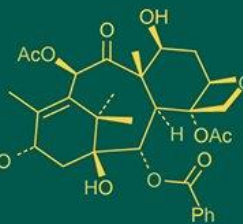
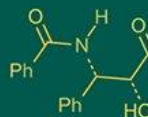


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Shikha Kumari
M.Sc. (Agri.), Department of
Agronomy, BTC College of
Agriculture and Research Station,
IGKV, Raipur, Chhattisgarh, India

Geet Sharma
Principal Scientist, Department of
Agronomy, BTC College of
Agriculture and Research Station,
IGKV, Raipur, Chhattisgarh, India

Dinesh Pandey
Senior Scientist, Department of
Agronomy, BTC College of
Agriculture and Research Station,
IGKV, Raipur, Chhattisgarh, India

PK Keshry
Senior Scientist, Department of Soil
Science & Agri. Chemistry, BTC
College of Agriculture and Research
Station, IGKV, Raipur,
Chhattisgarh, India

NK Chaure
Principal Scientist, Department of
Agricultural Statistics, BTC College
of Agriculture and Research
Station, IGKV, Raipur,
Chhattisgarh, India

Ram Sahu
M.Sc.(Agri.), Department of
Agronomy, BTC College of
Agriculture and Research Station,
IGKV, Raipur, Chhattisgarh, India

Nikita Lakra
M.Sc.(Agri.), Department of
Agronomy, BTC College of
Agriculture and Research Station,
IGKV, Raipur, Chhattisgarh, India

Bhimraj Sahu
M.Sc.(Agri.), Department of
Agronomy, BTC College of
Agriculture and Research Station,
IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Shikha Kumari
M.Sc. (Agri.), Department of
Agronomy, BTC College of
Agriculture and Research Station,
IGKV, Raipur, Chhattisgarh, India

Performance of new genotypes of wheat (*Triticum aestivum* L.) at different dates of sowing under irrigated conditions

Shikha Kumari, Geet Sharma, Dinesh Pandey, PK Keshry, NK Chaure, Ram Sahu, Nikita Lakra and Bhimraj Sahu

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Abstract

Wheat (*Triticum aestivum* L.) is an important cereal crop and a major source of food and nutritional security. Its productivity is influenced by several factors, among which sowing time and genotype play an important role in determining crop growth and yield. A field experiment was conducted during the rabi season of 2025-26 at the Agronomy Research-cum-Instructional Farm, BTC College of Agriculture and Research Station, Bilaspur, Chhattisgarh, to evaluate the performance of wheat genotypes under different dates of sowing in irrigated conditions. The experiment was laid out in a split-plot design with three replications, comprising two sowing dates, viz., 11 November (timely sown) and 4 December (late sown), as main-plot treatments and five genotypes, namely MP 1401, DBW 509, MACS 6768, GW 322 and HI 1669, as sub-plot treatments. Timely sowing on 11 November resulted in better crop growth and yield performance than late sowing on 4 December, as reflected by higher plant height, number of tillers, dry matter accumulation, spike length, test weight, grain yield and straw yield. The timely sown crop recorded a grain yield of 48.56 q ha⁻¹ and straw yield of 54.63 q ha⁻¹ compared with 45.55 and 52.44 q ha⁻¹, respectively, under late sowing. Among the genotypes, DBW 509 exhibited superior performance for plant height, number of tillers, dry matter accumulation, number of spikes, spike length, test weight, grain yield, straw yield and harvest index. It recorded the highest grain yield (50.59 q ha⁻¹) and straw yield (56.88 q ha⁻¹). DBW 509 also produced the maximum number of spikes (549 m⁻²), while MACS 6768 recorded the highest number of grains spike⁻¹ (26.68). The study indicated that timely sowing on 11 November, particularly with DBW 509, was favourable for achieving higher wheat productivity under irrigated conditions of Bilaspur, Chhattisgarh.

Keywords: Wheat, sowing date, genotype, growth, yield attributes, grain yield, irrigated conditions

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the major cereal crops cultivated worldwide and plays an important role in global food and nutritional security. Its grain is an important source of carbohydrates, protein, dietary fibre, minerals and vitamins, while gluten proteins contribute to the desirable processing and baking properties of wheat (Shewry, 2009) [13]. Global wheat production has remained close to 800 million tonnes in recent years, highlighting its importance in meeting the food requirements of a growing population (USDA-FAS, 2024) [15]. India is among the leading wheat-producing countries, and the crop occupies an important position in the country's food grain economy (Directorate of Economics and Statistics, 2026).

Wheat growth and productivity are strongly influenced by environmental conditions, particularly temperature. As a cool-season crop, wheat requires favourable thermal conditions for proper establishment, vegetative growth, flowering and grain filling. Temperature affects the rate of crop development and the duration of different phenological stages, thereby influencing biomass accumulation and final grain yield (Porter and Gawith, 1999) [8]. Deviations from the optimum temperature, particularly during reproductive and grain-filling stages, can accelerate crop development, shorten the grain-filling period and reduce yield potential (Asseng *et al.*, 2015) [1].

Sowing time is therefore an important agronomic determinant of wheat productivity because it governs the environmental conditions experienced by the crop throughout its growth cycle. Timely sowing generally allows the crop to utilize favourable temperature and radiation conditions, whereas delayed sowing may expose reproductive and grain-filling stages to higher temperatures. Field studies conducted under the Indo-Gangetic Plains have demonstrated significant effects of sowing time on wheat phenology, yield attributes and grain yield, with late sowing generally associated with greater heat stress and reduced yield performance (Sattar *et al.*, 2023) ^[12]. Recent studies have also emphasized that delayed sowing can adversely affect wheat growth, yield and grain quality because of increasing temperature during the later stages of crop development (Roy *et al.*, 2024) ^[10]. Besides sowing time, genotype is another important determinant of wheat productivity. Wheat genotypes differ in their growth duration, yield potential, phenological response and adaptation to varying environmental conditions. Therefore, identifying genotypes that maintain higher and more stable productivity under different sowing environments is important for improving wheat production. The performance of a genotype may vary with sowing time because of differences in its response to temperature and other environmental factors. Studies conducted across different agro-ecological regions of India have demonstrated that wheat genotypes can respond differently to changes in sowing dates, resulting in variation in yield performance and stability (Joshi *et al.*, 2018) ^[4]. Hence, evaluating genotype performance under contrasting sowing dates is essential for identifying genotypes better suited to specific production environments.

The study aimed to identify a suitable sowing window and high-performing genotypes for obtaining higher wheat productivity under the agro-climatic conditions of Bilaspur, Chhattisgarh, and to assess the interaction between sowing time and genotype.

2. Materials and methods

2.1 Experimental site and Location:

The field experiment was conducted during the *rabi* season of 2025-26 at the Agricultural Research Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh, India. The experimental site is located at 22.09° N latitude and 82.15° E longitude, with an elevation of approximately 298 m above mean sea level. Geographically, the site falls under the Chhattisgarh Plains agro-climatic zone of India and represents the Eastern Plateau and Hill Region (Agro-climatic Zone VII).

2.2 Soil characteristics

Before initiation of experiment, composite soil samples were collected from a depth of 0-15 cm and analysed using standard laboratory procedures. The experimental soil was neutral in reaction, low in available nitrogen, medium in available phosphorus, and high in available potassium, making it suitable for evaluating the response of new genotypes of wheat at different dates of sowing under irrigated conditions.

2.3 Experimental design and treatments

The experiment was conducted in a Split-Plot Design (SPD) with three replications. Two dates of sowing, viz., timely

sowing (11 November 2025) and late sowing (4 December 2025), were assigned to the main plots, while five newly released wheat varieties, namely MP 1401, DBW 509, MACS 6768, GW 322 and HI 1669, were allocated to the sub-plots.

2.4 Statistical analysis

The observations recorded for different growth and yield parameters were statistically analyzed using the analysis of variance (ANOVA) procedure suitable for a split-plot design. Sowing dates were considered as the main-plot treatments, while wheat genotypes were assigned to the subplots, with three replications. The significance of treatment effects was determined using the F-test as outlined by Gomez and Gomez (1984) ^[3]. When significant differences were observed among treatment means, the critical difference (CD) was calculated at the 5% level of significance for mean comparison. The standard error of the mean (SEm) was also estimated, and the interaction effect between sowing dates and genotypes was tested for statistical significance.

3. Results and Discussion

3.1 Growth Parameters

3.1.1 Plant population (per meter row length)

Plant population at 30 DAS was not significantly affected by sowing date. Timely sowing (D₁: 11 November) recorded a slightly higher population (24.41 plants m⁻¹ row length) than late sowing (D₂: 4 December) (23.20 plants m⁻¹ row length). The better establishment under timely sowing may be attributed to favourable temperature and soil-moisture conditions during germination and early growth. Among genotypes, V₂ (DBW 509) recorded the highest plant population (30.53 plants m⁻¹), followed by V₁ (MP 1401) and V₅ (HI 1669), while V₃ (MACS 6768) recorded the lowest (18.50 plants m⁻¹). However, the differences among genotypes were non-significant, indicating comparable establishment under the experimental conditions. The sowing date × genotype interaction was also non-significant. Similar observations were reported by Kakraliya *et al.* (2017) ^[5].

3.1.2 Plant height (cm)

Plant height was influenced by both sowing date and genotype throughout the crop growth period. The crop sown on 11 November (D₁) recorded greater plant height than the crop sown on 4 December (D₂) at all stages of observation. Plant height under D₁ was 31.31, 67.10, 92.73 and 89.19 cm at 30, 60, 90 DAS and harvest, respectively, compared with 29.01, 63.02, 88.07 and 84.02 cm under D₂. The difference between sowing dates was significant at 60 and 90 DAS, while it remained non-significant at 30 DAS and harvest. The better growth under timely sowing could be due to more favourable temperature conditions during the vegetative and reproductive phases, which supported better stem elongation. Delayed sowing subjected the crop to comparatively higher temperatures during later growth stages, resulting in faster development and reduced plant height. Among the genotypes, DBW 509 (V₂) recorded the maximum plant height at 30, 60, 90 DAS and harvest, with values of 33.58, 70.22, 92.66 and 90.24 cm, respectively. In contrast, MACS 6768 (V₃) produced the shortest plants, recording 26.54, 58.75, 87.57 and 81.36 cm at the corresponding stages. The differences among genotypes

indicate the presence of genetic variation for plant height. Similar variation in plant height among wheat genotypes grown under different sowing dates was also reported by Saikia *et al.* (2021) [11]. The interaction between date of sowing and genotype was non-significant at all stages, suggesting that the genotypes responded in a relatively consistent manner to the different sowing dates.

3.1.3 Number of tillers (m^{-2})

The number of tillers m^{-2} was significantly affected by sowing dates, genotypes and their interaction at different growth stages. Timely sowing (D_1 , 11 November) produced more tillers than late sowing (D_2 , 4 December), recording 327.82, 457.66, 522.19 and 518.25 tillers m^{-2} at 30, 60, 90 DAS and harvest, respectively. Among the genotypes, V_2 (DBW 509) recorded the highest number of tillers at all stages, reaching 554.10 tillers m^{-2} at harvest, while V_3 (MACS 6768) recorded the lowest (439.50 tillers m^{-2}). The higher tiller production under timely sowing may be attributed to favourable temperature conditions during the vegetative and tillering phases. The significant interaction between sowing dates and genotypes indicates that genotypes differed in their tillering response under different sowing dates. Similar variation in tiller production with sowing time and genotype has been reported by Dhaliwal *et al.* (2020) [12].

3.1.4 Dry matter accumulation (g plant^{-1})

A marked variation in dry matter production was observed with changes in sowing time and genotype. Timely sowing on 11 November resulted in greater dry matter accumulation than late sowing on 4 December throughout the crop growth period. Under timely sowing, dry matter accumulation increased from 0.58 g plant^{-1} at 30 DAS to 21.20 g plant^{-1} at harvest, whereas late sowing recorded 0.48 and 17.86 g plant^{-1} , respectively. Among the genotypes, DBW 509 (V_2) recorded the highest dry matter accumulation, with values of 0.57, 6.92, 14.86 and 21.93 g plant^{-1} at 30, 60, 90 DAS and harvest, respectively, while MACS 6768 (V_3) recorded the lowest values of 0.47, 5.25, 11.72 and 17.02 g plant^{-1} , respectively. The greater dry matter accumulation under timely sowing may be attributed to more favourable environmental conditions and a longer period of crop growth, while the superior biomass production of DBW 509 suggests its better growth and assimilate-producing ability. The sowing date $\times$ genotype interaction was non-significant at all the growth stages, indicating a similar response of the genotypes across the two sowing dates. Similar enhancement in dry matter accumulation under normal sowing compared with delayed sowing has also been reported in wheat (Tyagi *et al.*, 2004) [14].

3.2 Yield parameters

3.2.1 Number of spikes (m^{-2})

The number of spikes varied with sowing date, although the difference was statistically non-significant. Timely sowing on 11 November recorded a comparatively higher number of spikes (514.00 m^{-2}) than late sowing on 4 December (501.00 m^{-2}). Among the genotypes, DBW 509 (V_2) produced the maximum number of spikes (549.00 m^{-2}), whereas MACS 6768 (V_3) recorded the minimum (438.00 m^{-2}). The genotypic differences were significant at the 5% level, while the interaction between sowing dates and genotypes remained non-significant.

3.2.2 Spike length (cm)

Spike length was markedly influenced by the sowing date, with timely sown wheat producing significantly longer spikes (10.27 cm) than the late-sown crop (8.46 cm). Among the genotypes, DBW 509 (V_2) exhibited the longest spikes (10.82 cm), followed by MP 1401 (V_1) at 9.98 cm, while MACS 6768 (V_3) produced the shortest spikes (7.51 cm). The genotype effect was significant, whereas the interaction between sowing date and genotype was non-significant.

3.2.3 Number of grains spike $^{-1}$

The number of grains per spike showed only a slight variation between sowing dates, with 22.70 grains spike $^{-1}$ under late sowing compared with 22.39 grains spike $^{-1}$ under timely sowing; however, the difference was statistically non-significant. In contrast, significant variation was observed among genotypes. MACS 6768 (V_3) recorded the highest number of grains (26.68 spike $^{-1}$), whereas DBW 509 (V_2) had the lowest (19.96 spike $^{-1}$). The interaction between sowing dates and genotypes was non-significant.

3.2.4 Test weight (g)

Test weight was 42.84 g under timely sowing and 40.68 g under late sowing, indicating a numerical advantage of timely sowing, although the difference was statistically non-significant. Significant differences were observed among genotypes, with DBW 509 (V_2) recording the highest test weight (46.45 g), followed by MP 1401 (V_1) at 43.29 g. The lowest test weight was recorded in MACS 6768 (V_3) at 37.47 g. The interaction effect of sowing date and genotype was non-significant.

3.2.5 Grain yield (q ha^{-1})

Grain yield was significantly influenced by sowing time, with timely sowing on 11 November producing a higher yield (48.56 q ha^{-1}) than late sowing on 4 December (45.55 q ha^{-1}). Among the genotypes, DBW 509 (V_2) recorded the highest grain yield (50.59 q ha^{-1}), which was statistically at par with MP 1401 (V_1) (48.59 q ha^{-1}) and HI 1669 (V_3) (47.74 q ha^{-1}), while MACS 6768 (V_3) recorded the lowest yield (43.45 q ha^{-1}). The higher productivity under timely sowing may be attributed to the availability of more favourable temperature and radiation conditions during critical growth and grain-filling stages, whereas delayed sowing exposes the crop to increasing temperatures during reproductive development. Similar reductions in wheat grain yield.

With delayed sowing have been reported by Ortiz-Monasterio *et al.* (1994) [17].

3.2.6 Straw yield (q ha^{-1})

Straw yield showed a numerical advantage with timely sowing, recording 54.63 q ha^{-1} compared with 52.44 q ha^{-1} under late sowing; however, the difference between sowing dates was non-significant. Among the genotypes, DBW 509 (V_2) produced the highest straw yield (56.88 q ha^{-1}), which remained statistically at par with MP 1401 (V_1) (55.39 q ha^{-1}) and HI 1669 (V_3) (55.11 q ha^{-1}). The minimum straw yield was recorded in MACS 6768 (V_3) (51.27 q ha^{-1}), followed by GW 322 (V_4) (52.66 q ha^{-1}). The greater biomass production with timely establishment may be associated with improved vegetative growth and a longer period of exposure to favourable growing conditions.

Prathap Reddy *et al.* (2021) ^[9] similarly observed higher biomass and straw yield in wheat with early sowing compared with delayed sowing.

3.2.7 Harvest index (%)

Harvest index was slightly higher under timely sowing (47.06%) than under late sowing (46.48%), suggesting

relatively better partitioning of total biomass towards grain formation when the crop was established at the optimum time. Among the genotypes, DBW 509 (V₂) recorded the highest harvest index (47.07%), followed by MP 1401 (V₁) (46.73%), HI 1669 (V₅) (46.45%), GW 322 (V₄) (46.02%) and MACS 6768 (V₃) (45.87%). Kour *et al.* (2012) ^[6].

Table 1: Effect of sowing dates and genotypes on plant population (m⁻¹ row length) of wheat (*Triticum aestivum* L.).

Treatments	Plant population (m ⁻¹ row length)
A. Date of sowing(Main plot): 02	30 DAS
D ₁ .Timely sown (11 th Nov)	24.41
D ₂ .Late sown (4 th Dec)	23.20
SEm (±)	1.77
CD at 5%	NS
B. Genotypes (Sub-plot): 05	
V ₁ -MP 1401	25.43
V ₂ -DBW 509	30.53
V ₃ -MACS 6768 (C)	18.50
V ₄ -GW 322 (C)	19.75
V ₅ -HI 1669 (C)	24.82
SEm (±)	2.76
CD at 5%	NS
Interaction	
SEm (±)	3.90
CD at 5%	NS

Table 2: Effect of date of sowing and genotypes on plant height (cm) of wheat (*Triticum aestivum* L.).

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At Harvest
A. Date of sowing(Main plot): 02				
D ₁ .Timely sown (11 th Nov)	31.31	67.10	92.73	89.19
D ₂ .Late sown (4 th Dec)	29.01	63.02	88.07	84.02
SEm (±)	0.42	0.64	0.47	0.85
CD at 5%	2.53	3.88	2.86	5.18
B. Genotypes (Sub-plot): 05				
V ₁ -MP 1401	31.49	67.72	91.46	88.39
V ₂ -DBW 509	33.58	70.22	92.66	90.24
V ₃ -MACS 6768 (C)	26.54	58.75	87.57	81.36
V ₄ -GW 322 (C)	29.11	63.58	89.65	85.08
V ₅ -HI 1669 (C)	30.08	65.04	90.67	87.95
SEm (±)	1.18	2.10	0.73	1.63
CD at 5%	3.54	6.28	2.19	4.90
Interaction				
SEm (±)	1.67	2.96	1.03	2.31
CD at 5%	NS	NS	NS	NS

Table 3: Effect of sowing dates and genotypes on number of tillers (m⁻²) of wheat (*Triticum aestivum* L.).

Treatments	Number of tillers (m ⁻²)			
	30 DAS	60 DAS	90 DAS	AT HARVEST
A. Date of sowing(Main plot): 02				
D ₁ .Timely sown (11 th Nov)	327.82	457.66	522.19	518.25
D ₂ .Late sown (4 th Dec)	319.12	445.75	507.69	504.53
SEm (±)	2.67	3.40	4.47	4.33
CD at 5%	8.01	10.26	13.40	12.99
B. Genotypes (Sub-plot): 05				
V ₁ -MP 1401	341.30	473.24	540.75	535.39
V ₂ -DBW 509	355.05	490.28	560.83	554.10
V ₃ -MACS 6768 (C)	276.43	386.05	441.34	439.50
V ₄ -GW 322 (C)	322.08	448.70	508.75	505.04
V ₅ -HI 1669 (C)	330.20	460.90	525.10	520.21
SEm (±)	8.28	10.09	12.24	11.29
CD at 5%	24.85	30.28	36.73	33.89
Interaction				
SEm (±)	2.63	6.02	7.94	7.83
CD at 5%	7.89	18.04	23.81	23.48

Table 4: Effect of sowing dates and genotypes on dry matter accumulation (g plant⁻¹) of wheat (*Triticum aestivum* L.).

Treatments	Dry matter accumulation (g plant ⁻¹)			
	30 DAS	60 DAS	90 DAS	AT HARVEST
A. Date of sowing (Main plot): 02				
D ₁ -Timely sown (11 th Nov)	0.58	6.68	15.06	21.20
D ₂ -Late sown (4 th Dec)	0.48	5.48	11.90	17.86
SEm (±)	0.01	0.02	0.18	0.12
CD at 5%	0.03	1.19	1.11	0.72
B. Genotypes (Sub-plot): 05				
V ₁ -MP 1401	0.56	6.30	14.01	20.32
V ₂ -DBW 509	0.57	6.92	14.86	21.93
V ₃ -MACS 6768 (C)	0.47	5.25	11.72	17.02
V ₄ -GW 322 (C)	0.52	5.82	13.21	18.70
V ₅ -HI 1669 (C)	0.54	6.10	13.51	19.67
SEm (±)	0.02	0.28	0.50	0.58
CD at 5%	0.05	0.83	1.50	1.74
Interaction				
SEm (±)	0.02	0.39	0.71	0.82
CD at 5%	NS	NS	NS	NS

Table 5: Effect of sowing dates and genotypes on number of spikes (m⁻²), length of spike (cm), number of grains spike⁻¹ and test weight (g) of wheat (*Triticum aestivum* L.).

Treatments	Number of spikes (m ⁻²)	Spike length (cm)	Number of grains spike ⁻¹	Test weight (g)
A. Date of sowing (Main plot): 02				
D ₁ -Timely sown (11 th Nov)	514.00	10.27	22.39	42.84
D ₂ -Late sown (4 th Dec)	501.00	8.46	22.70	40.68
SEm (±)	7.19	0.28	0.25	0.43
CD at 5%	NS	1.68	NS	NS
B. Genotypes (Sub-plot): 05				
V ₁ -MP 1401	531.00	9.98	21.17	43.29
V ₂ -DBW 509	549.00	10.82	19.96	46.45
V ₃ -MACS 6768 (C)	438.00	7.51	26.68	37.47
V ₄ -GW 322 (C)	503.00	8.78	22.35	40.31
V ₅ -HI 1669 (C)	516.00	9.72	22.57	41.28
SEm (±)	12.88	0.43	1.14	1.03
CD at 5%	38.63	1.30	3.41	3.09
Interaction				
SEm (±)	18.22	0.61	1.61	1.46
CD at 5%	NS	NS	NS	NS

Table 6: Effect of sowing dates and genotypes on grain yield (q ha⁻¹), straw yield (q ha⁻¹) and harvest index (%) of wheat (*Triticum aestivum* L.).

Treatments	Grain Yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest Index (%)
A. Date of sowing (Main plot): 02			
D ₁ -Timely sown (11 th Nov)	48.56	54.63	47.06
D ₂ -Late sown (4 th Dec)	45.55	52.44	46.48
SEm (±)	0.47	0.72	
CD at 5%	2.86	4.38	
B. Genotypes (Sub-plot): 05			
V ₁ -MP 1401	48.59	55.39	46.73
V ₂ -DBW 509	50.59	56.88	47.07
V ₃ -MACS 6768 (C)	43.45	51.27	45.87
V ₄ -GW 322 (C)	44.91	52.66	46.02
V ₅ -HI 1669 (C)	47.74	55.11	46.45
SEm (±)	1.41	1.38	
CD at 5%	4.23	4.15	
Interaction			
SEm (±)	2.00	1.96	
CD at 5%	NS	NS	

4. Conclusion

The findings indicated that timely sowing on 11 November provided a more favourable environment for wheat growth and yield formation than delayed sowing on 4 December. Timely establishment generally improved plant height, tiller

production, dry matter accumulation, number of spikes, spike length, grains spike⁻¹, test weight, grain yield and straw yield, while plant population showed little variation among treatments. Among the genotypes, DBW 509 (V₂) exhibited comparatively better performance for most growth

and yield attributes and achieved the highest grain yield (50.59 q ha⁻¹), straw yield (56.88 q ha⁻¹) and harvest index (47.07%). Its superior performance was also reflected in plant height, tillering, dry matter production, spike characteristics, grains spike⁻¹ and test weight. Thus, under the irrigated conditions of the Chhattisgarh plains, timely sowing around 11 November with DBW 509 can be considered a promising combination for obtaining improved crop growth, yield components and overall wheat productivity.

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