown condition

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Abstract
A field experiment was conducted during Rabi season of 2023-24 at Agricultural Research Farm, Department of Agronomy, R.B.S. College, Bichpuri, Agra (U.P.) the investigation entitled "Performances of wheat (*Triticum aestivum* L.) varieties at different levels of nitrogen under late sown condition". The variable involved in this study were three nitrogen levels (N_1- 100, N_2- 150 and N_3- 200 Kg N ha^{-1}) and three varieties (V_1- Raj 3765, V_2-DBW 173 and V_3- Raj 4037) thus in all nine treatment combinations were compared in Factorial Randomized Block Design with three replications. Result revealed that the highest biological yield (114.76 q ha^{-1}), grain yield (46.60 q ha^{-1}), straw yield (68.60 q ha^{-1}), harvest index (40.60%), gross income (₹. 1,33,325 ha^{-1}), net income (₹. 85,968 ha^{-1}) and benefit-cost (B:C) ratio (1.81) was recorded at the 200 kg ha^{-1}nitrogen level (N_3) followed by 150 kg ha^{-1} and 100 kg ha^{-1}. Among all the varieties tested in the experiment, gave better results variety DBW 173 (V_2) recorded the highest biological yield (114.13 q ha^{-1}), grain yield (47.38 q ha^{-1}), straw yield (66.75 q ha^{-1}), harvest index (41.57%), highest gross income (₹. 1,34,057 ha^{-1}), net income (₹. 86,699 ha^{-1}) and B:C ratio (1.83) was obtained from the DBW 173 variety followed by variety Raj 3765 and variety Raj 4037.

Keywords: B:C ratio, late sown condition, nitrogen wheat, varieties, yield

Introduction
Wheat (*Triticum aestivum* L.) is the most important staple food crop of the world and emerged as the backbone of India's food security. It is grown all over the world for its wider adaptability and high nutritive value. It is an important winter cereal contributing about 35 per cent of the total food grain production in India. Wheat straw is an important source of fodder for a large animal population in India. (Kumar *et al.*, 2019) [7]. In general wheat contains carbohydrate (70%), protein (12%), lipid (2%), vitamins & minerals (2% each) and crude (Archna, *et al*., 2023) [2]. On the other hand, enhanced cultivars that have been chosen for high yields under high nutrient input circumstances are frequently generated without taking into account their capacity to grow and yield under low soil nutrient status. (Lokendra *et al.*, 2024) [8]. In spite of a changing climate, climate-resilient agronomy aims to maintain sustainable food production and stable livelihoods for farmers. (Singh *et al.*, 2023) [18]. In India, wheat is the second most important cereal crop after rice covering an area of 34.15 million hectares. Total annual production of wheat in India is 113.29 million tonnes with the productivity of 3.61 tonnes per hectare during 2023-24. India witnessed an all-time high wheat production during the year 2023-24. India is the second largest wheat producer (approximately 12.60 per cent world's wheat production) and consumer after China. (Anonymous, 2023-24) [1]. Fertilizer N management strategies need to be formulated to address the challenges of increasing agricultural productivity and improving sustainability. Split applications of nitrogen at different crop development stages, along with the selection of suitable cultivars, are essential for maximizing wheat yields. (Singh *et al.*, 2023) [18]. Nitrogen plays a key role in wheat development and growth, and proper management strategies are necessary for sustainable wheat production in India. mineral nitrogen is easily lost by leaching or de-nitrification, the N rate needs to be optimized for the actual year, while application of P and K can be based on the principles of substitution of harvest P and K because soil available P and K changes slowly.

One of the biggest obstacles to raising the commercial yield of crops is the current increase in fertilizer prices. Therefore, measures to reduce its losses and improve its economic utilization are required (Lokendra *et el*., 2024) [8]. As (Virendra, *et al*., 2024) [8]. Every farmer concentrates on crop production to feed the family (Harish *et al*., 2023) [5]. Late sown varieties, delay in barley sowing from late to very late lead to decline by the grain yield. (Islamuddeen, *et al.*, 2022) [6]. Presently, development of new varieties for higher yields has reached a plateau and no further increase is achieved unless biotechnological interventions are made (Archna, *et al*., 2023) [2].

Materials and Methods

A field experiment was conducted at agricultural research farm of Raja Balwant Singh Collage, Bichpuri, Agra, during *Rabi* season of 2023-24 to the investigation reported here was carried out during *Rabi* season on 2023. The soil of experimental field was moderately fertile, being low in organic carbon (0.31%), available nitrogen (181.50 kg ha^{-1}), available phosphorus (27.5 kg P_2O_5 ha^{-1}) and rich in available potassium (285.0 kg K ha^{-1}). The variable involved in this study were three nitrogen levels (N_1- 100, N_2- 150 and N_3- 200 Kg N ha^{-1}) and three varieties (V_1- Raj 3765, V_2-DBW 173 and V_3- Raj 4037) thus in all nine treatment combinations were compared in Factorial Randomized Block Design with three replications. Sowing the seeds of all the varieties Raj 3765, DBW 173, and Raj 4037 were treated with Agrosan GN @ 2 g kg^{-1} seed. Full dose of PK (60:40) was applied as basal were supplied through DAP and MOP, respectively as basal dose at sowing time along with half of the recommended dose of nitrogen. Nitrogen supplied by DAP was calculated and deducted from treatment wise N and rest was supplied through urea at first node stage (35-40 DAS) by top dressing of urea.

Results and Discussion

Yield attributes

Effect of nitrogen levels: The yield attributes of wheat were significantly influenced by different nitrogen levels as shown in Table-1. The highest spike length (9.16 cm) was recorded at 200 kg N/ha (N_3), followed by 150 kg N/ha (N_2) with 9.11 cm, while the lowest spike length (8.60 cm) was observed at 100 kg N/ha (N_1). A similar trend was observed for the number of spikelets per spike, which was highest (17.32) under N_3, followed by 150 kg N/ha (N_2) (17.19), and lowest number of spikelets per spike (16.71) under 100 kg N/ha (N_1). The number of grains per spike was also highest (51.54) at 200 kg N/ha (N_3), followed by 150 kg N/ha (N_2) (51.48), and the lowest (48.42) was noted under 100 kg N/ha (N_1). Grain weight per spike increased with nitrogen application, being highest (2.11 g) at 200 kg N/ha (N_3), followed by 150 kg N/ha (N_2) (2.08 g), and lowest (2.00 g) at 100 kg N/ha (N_1). The 1000 grain weight showed a slight but consistent increase, with the highest value (42.94 g) recorded at 200 kg N/ha (N_3), followed by 150 kg N/ha (N_2) (42.86 g), and the lowest (42.53 g) at 100 kg N/ha (N_1). Nitrogen application at 200 kg/ha resulted in higher yield attributes compared to 150 and 100 kg/ha, indicating a positive response of wheat to increasing nitrogen levels. The progressive increase in nitrogen levels from 100 to 200 kg/ha led to significant improvements in spike length, number of spikelets per spike, grains per spike, grain weight per spike, and 1000 grain weight. The highest nitrogen level (200 kg/ha) resulted in superior performance across all traits, indicating the positive role of nitrogen in enhancing vegetative and reproductive growth. Nitrogen is a critical component of chlorophyll and amino acids, contributing to improved photosynthesis, tillering, and spike development. The increase in the number of grains per spike and grain weight per spike suggests better nutrient availability and translocation of assimilates to developing grains under higher nitrogen regimes. Similar findings have also been reported by Kumar *et al*., (2019) [7], Singh *et al.*, (2022) [14], Singh *et al.*, (2022) [14], Singh *et al.*, (2023) [18], Singh *et al.*, (2024) [13], Lokendra *et el.*, (2024) [8], Babu and Singh (2024) [12] and Singh *et al*. (2024) [13].

Table 1: Yield attributes of wheat as influenced by nitrogen levels and variety

Treatments		Spike Length (cm)	No of spikelets $spike^{-1}$	No of grains $spike^{-1}$	Grains weight $spike^{-1}$ (g)	1000 grain weight (g)
Effect of Nitrogen Levels						
100	N_1	8.60	16.71	48.42	2.00	42.53
150	N_2	9.11	17.19	51.48	2.08	42.86
200	N_3	9.16	17.32	51.54	2.11	42.94
SEm ±		0.17	0.21	0.97	0.03	0.11
CD at 5%		0.48	0.59	2.78	0.08	0.32
Effect of Varieties						
Raj 3765	V_1	8.91	17.02	49.41	2.02	42.72
DBW 173	V_2	8.97	17.20	51.45	2.10	42.80
Raj 4037	V_3	8.66	16.59	47.75	1.94	41.78
SEm ±		0.19	0.24	1.12	0.03	0.13
CD at 5%		0.55	0.68	3.21	0.09	0.37

Effect of Varieties

The yield attributes of wheat were also influenced by the variety grown. Among the three varieties, variety DBW 173 (V_2) recorded the highest yield attributes for most parameters. The highest spike length (8.97 cm) was observed in variety DBW 173, followed by variety Raj 3765 (V_1) with 8.91 cm, while the lowest spike length (8.66 cm) was recorded in variety Raj 4037 (V_3). Similarly, the number of spikelets per spike was higher in variety DBW 173 (17.20), followed by variety Raj 3765 (17.02), and lower number of spikelets per spike in variety Raj 4037 (16.59). The number of grains per spike, variety DBW 173 showed the highest number of grains per spike (51.45), followed by variety Raj 3765 (49.41), while variety Raj 4037 had the lowest number of grains per spike (47.75). The grain weight per spike was highest in variety DBW 173 (2.10 g), followed by variety Raj 3765 (2.02 g), and lowest grain weight per spike in variety Raj 4037 (1.94 g). A similar pattern was noted in the 1000 grain weight, with variety DBW 173 having the highest value (42.80 g),

followed by variety Raj 3765 (42.72 g), and the lowest 1000 grain weight (41.78 g) in variety Raj 4037. These results clearly indicate that variety DBW 173 performed better in terms of yield attributes, followed by variety Raj 3765, while variety Raj 4037 recorded the lowest performance across all measured parameters. Most agricultural soils contain larger amount of fixed form of P than available P, a considerable part of which has accumulated as a consequence of regular applications of P fertilizers (Sonia, *et al*., 2023) [18]. The results indicate that wheat varieties differ significantly in their yield attributes, emphasizing the importance of varietal selection in optimizing wheat productivity. Among the varieties tested, this variation among varieties highlights the role of genotype in determining the efficiency of nutrient use and yield component expression. Similarly finding data to supported by Singh *et al*., (2023) [18], Singhal *et al*., (2023) [16], Singh *et al*., (2024) [13] and Babu and Singh (2024) [12].

Yield

Effect of Nitrogen Levels

A presented on the data arranged in Table 2 indicates that the analysis of different nitrogen levels revealed significant effects on biological yield, grain yield, straw yield, and harvest index. The maximum biological yield (114.76 q/ha) was recorded at 200 kg N/ha (N_3), which was significantly higher than other treatments. It was followed by nitrogen level 150 kg N/ha (N_2) with 110.82 q/ha, while the minimum (108.10 q/ha) was observed at nitrogen level 100 kg N/ha (N_1). A similar trend was observed for grain yield, where the maximum (46.60 q/ha) was obtained at nitrogen level 200 kg N/ha (N_3), followed by nitrogen level 150 kg N/ha (N_2) (44.61 q/ha), and the minimum (42.23 q/ha) was recorded at nitrogen level 100 kg N/ha (N_1). Grain yield at nitrogen level 150 kg N/ha (N_2) and nitrogen level 200 kg N/ha (N_3) was found to be significantly higher, while the difference between nitrogen level 100 kg N/ha (N_1) and nitrogen level N_2 was at par at the 5% level. The increase in biological and grain yield with rising nitrogen levels can be attributed to improved vegetative growth and enhanced photosynthetic efficiency, which lead to increased biomass production and better grain filling. Nitrogen supports key physiological processes such as tailoring, spikelet formation, and grain development, which together contribute to higher yield potential. Straw yield, nitrogen level 200 kg N/ha (N_3), also resulted in the maximum (68.60 q/ha), followed by nitrogen level 150 kg N/ha (N_2) (66.21 q/ha), and the minimum (65.87 q/ha) was recorded at nitrogen level 100 kg N/ha (N_1). The differences between treatments were significant. The straw yield also followed this positive trend, indicating that the overall plant biomass benefited from higher nitrogen availability. This reflects nitrogen's contribution to increased leaf area, longer crop duration, and improved structural development of the plant. Nitrogen levels significantly influenced the biological, grain, and straw yields of wheat, as well as the harvest index and economic returns. The application of 200 kg N/ha (N_3) consistently resulted in the highest values across all parameters, demonstrating the crucial role of nitrogen in enhancing wheat productivity. The harvest index (HI) improved with nitrogen application, with the highest HI (40.60%) at nitrogen level 200 kg N/ha (N_3), followed by nitrogen level 150 kg N/ha (N_2) (40.43%), and the lowest (39.06%) at nitrogen level 100 kg N/ha (N_1). However, the difference in HI between N_2 and N_3 was at par. The harvest index (HI), which reflects the efficiency of the plant in converting biomass into economic yield (grain), also improved with nitrogen. The highest HI at 200 kg N/ha suggests better partitioning of assimilates towards the grain rather than vegetative parts under optimal nitrogen conditions. In economics of net income, 200 kg N/ha (N_3), yielded the maximum (₹. 85,968/ha), followed by nitrogen level 150 kg N/ha (N_2) (₹. 79,960/ha), while the minimum net return (₹. 75,899/ha) was associated with nitrogen level 100 kg N/ha (N_1).Similarly, the B:C ratio was highest at nitrogen level 200 kg N/ha (N_3), (1.81), followed by nitrogen level 150 kg N/ha (N_2) (1.66), and lowest at nitrogen level 100 kg N/ha (N_1). (1.62), indicating that higher nitrogen input led to better economic returns. Economically, the application of 200 kg N/ha resulted in the highest net income and B:C ratio, justifying the cost of additional fertilizer through significantly enhanced returns. Similar results were also reported by Singh *et al*., (2023) [18], Singh *et al*., (2024) [13].

Table 2: Biological, grain and straw yields of wheat and harvest index and economic as influenced by nitrogen levels and varieties

Treatments		Biological yield (q ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Net income (₹. ha^{-1})	B:C ratio
Effect of Nitrogen Levels							
100	N_1	108.10	42.23	65.87	39.06	75899	1.62
150	N_2	110.82	44.61	66.21	40.43	79960	1.66
200	N_3	114.76	46.60	68.60	40.60	85968	1.81
SEM ±		1.14	0.69	0.55	0.40	1330	0.04
CD at 5%		3.47	2.10	1.68	1.20	3065	0.13
Effect of Varieties							
Raj3765	V_1	109.30	44.11	65.19	40.35	78967	1.66
DBW173	V_2	114.13	47.38	66.75	41.57	86699	1.83
Raj4037	V_3	106.88	42.50	64.38	39.76	75144	1.58
SEM ±		0.70	0.37	0.30	0.26	1330	0.04
CD at 5%		2.12	1.12	0.91	0.78	3065	0.13

Effect of Varieties

The performance of wheat varieties showed significant variation in yield components and economic returns as detailed in Table-2. The maximum biological yield (114.13 q/ha) was recorded in DBW 173 (V_2), which was significantly higher, followed by Raj 3765 (V_1) with 109.30 q/ha, while the minimum (106.88 q/ha) was observed in Raj 4037 (V_3). In terms of grain yield, DBW 173 again showed the maximum (47.38 q/ha), which was significantly higher than both Raj 3765 (44.11 q/ha) and Raj 4037 (42.50 q/ha). The difference between Raj 3765 and Raj 4037 was at par. For straw yield, DBW 173 recorded the highest value (66.75

q/ha), followed by Raj 3765 (65.19 q/ha), and the lowest was observed in Raj 4037 (64.38 q/ha). The harvest index (HI) was also highest in DBW 173 (41.57%), which was followed by Raj 3765 (40.35%), and the minimum HI (39.76%) was recorded in Raj 4037. In terms of net income, DBW 173 gave the maximum return (Rs. 86,699/ha), followed by Raj 3765 (₹. 78,967/ha), while the minimum income (₹. 75,144/ha) was obtained from Raj 4037. The trend was similarly reflected in the B:C ratio, which was highest in DBW 173 (1.83), followed by Raj 3765 (1.66), and lowest in Raj 4037 (1.58). The data clearly indicate that wheat varieties differ significantly in terms of yield performance and economic returns. Among the tested varieties, DBW 173 (V_2) recorded the highest biological yield, grain yield, straw yield, harvest index, net income, and benefit-cost (B:C) ratio, indicating its superior productivity and profitability. The higher grain yield of DBW 173 can be attributed to its better growth characteristics, efficient nutrient uptake, and higher biomass accumulation. Its superior harvest index (41.57%) also reflects more effective partitioning of assimilates toward grain production, which is a desirable trait in modern high-yielding wheat cultivars. Raj 3765 (V_1) showed moderate performance in all parameters, with values lower than DBW 173 but higher than Raj 4037. These results suggest that DBW 173 is the most productive and economically beneficial variety under the tested conditions. Similar results were also reported by Singh *et al.*, (2024) [13].

Conclusion

The present investigation demonstrated that both nitrogen levels and varietal selection significantly influenced the growth, yield attributes, productivity, and economic returns of wheat under late sown conditions. Result revealed that the highest biological yield (114.76 q ha^{-1}), grain yield (46.60 q ha^{-1}), straw yield (68.60 q ha^{-1}), harvest index (40.60%), gross income (₹. 1,33,325 ha^{-1}), net income (₹. 85,968 ha^{-1}) and B:C ratio (1.81) was recorded at the nitrogen level 200 kg ha^{-1} (N_3) followed by nitrogen level 150 kg ha^{-1} and nitrogen level 100 kg ha^{-1}. Among all the varieties tested in the experiment, gave better results variety DBW 173 (V_2) recorded the highest biological yield (114.13 q ha^{-1}), grain yield (47.38 q ha^{-1}), straw yield (66.75 q ha^{-1}), harvest index (41.57%), highest gross income (₹. 1,34,057 ha^{-1}), net income (₹. 86,699 ha^{-1}) and B:C ratio (1.83) was obtained from the variety DBW 173 followed by variety Raj 3765 and variety Raj 4037. The combination of variety DBW 173 with nitrogen level 200 kg N/ha (N_3) proved to be the most effective in enhancing wheat yield and profitability under late sown conditions. Therefore, it can be concluded that adopting high-yielding varieties like DBW 173, along with an optimal nitrogen level 200 kg N/ha, can substantially improve wheat productivity and economic viability in late sown wheat cultivation systems.

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