E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; SP-8(8): 281-283
Received: 30-05-2025
Accepted: 02-07-2025

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Response of wheat cultivars (*Triticum aestivum* L.) to different sowing methods and their impact on yield components and economic profitability

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DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i8Sd.3553

Abstract
A field experiment was conducted at an Agricultural Farm Rama University, Kanpur (U.P) India. The Central Plain zone of Uttar Pradesh, during Rabi season of 2023-24. The experiment comprised of 12 treatment combinations in factorial randomized block design with three replications consisted of four wheat cultivars viz. V1: NW-5054, V2: NW-4018, V3: K-1006 and V4: K-8804 and three sowing methods viz. M1: Broadcasting, M2: Line Sowing and M3: Raised Bed methods. On the basis of the results emanated from present investigation, it could be concluded that variety K-1006 sowing by raised bed method have higher growth parameter i.e. plant height & dry matter accumulation and yield attributes i.e. length of ear, number of ear, number of grains per ear and test weight. Results also showed that variety K-1006 sowing by raised bed method significantly enhanced productivity parameters i.e. grain yield, straw yield. Higher values of economics viz., gross return (Rs. 75344.67 ha^{-1}), net return (Rs. 44799.67 ha^{-1}) and B: C ratio (1.47) in wheat was observed in the combination of variety K-1006 sowing by raised bed method.

Keywords: Economics, grain, nitrogen and yield

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important cereal crops worldwide, serving as a staple food for a significant portion of the global population. Its cultivation traces back to early agricultural civilizations, with archaeological evidence from regions like Jarmo (Iraq) and Çayönü (Turkey) marking the domestication of wild wheat species such as *T. dicoccum* and *T. monococcum*. Today, wheat contributes approximately 18-20% of the globalcaloric intake and plays a crucial role in ensuring food and economic security across nations (FAO, 2023-24). India ranks among the top three wheat producers globally, with an estimated output of 113.29 million metric tonnes in the 2023-24 Rabi season (Ministry of Agriculture & Farmers Welfare, 2023-24). Major wheat-growing states include Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, and Rajasthan, where varied climatic conditions, soil types, and cultivation techniques influence productivity. For instance, Uttar Pradesh leads in total production, while Punjab and Haryana report the highest yields, averaging over 5 tons per hectare (USDA, 2023-24). The Green Revolution significantly transformed wheat production in India through the adoption of high-yielding varieties, improved irrigation, and fertilizer use. However, issues such as climate change, water scarcity, and soil degradation now necessitate a shift toward sustainable agricultural practices. Consequently, optimizing both varietal selection and sowing techniques has emerged as a key strategy for enhancing wheat productivity and profitability. Different wheat cultivars exhibit varying responses to environmental conditions and agronomic inputs. In Central Uttar Pradesh, varieties such as NW-5054, NW-4018, K-1006, and K-804 have demonstrated adaptability and disease resistance (Hussain *et al*., 2012) [15]. Simultaneously, sowing methods play a vital role in determining plant establishment, growth dynamics, and resource use efficiency. Traditional broadcasting, although widely practiced, often results in uneven seed distribution, while advanced techniques such as line sowing, drill sowing, and raised bed planting ensure better crop stands, reduced weed pressure, and improved water and nutrient utilization (S.P. Datta& A. Dey, 2011; Shi, 2017) [16, 17]. Recent studies also highlight

the benefits of conservation agriculture practices like zero tillage in preserving soil structure, reducing costs, and enhancing productivity under limited resource conditions (Chouhan *et al*., 2017; Dagash *et al*., 2014) [6, 18]. Integration of cultivar-specific responses with suitable sowing techniques offers a pathway to optimize yield components such as spike length, grain number, and thousand-grain weight, while ensuring economic sustainability. In this context, the present study titled "Response of Wheat Cultivars (*Triticum aestivum* L.) to Different Sowing Methods and Their Impact on Yield Components and Economic Profitability" aims to: Identify the most productive wheat cultivar under local agro-climatic conditions. Evaluate the most effective sowing method for maximizing wheat yield. Analyze the interaction effects of cultivars and sowing methods on growth and yield traits. Assess the cost-effectiveness and economic returns associated with different treatment combinations.

Materials and Methods

The experiment was conducted during the Rabi season of 2023-24 at the Agricultural Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.). The site lies in the Indo-Gangetic alluvial plains with sandy loam soil and a semi-arid subtropical climate. Experimental Design: Design: Factorial Randomized Block Design (FRBD) Replications: 3 Treatments: 12 combinations (4 wheat cultivars × 3 sowing methods)Cultivars: NW-5054, NW-4018, K-1006, K-8804 Sowing Methods: Broadcasting, Line Sowing, Raised Bed Plot Details: Total Plots: 36 Gross Plot Size: 4.0 m × 3.6 m Net Plot Size: 3.6 m × 3.0 m Soil Analysis: Texture: Sandy loam pH: 7.9 EC: 0.3 dS/m Organic Carbon: 4.5 g/kg Available N, P, K: 210, 12.8, and 198 kg/ha respectively Cultural Practices: Fertilizer Dose: 120:60:60 kg N:P_2O_5:K_2O/ha Sowing Date: 7th December 2023 Seed Rate: 100-125 kg/ha Irrigations: 5, scheduled at CRI, tillering, boot, flowering, and milk stages Observations Recorded: Growth Parameters: Plant height, number of shoots, leaf area index, and dry matter accumulation at 30, 60, 90 DAS and at harvest Yield Attributes: Effective tillers, number of ears, grains per ear, ear length, 1000-grain weight Yields: Grain, straw, and biological yield; harvest index Economics: Cost of cultivation, gross and net returns, and benefit-cost ratio Statistical Analysis: Data were analyzed using ANOVA (as per Cochran and Cox, 1950), and critical differences were used to determine treatment significance.

Results and Discussion

Growth Parameters: Initial Plant Population: Results: Maximum population (180 plants/m²) was under M3 (Raised-bed), followed by M2 (165) and M1 (140). Among cultivars, V4 (K-8804) had the highest (185), and V1 (NW-5054) the lowest (145). Discussion: Raised-bed sowing promotes better seed-soil contact and moisture retention, improving emergence rates. Plant Height Results: Highest plant height was recorded in M3 × V4 combination (83.87-84.01 cm), lowest in M1 × V1 (59.57-60.77 cm).Discussion: Raised-bed improves root aeration, supporting vertical growth. K-8804 showed superior growth across stages. Dry Matter Accumulation: Results: Highest at all stages under M3 × V3 (up to 152.67 g/m² at 90 DAS); lowest under M1 × V2 (112.33 g/m²). Discussion: Raised-bed and cultivar K-1006 significantly improved dry matter; aligned with studies by Khan *et al*. (2007) [19] and Chauhdary *et al*. (2016) [4] Leaf Area Index (LAI): Results: At 60 DAS, highest LAI in M2 × V4 (3.32); at 90 DAS, in M3 × V4 (3.81). Lowest was M1 × V1 (1.47). Discussion: V3 and V4 had better canopy due to genetic vigor. Higher LAI indicates superior photosynthetic efficiency. Yield Attributes: Effective Tillers/m²: Highest in M3 × V3 (305.94), lowest in M1 × V2 (280.13).Ears/m: Highest in M3 × V3 (308), lowest in M1 × V2 (274).Grains/Ear: Max 40 grains/ear in M3 × V3, min 30 in M1 × V2.Ear Length: Max 8.41 cm (M3 × V3), min 7.92 cm (M1 × V2).1000-Grain Weight: Max 43.90 g (M3 × V3), min 36.22 g (M1 × V2).Discussion: Sowing methods and genetic potential had synergistic effects. Raised-bed plus K-1006 or K-8804 yielded superior values. Productivity Parameters: Grain Yield: Highest in M3 × V4 (3215.33-3030.11 kg/ha); lowest in M1 × V1 (1944.7-2074.11 kg/ha). Straw Yield: Max 4455.11 kg/ha (M3 × V4), min 3296.67 (M1 × V1). Biological Yield: Max 8778.6 kg/ha (M3 × V4), min 4135.33 (M1 × V1).Harvest Index: Max 43.31% (M3 × V3), min 42.11% (M1 × V2).Discussion: Productivity benefits from Raised-bed sowing and K-8804; consistent with findings by Yadav *et al*. (2017) [14] and Punia *et al*. (2017) Economics: Cost of Cultivation: Lowest in M1 (₹27,095), highest in M3 (₹30,545).Gross Return: Max in M3 (₹75,344.67); among cultivars, V4 (₹72,362.44). Net Return: Highest under M3 × V3 (₹44,799.67); cultivar-wise, V4 (₹42,411.44).B:C Ratio: Max 1.47 under M3, and 1.42 for V4; lowest in M1 (0.81) and V1 (0.86). Discussion: Raised-bed sowing with K-8804 is the most profitable; confirms economic analyses by Pandey *et al*. (2008) [20] and Ramadas *et al*. (2019) [21] Conclusion Best Combination: Raised-bed sowing + K-8804 (M3 ×V4). This combination consistently yielded the best results across growth, yield, and economic parameters, and is recommended for the eastern plain zone of Uttar Pradesh.

Influence of sowing method and cultivars scheduling on plant heights in wheat

Table 1: Effect of Different Cultivars and Sowing Methods on Plant Height (cm) at Various Growth Stages of the Crop

Treatment	Plant Height (cm)			
	Days After Sowing			
	30 DAYS	60 DAYS	90 DAYS	At Harvest
Cultivars				
V1	24.25	62.91	75.57	80.10
V2	23.21	60.51	77.97	79.24
V3	21.39	58.26	78.70	82.24
V4	25.21	65.56	84.01	87.46
SEm±	0.82	1.55	1.68	1.68
CD(P=0.05)	2.16	4.93	5.34	5.34
Method of Sowing				
M1	20.91	48.96	77.77	81.17
M2	19.23	51.17	79.55	80.19
M3	22.65	62.80	81.87	83.87
SEm±	0.99	4.22	1.18	0.80
CD(P=0.05)	4.26	18.15	5.07	3.44
M×V	NS	NS	NS	NS

Influence of sowing method and cultivars on dry matter accumulation

Table 2: Effect of Different Cultivars and Sowing Methods on Dry Matter Accumulation (g/m²) at Various Growth Stages of the Crop

Treatment	Dry Matter Accumulation (g/m²)			
Days After Sowing	**30 DAYS**	**60 DAYS**	**90 DAYS**	**At Harvest**
Cultivars				
V1	4.49	44.45	112.33	132.02
V2	5.87	56.60	128.04	154.71
V3	5.91	64.73	147.74	169.88
V4	5.89	74.22	151.03	176.21
SEm±	0.34	3.90	5.35	6.54
CD(P=0.05)	0.98	11.45	15.68	19.19
Method of Sowing				
M1	4.74	46.56	114.26	137.56
M2	5.33	59.66	137.43	152.34
M3	6.56	73.78	152.67	184.72
SEm±	0.29	3.38	4.63	5.67
CD(P=0.05)	0.85	9.92	13.58	16.62
M×V	NS	NS	NS	NS

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