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Growth dynamics of newly released wheat (*Triticum aestivum L.*) genotypes under late and very late sown irrigated conditions in Chhattisgarh plain

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Abstract
A field experiment entitled "Growth Dynamics of Newly Released Wheat (*Triticum aestivum* L.) Genotypes under Late and Very Late Sown Irrigated Conditions in Chhattisgarh Plain" was conducted during Rabi 2024–25 at the Instructional-cum-Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh. The experiment was laid out in a split-plot design with three replications, comprising two sowing dates as main plot treatments, *viz*., D_1 (6 December; late sown) and D_2 (24 December; very late sown), and seven newly released wheat genotypes as subplot treatments: V_1 [CG 1029(c)], V_2 [MP 4010(c)], V_3 (GW 556), V_4 (WSM 138), V_5 [HI 1634(c)], V_6 (DBW 425), and V_7 [HD 2932(c)]. Growth parameters including number of tillers m^{-2}, dry matter accumulation, crop growth rate (CGR), and relative growth rate (RGR) were recorded at different growth stages.

The results revealed that late sowing (D_1) significantly enhanced crop growth compared with very late sowing (D_2). Maximum CGR values were observed during the 60–90 DAS period under D_1 (0.5152 g plant^{-1} day^{-1}) compared to D_2 (0.4190 g plant^{-1} day^{-1}), indicating superior biomass production under timely sowing. Dry matter accumulation increased progressively with crop age and attained the highest values at harvest. Among the genotypes, CG 1029(c) (V_1) recorded the highest dry matter accumulation (25.17 g plant^{-1} at harvest), maximum tiller density (292.95 tillers m^{-2} at harvest), and superior crop growth rate across growth stages. Relative growth rate was highest during the early growth period (0–30 DAS) and declined with crop advancement in all genotypes. CG 1029(c) (V_1) exhibited the highest RGR during the initial growth stage (0.0239 g g^{-1} day^{-1}), followed closely by GW 556 (V_3). In contrast, MP 4010(c) (V_2) and HI 1634(c) (V_5) recorded comparatively lower values for most growth parameters.

The study demonstrated that late sowing on 6 December provided a more favorable environment for wheat growth than very late sowing on 24 December. Among the evaluated genotypes, CG 1029(c) showed superior growth performance in terms of tillering ability, biomass accumulation, CGR, and RGR, followed by GW 556, suggesting their suitability for late and very late sown irrigated conditions of the Chhattisgarh Plain.

Keywords: Wheat, growth dynamics, CGR, RGR, dry matter accumulation, tillers, late sowing

Introduction

Wheat (*Triticum aestivum* L.) Known as the "king of cereals," is farmed in irrigated, desert, and semi-arid regions all over the world. Originally from West Asia, this self-pollinating crop is regarded as the world's second most significant grain crop. It is a member of the poaceae family's genus "Triticum," which contains 17 species. Of these, only three are grown globally: 95% of the world's population grows bread wheat (*Triticum aestivum*), 4% grows macaroni wheat (*Triticum durum*), and 1% grows emmer wheat (Triticum dicocum). In the world most significant agricultural area is allocated to wheat with largest production quantity to any other crop (Ahmad *et al*. 2014) [12].

In India, wheat (*Triticum aestivum* L.) has been under cultivation in 31.82 million ha annually, with a production of 113.29 million tonnes with national average productivity of 33.11 q ha^{-1} (2023-24). Wheat (*Triticum aestivum* L.) is grown on around 267.04 (000) ha of land in Chhattisgarh with a productivity of 1600 kg ha^{-1} during the year 2023-24. (Anonymous, 2023-24) [1].

Any region can sustain increased wheat (*Triticum aestivum* L.) productivity by choosing the right cultivars. Late sowing of some wheat (*Triticum aestivum* L.) types usually results in significant temperature stress, which ultimately has a negative impact on phenology, growth, and yield (Yusuf *et al*., 2019).

Over 50% of the wheat (*Triticum aestivum* L.) in Chhattisgarh is planted after the first week of December and experiences heat stress, which significantly lowers yield. Late-planted wheat (*Triticum aestivum* L.) yields significant losses, potentially as much as 40 to 50 percent. It has previously been demonstrated that heat stress significantly reduces wheat (*Triticum aestivum* L.) yield and quality.

For the best yield, it is essential to grow the right kind of plant at the right time. Selecting the right variety is crucial to maximizing yields under ideal input and management circumstances. Time commitment is a significant non-monetary factor that influences productivity. Controlling the planting season is necessary to ensure that the crop grows in the optimal climate and effectively utilizes the soil moisture stored in the profile for early growth and development. The wheat crop's growth, development, and yield are all impacted by variations in the planting date.

Material and methods

A field experiment entitled "Growth Dynamics of Newly Released Wheat (*Triticum aestivum* L.) Genotypes under Late and Very Late Sown Irrigated Conditions in Chhattisgarh Plain" was conducted during the Rabi season of 2024–25 at the Instructional-cum-Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, Chhattisgarh. The experimental field was characterized by sandy clay loam soil having a pH of 7.2 and electrical conductivity (EC) of 0.23 dS m^{-1} in the 0–30 cm soil layer. The soil was low in available nitrogen and medium in available phosphorus, potassium, and organic carbon content.

The experiment was laid out in a split-plot design with three replications. Two sowing dates, *viz*., D_1 (6 December, late sown) and D_2 (24 December, very late sown), were assigned to the main plots, while seven newly released wheat genotypes, namely V_1 [CG 1029(c)], V_2 [MP 4010(c)], V_3 (GW 556), V_4 (WSM 138), V_5 [HI 1634(c)], V_6 (DBW 425), and V_7 [HD 2932(c)], were allotted to the sub-plots.

A uniform fertilizer dose of 90:60:40 kg N:P_2O_5:K_2O ha^{-1} was applied to all treatments. Full doses of phosphorus and potassium along with one-third nitrogen were applied as basal through single super phosphate, muriate of potash, and urea, respectively. The remaining nitrogen was top-dressed in two equal splits after the first and second irrigations.

The crop was sown using a seed rate of 125 kg ha^{-1} with a row spacing of 20 cm. An irrigation was applied immediately after sowing to ensure proper germination, followed by five irrigations at critical crop growth stages, namely crown root initiation (21 DAS), late tillering (40 DAS), late jointing (60 DAS), flowering (80 DAS), and milk stage (90 DAS).

Observations on growth dynamics were recorded at 30, 60, and 90 days after sowing (DAS) and at harvest. Growth parameters such as number of tillers m^{-2}, dry matter accumulation, crop growth rate (CGR), and relative growth rate (RGR) were determined using standard procedures. Crop growth rate and relative growth rate were computed for different growth intervals (0–30, 30–60, 60–90 DAS, and 90 DAS to harvest) to assess biomass production and growth efficiency of the genotypes under varying sowing environments.

The crop from the net plot area was harvested manually at physiological maturity using a sickle. The harvested produce was sun-dried for 2–3 days, after which the total bundle weight was recorded. The crop was then threshed, cleaned, and the grain and straw yields from each plot were measured and converted into quintals per hectare. The collected data were subjected to statistical analysis following the procedures appropriate for a split-plot design, and treatment means were compared at the 5% level of significance.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Number of tillers (m^{-2})

The results showed that D_1 (late sown) had the most no. of tillers, while D_2 (very late sown) had the lowest no. of tillers. The quantity of tillers varied statistically among the seven genotypes that were the subject of the investigation. Amongst varieties (V_1) CG 1029 (c) recorded the highest no. of tillers, which was significantly superior over (V_5) HI 1634 (c), (V_2) MP 4010 (c), (V_4) WSM 138, (V_6) DBW 425 and (V_7) HD 2932 (c) but was at par with variety (V_3) GW 556. It was found that there was no significant interaction between genotypes and planting dates. The findings of Singh *et al*. (1995) [10] and Prajapat *et al*. (2018) [8] supported these findings.

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

Total dry matter accumulation per plant was significantly influenced by different sowing dates at all growth stages. The late-sown treatment (D_1) recorded the highest dry matter accumulation per plant at 30 DAS, which was significantly higher than that observed under the very late-sown treatment (D_2). A similar trend was observed at 60 DAS, 90 DAS, and at harvest.

Among the evaluated varieties, CG 1029(c) (V_1) produced the highest dry matter accumulation at 30 DAS and was significantly superior to WSM 138 (V_4), MP 4010(c) (V_2), DBW 425 (V_6), HD 2932(c) (V_7), and HI 1634(c) (V_5), while remaining statistically at par with GW 556 (V_3). Comparable results were recorded at 60 DAS, 90 DAS, and at harvest. The interaction effect between sowing dates and genotypes was found to be non-significant. These results corroborate the findings of Singh *et al.* (1995) [10] and Singh *et al.* (1998) [9].

Crop growth rate (g $plant^{-1}$ day^{-1})

The data pertaining to crop growth rate (g $plant^{-1}$ day^{-1}) as influenced by different sowing dates and wheat genotypes are presented in Table 3. Crop growth rate was measured during the intervals of 0–30, 30–60, 60–90 DAS, and 90 DAS to harvest. The results indicated that sowing dates significantly affected crop growth rate at all growth stages. The highest crop growth rate was observed under D_1 (late sowing), whereas the lowest values were recorded under D_2 (very late sowing) throughout the crop growth period.

Among the genotypes, V_1 [CG 1029 (c)] exhibited the highest crop growth rate and was significantly superior to V_5 [HI 1634 (c)], V_2 [MP 4010 (c)], V_6 (DBW 425), V_7 [HD

2932 (c)], and V_4 (WSM 138). However, its performance was statistically at par with V_3 (GW 556) across all growth stages, namely 0–30, 30–60, 60–90 DAS, and 90 DAS to harvest. The interaction effect between sowing dates and genotypes was found to be non-significant at all observation intervals.

Relative growth rate (g g^{-1} day^{-1})

The data on relative growth rate (g g^{-1} day^{-1}) of wheat, as influenced by different sowing dates and genotypes, are presented in Table 4. Relative growth rate was evaluated during the intervals of 30–60, 60–90 DAS, and 90 DAS to harvest. The results revealed that sowing dates had a significant effect on relative growth rate at all growth stages. The highest relative growth rate was recorded under D_1 (late sowing), whereas the lowest values were observed under D_2 (very late sowing) throughout the crop growth period.

Among the genotypes, V_1 [CG 1029 (c)] registered the maximum relative growth rate and was statistically at par with V_3 (GW 556). The lowest relative growth rate was recorded in V_5 [HI 1634 (c)], followed by V_2 [MP 4010 (c)]. A similar trend was observed during the 30–60 DAS, 60–90 DAS, and 90 DAS to harvest intervals. The interaction effect between sowing dates and genotypes was found to be non-significant for relative growth rate at all stages of observation.

Table 1: Number of tillers (m^{-2}) of wheat influenced by different sowing dates and genotypes.

Treatments	Number of tillers (m^{-2})			
	30 DAS	60 DAS	90 DAS	At harvest
A. Sowing dates (Main-plot): 02				
D_1 – Late sowing (6th Dec)	176.65	266.80	282.55	280.09
D_2 – Very late sowing (24th Dec)	164.37	245.73	264.15	261.73
S.Em (±)	**0.89**	**1.27**	**0.99**	**1.17**
CD (5%)	**5.45**	**7.75**	**6.03**	**7.14**
B. Genotypes (Sub-plot): 07				
CG 1029 (c)	188.01	282.57	310.47	292.95
MP 4010 (c)	158.56	238.30	261.83	247.06
GW 556	181.57	272.89	299.84	282.92
WSM 138	175.09	263.15	289.13	272.82
HI 1634 (c)	154.11	231.62	254.49	240.13
DBW 425	164.25	246.86	271.24	255.93
HD 2932 (c)	171.98	258.49	284.01	267.98
S.Em (±)	1.93	1.69	1.11	1.17
CD (5%)	5.63	4.95	3.23	3.42

Table 2: Dry matter accumulation (g plant^{-1}) of wheat influenced by different sowing dates and genotypes.

Treatments	Dry matter accumulation			
	30 DAS	60 DAS	90 DAS	At harvest
A. Sowing dates (Main-plot): 02				
D_1 – Late sowing (6th Dec)	0.71	7.67	20.34	25.72
D_2 – Very late sowing (24th Dec)	0.57	6.16	16.84	21.29
S.Em (±)	**0.01**	**0.12**	**0.26**	**0.32**
CD (5%)	**0.04**	**0.73**	**1.56**	**1.96**
B. Genotypes (Sub-plot): 07				
CG 1029 (c)	0.68	7.41	19.91	25.17
MP 4010 (c)	0.57	6.24	16.79	21.23
GW 556	0.66	7.15	19.23	24.31
WSM 138	0.64	6.89	18.54	23.44
HI 1634 (c)	0.56	6.07	16.32	20.63
DBW 425	0.59	6.47	17.39	21.99
HD 2932 (c)	0.62	6.77	18.21	23.03
S.Em (±)	0.02	0.33	0.28	0.29
CD (5%)	0.06	0.98	0.81	0.85

Table 3: Sowing dates and genotypes on Crop growth rate (g plant^{-1} day^{-1}) of wheat.

Treatments	0-30 DAS	30-60 DAS	60-90 DAS	90-Harvest
A. Sowing dates (Main-plot): 02				
D_1 – Late sowing (6th Dec)	0.02763	0.2651	0.5152	0.2726
D_2 – Very late sowing (24th Dec)	0.0245	0.242	0.419	0.153
B. Genotypes (Sub-plot): 07				
CG 1029 (c)	0.022756	0.224081	0.416872	0.175409
MP 4010 (c)	0.019191	0.188978	0.351569	0.147931
GW 556	0.021977	0.216409	0.4026	0.169403
WSM 138	0.021192	0.208682	0.388225	0.163355
HI 1634 (c)	0.018653	0.18368	0.341712	0.143783
DBW 425	0.01988	0.195767	0.364198	0.153245
HD 2932 (c)	0.020816	0.204984	0.381346	0.16046

Table 4: Sowing dates and genotypes on relative growth rate (g g^{-1} day^{-1}) of wheat

Treatments	0-30 DAS	30-60 DAS	60-90 DAS	90-Harvest
A. Sowing dates (Main-plot): 02				
D_1 – Late sowing (6th Dec)	0.025	0.025	0.015	0.004
D_2 – Very late sowing (24th Dec)	0.022	0.22	0.014	0.002
B. Genotypes (Sub-plot): 07				
CG 1029 (c)	0.023907	0.023907	0.014318942	0.003394841
MP 4010 (c)	0.019061	0.019061	0.014318942	0.003394841
GW 556	0.022907	0.022907	0.014318942	0.003394841
WSM 138	0.021696	0.021696	0.014318942	0.003394841
HI 1634 (c)	0.018007	0.018007	0.014318942	0.003394841
DBW 425	0.020104	0.020104	0.014318942	0.003394841
HD 2932 (c)	0.021237	0.021237	0.014318942	0.003394841

Conclusion

The study revealed that late sowing (6 December) resulted in better growth performance than very late sowing (24 December) under irrigated conditions of the Chhattisgarh Plain. Among the evaluated wheat genotypes, CG 1029(c) exhibited superior growth dynamics, recording the highest dry matter accumulation, tiller density, CGR, and RGR, followed by GW 556. Therefore, CG 1029(c) and GW 556 can be recommended for late and very late sown irrigated conditions due to their better growth potential and adaptability.

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