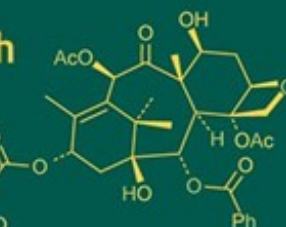


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Effect of different sowing dates on hulless barley (*Hordeum vulgare* L.)

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ABSTRACT

The Present investigation entitled Effect of different sowing dates on hulless barley (*Hordeum vulgare* L.) in Chhattisgarh was conducted at the Research-cum-Instructional Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.), during the Rabi season of 2025. The experiment was laid out in a Split plot design (SPD) with two date of sowing (12 November and 4 December) in main plots and five genotype (PL 891 (C), RD 3088, KARAN 16 (C), K 1149 (C) RD 3089) kept in sub plots replicated thrice. Crop sown on 12th November produced significantly higher values of growth parameters, yield attributes (198 productive tillers (m⁻²), and test weight -40.39) and yield (grain yield- 44.3 q ha⁻¹ and straw yield- 44.09 q ha⁻¹). Observations on plant population, plant height, dry matter accumulation, were recorded at different growth stages of the crop. Yield attributes such as number of grain per spike, spike length, grain yield, and harvest index were subjected to statistical analysis. Among the cultivars K 1149 (C) produced significantly higher grain yield (44.3 q ha⁻¹) and test weight (40.39g) than other cultivars.

Keywords: Hulless Barley, Genotype, Sowing date, Growth, Yield

1. Introduction

Barley (*Hordeum vulgare* L.) is the fourth most widely cultivated cereal crop globally and contributes approximately 7% of total cereal production. It belongs to the family Poaceae and subfamily Pooideae and is closely related to other major small-grain cereals, particularly wheat and rye. Owing to its wide geographical distribution, adaptability, and diverse applications, barley is considered one of the major cereal crops worldwide, ranking fourth in importance after maize, rice, and wheat (Chen *et al.*, 2020) [1]. Barley grains are a valuable source of several bioactive and health promoting functional components, including β -glucan, tocopherols, and resistant starch. Barley β -glucan has been associated with beneficial effects on metabolic and gastrointestinal health, including reductions in serum cholesterol and blood glucose levels and improvements in intestinal function. Tocopherols, including tocopherols and tocotrienols, may contribute to cholesterol-lowering effects, while resistant starch can help regulate postprandial blood glucose levels and support healthy intestinal function. Collectively, these bioactive components enhance the nutritional and functional value of barley as a health-promoting cereal grain (Geng *et al.*, 2022) [2]. Barley genotypes are broadly classified into two types: hulled and hull-less. Most barley cultivated worldwide is of the hulled type, which is particularly suitable for malting and other industrial applications. The hull constitutes approximately 10–20% of the barley grain, although its proportion varies depending on the genotype and environmental conditions during crop growth (Lukinac *et al.*, 2022) [3]. Based on the number of kernel rows per spike, barley is broadly classified into two major types: two-row and six-row barley. Six-row barley generally exhibits greater enzymatic potential than two-row barley, particularly in malting, owing to its higher capacity to convert starch into fermentable sugars. In the major barley-growing regions, the combined production is estimated at approximately 1.75 million tonnes, covering a total cultivated area of about 656,000 hectares. (FAO's 2017) [4]. Under the prevailing conditions of climate change, water stress has emerged as a major constraint to cereal production, adversely affecting both yield and grain quality. The variation in the qualitative characteristics of winter barley grain under water-limited conditions indicates significant differences among genotypes in their ability to tolerate moisture stress and efficiently translocate assimilates to the developing grains. These findings provide a valuable basis for identifying and selecting barley genotypes with improved adaptability and productivity under challenging pedoclimatic conditions. (Vasilescu *et al.*, 2023) [5]. The relatively lower grain yield and the requirement for higher seed rates are considered important disadvantages of hulless barley production. However, hulless barley offers an advantage in terms of its lower husk content, with approximately 13–15% less husk than hulled barley. This characteristic may contribute to a higher proportion of edible grain and improve its suitability for various food and processing applications. (Özdemir *et al.*, 2022) [6]. A comprehensive evaluation of the vegetative characteristics of newly developed

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varieties and their adaptability to the prevailing agro-climatic conditions of a region is essential for both farmers and end-users. Optimization of plant density is one of the key agronomic factors influencing grain yield, and therefore, an appropriate plant population should be established based on the climatic and environmental conditions of the target region (Balaban *et al.*, 2022) [7]. Although numerous studies have investigated the influence of sowing date on crop productivity, its effects on grain yield vary considerably depending on regional and environmental conditions. Previous studies have demonstrated the feasibility of winter barley production systems in south-central China; however, forage production from winter barley sown within the conventional sowing period remains insufficient to meet the required production levels. (Chen *et al.*, 2021) [8]. Barley's high nutritional value is the main reason why it is included in diets nowadays potential health benefits. (Bhall *et al.*, 2004) [9] Discovered that β -glucans can aid in the reduction of blood cholesterol levels. The glycemic index of barley has been extensively studied (Pins and al, 2002). Its primary role is as an important food additive for animals, as well the base malt utilized in beer and other distilled spirits. beverages. Barley is a perennial crop that is grown in deserts, desert environments, and the dryland. The area from the Middle East to the Himalayas is elevated. Barley is a short crop that can withstand drought and salt well during its growing season. management. The chemical method of weed control is economical and effective in reducing weed infestation for a longer duration when applied properly. In recent years, several new herbicide molecules have been developed that provide higher weed control efficiency even at lower doses,

2. Materials and methods

2.1 Experimental site and location

The field experiment was conducted during the *Rabi* 2025 at the Agricultural Research Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (Chhattisgarh). The Research Farm is located at 22. 09° N latitude, 82.15° E longitude and at an altitude of 298 m above mean sea level. The region comes under the Eastern Plateau and Hill Region (Agro-climatic Zone VII) of India. Chhattisgarh state is classified into 3 agro-climatic zones, and Bilaspur falls into the Chhattisgarh.

2.2 Climate Condition: During the experimental period, the area experienced high to moderate temperatures, with average daily temperatures ranging between 26.9 °C and 30.1 °C, and relative humidity fluctuating between 80% and 96%. The minimum rainfall received during the crop growing period was 1.8 mm, and the maximum rainfall of 9.6 mm.

2.3 Treatment details

The experiment was laid out in a Split plot Design (SPD) with two sowing dates and replicated thrice. The treatments were D₁ – Timely sowing (12 November), D₂ – Late sowing (4 December), as main plot and five hullless barley genotypes, viz.,- V₁- PL 891 (C) V₂- RD 3088, V₃- KARAN 16(C), V₄- K1149 (C), V₅- RD 3089 as sub-plot.

2.4 Statistical analysis

The observations recorded for various growth and yield parameters were subjected to statistical analysis using the analysis of variance (ANOVA) appropriate for a split-plot design. Sowing dates were treated as main-plot treatments, whereas barley genotypes were assigned to the sub-plots, with three replications. The significance of the treatment effects was assessed using the *F*-test following the procedure described by Gomez *et al.* (1984) [10]. In cases where significant differences among treatment means were observed, the critical difference (CD) at the 5% level of significance was calculated for comparison of the means. The standard error of the mean (SEm) was also estimated. The significance of the interaction between sowing dates and barley genotypes was assessed to determine their combined effect on the growth and yield parameters under study.

3. Results and discussion

3.1 Growth parameters

3.1.1 Plant population

Plant population at 30 days after sowing (DAS) was not significantly influenced by sowing date. Timely sowing (D₁: 12 November) recorded a comparatively higher plant population of 28.07 plants m⁻¹ row length than late sowing (D₂: 4 December), which recorded 25.14 plants m⁻¹ row length. The relatively better plant establishment under timely sowing may be attributed to the prevailing favourable temperature and soil-moisture conditions during germination and the initial stages of crop growth.

Among the genotypes, V₄ (K 1149 (C)) recorded the highest plant population (30.36 plants m⁻¹), followed by V₃ (KARAN 16(C)) and V₁ (PL 891 (C)), whereas V₅ (RD 3089) recorded the lowest plant population (23.86 plants m⁻¹). However, the differences among the genotypes were statistically non-significant, indicating that all the genotypes exhibited comparable plant establishment under the prevailing experimental conditions.

3.1.2 Plant height (cm)

Plant height was influenced by both sowing date and genotype at different stages of crop growth. The crop sown on 12 November (D₁) consistently recorded greater plant height than that sown on 4 December (D₂) at all stages of observation. Under timely sowing (D₁), the mean plant height was 30.10, 67.01, 86.06 and 104.30 cm at 30, 60, 90 DAS and harvest, respectively, whereas the corresponding values under late sowing (D₂) were 26.32, 57.05, 82.31 and 97.40 cm. The effect of sowing date was statistically significant at 60 and 90 DAS, while it remained non-significant at 30 DAS and harvest. The comparatively greater plant height under timely sowing may be attributed to more favourable temperature conditions during the vegetative and reproductive stages, which promoted vegetative growth and stem elongation. In contrast, delayed sowing exposed the crop to relatively higher temperatures during the later stages of growth, which may have accelerated crop development and consequently reduced plant height. Considerable variation in plant height was also observed among the barley genotypes. K1149 (C) (V₄) recorded the highest plant height at 30, 60, 90 DAS and harvest, with values of 30.85, 66.04, 91.44 and 105.01 cm, respectively. In contrast, RD 3089 (V₅) recorded the lowest plant height, with corresponding values of 25.29, 56.56, 77.47 and 96.63 cm. The variation in plant height among the genotypes may be attributed to differences in their genetic potential for plant growth and development. Similar genotypic variation in plant height under different sowing dates was reported by Ram *et al.* (2019) [11]. The interaction effect between sowing date and genotype was found to be non-significant at all stages of observation. This indicates that the relative performance of the genotypes with respect to plant height remained largely consistent across the different sowing dates.

3.1.3 Number of tillers (m⁻²)

The number of tillers m⁻² was significantly influenced by sowing date, genotype, and their interaction at different stages of crop growth. Timely sowing (D₁: 12 November) consistently produced a greater number of tillers m⁻² than late sowing (D₂: 4 December), recording 198.69, 351.86, 390.10 and 380.26 tillers m⁻² at 30, 60, 90 DAS and harvest, respectively. Among the genotypes, V₄ (K 1149 (C)) recorded the highest number of tillers at all stages of observation and attained 387.86 tillers m⁻² at harvest, whereas V₅ (RD 3089) recorded the lowest value of 364.13 tillers m⁻². The greater tiller production under timely sowing may be attributed to the more favourable temperature conditions prevailing during the vegetative and tillering phases, which promoted enhanced tiller initiation and development. The significant interaction between sowing date and genotype indicates differential tillering responses of the genotypes under different sowing environments. These findings are in agreement with those reported by Rawat *et al.* (2025) [12], who observed significant variation

in tiller production among barley genotypes under different sowing dates.

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

Dry matter accumulation varied considerably with sowing date and genotype throughout the crop growth period. Timely sowing on 12 November resulted in greater dry matter accumulation than late sowing on 4 December at all stages of observation. Under timely sowing, dry matter accumulation increased from 0.84 g plant⁻¹ at 30 DAS to 25.48 g plant⁻¹ at harvest, whereas the corresponding values under late sowing were 0.74 and 20.10 g plant⁻¹, respectively. Among the genotypes, K 1149 (C) (V₄) recorded the highest dry matter accumulation at all stages, with values of 0.86, 8.03, 18.99 and 25.87 g plant⁻¹ at 30, 60, 90 DAS and harvest, respectively. In contrast, RD 3089 (V₅) recorded the lowest dry matter accumulation, with corresponding values of 0.73, 6.11, 14.87 and 20.12 g plant⁻¹.

The higher dry matter accumulation under timely sowing may be attributed to more favourable environmental conditions and a comparatively longer period for crop growth and biomass accumulation. The greater biomass production recorded by K 1149 (C) (V₄) indicates its superior growth and assimilatory capacity compared with the other genotypes. The interaction between sowing date and genotype was non-significant at all stages of observation, indicating that the genotypes exhibited a relatively consistent response to the different sowing dates. The present findings are in accordance with those of Miroslavljević *et al.* (2018), who reported greater dry matter accumulation in barley under normal sowing conditions compared with delayed sowing.

3.2 Yield parameter

3.2.1 Ear length (cm)

Ear length was significantly influenced by sowing date and genotype. Timely sowing resulted in significantly longer spikes (9.68 cm) compared with late sowing (7.26 cm). Among the genotypes, K 1149 (C) (V_4) recorded the maximum Ear length (10.74 cm), followed by KARAN 16(C) (V_3) with 9.29 cm, whereas RD 3089 (V_5) recorded the minimum ear length (6.77 cm). The differences among the genotypes were statistically significant, indicating considerable genotypic variation for ear length. However, the interaction between sowing date and genotype was non-significant, suggesting that the genotypes responded similarly to the different sowing dates with respect to ear length. These findings are in close conformity with reports of Priya Devi *et al.* (2018) [13].

3.2.2 Number of grains ear head⁻¹

Statistical analysis revealed significant differences in the number of grains ear head⁻¹ as influenced by sowing dates and barley genotypes at harvest. The timely sown crop (D₁) recorded a significantly higher number of grains ear head⁻¹ than the late-sown crop (D₂). Among the five barley genotypes evaluated, RD 3088 produced the maximum number of grains ear head⁻¹ and was significantly superior to the other genotypes. However, RD 3088 remained statistically at par with PL 891 (C). In contrast, the minimum number of grains ear head⁻¹ was recorded in KARAN 16 (C). The interaction between sowing dates and genotypes was found to be non-significant for the number of grains ear head⁻¹ at harvest. The present findings are in accordance with the observations reported by Kumar *et al.* (2021) [14].

3.2.3 Test weight (g)

Test weight exhibited a numerical advantage under timely sowing (37.76 g) compared with late sowing (36.79 g); however, the difference between sowing dates was statistically non-significant. In contrast, significant variation in test weight was observed among the bar-

ley genotypes. K 1149 (C) (V₄) recorded the highest test weight (40.39 g), whereas RD 3088 (V₂) recorded the lowest test weight (35.26 g). The interaction effect between sowing date and genotype was found to be non-significant, indicating that the genotypes responded similarly across the different sowing dates.

3.2.4 Number of ear head (m^{-2})

The number of ear head m^{-2} showed a numerical variation with sowing date; however, the effect of sowing date was statistically non-significant. Timely sowing on 12 November (D_1) recorded a comparatively higher number of ear (412.00 m^{-2}) than late sowing on 4 December (D_2), which recorded $386.00 \text{ ear m}^{-2}$. In contrast, a significant variation was observed among the barley genotypes. K 1149 (C) (V_4) produced the highest number of spikes (429.00 m^{-2}), whereas RD 3089 (V_5) recorded the lowest (379.00 m^{-2}). The genotypic differences were significant at the 5% level of significance, indicating variability among the genotypes in ear production. The interaction between sowing dates and genotypes was found to be non-significant for the number of ears m^{-2} at harvest, indicating that the response of genotypes to different sowing date was statistically comparable. Similar findings reported by [Tripathy *et al.* \(2020\)](#) ^[15].

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

Grain yield was significantly affected by sowing time, with timely sowing on 12 November resulting in a significantly higher grain yield (42.01 q ha⁻¹) than late sowing on 4 December (37.40 q ha⁻¹). Among the genotypes, K 1149 (C) (V₄) recorded the highest grain yield (44.03 q ha⁻¹), which was statistically at par with KARAN 16 (C) (V₃) (41.00 q ha⁻¹). In contrast, RD 3089 (V₅) recorded the lowest grain yield (36.68 q ha⁻¹).

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

Straw yield exhibited a numerical advantage under timely sowing (44.79 q ha⁻¹) compared with late sowing (37.47 q ha⁻¹); however, the difference between sowing dates was statistically non-significant. Significant variation was observed among the genotypes, with K 1149 (C) (V₄) recording the highest straw yield (44.09 q ha⁻¹), which was statistically at par with KARAN 16 (C) (V₃) (43.85 q ha⁻¹) and PL 3089 (C) (V₁) (41.74 q ha⁻¹). The lowest straw yield was recorded in RD 3088 (V₃) (39.67 q ha⁻¹), followed by RD 3089 (V₄) (36.68 q ha⁻¹). The relatively higher straw yield under timely sowing may be attributed to better crop establishment, enhanced vegetative growth, and prolonged exposure to favourable environmental conditions, resulting in greater biomass accumulation. In contrast, delayed sowing may restrict vegetative growth due to less favourable temperature conditions during crop development. These findings are in accordance with Kharub *et al.* (2025) [16], who reported higher biomass production and straw yield in barley under early sowing compared with delayed sowing.

3.2.7 Harvest index (%)

Harvest index was slightly higher under timely sowing (52.57%) than under late sowing (43.77%), indicating comparatively better partitioning of accumulated biomass towards grain production under optimum sowing conditions. Among the genotypes, K 1149 (C) (V₄) recorded the highest harvest index (51.70%), followed by KARAN 16 (C) (V₃) (49.84%), PL 891 (C) (V₁) (48.50%), RD 3088 (V₂) (46.53%), and RD 3089 (V₅) (44.28%). The higher harvest index observed in K 1149 (C) suggests its greater efficiency in partitioning photosynthates towards reproductive growth and grain formation. Similar variations in harvest index among barley genotypes under different sowing conditions have been reported by Chaudhary *et al.* (2017) [17]

Table 1. Effect of dates of sowing and genotypes on plant population of barley.

Treatments	Plant population (m ⁻¹) row length
	30 DAS
A. Date of sowing (Main plot): 02	
D ₁ - Timely sown (11 th Nov)	28.07
D ₂ - Late sown (4 th Dec)	25.14
SEm (±)	0.39
CD (5%)	NS
B. Genotypes (Sub- plot): 05	
V ₁ - PL 891(C)	27.61
V ₂ - RD 3088	25.90
V ₃ - KARAN 16 (C)	28.27
V ₄ - K 1149(C)	30.36
V ₅ - RD 3089	23.86
SEm (±)	1.84
CD (5%)	NS
Interaction	
SEm (±)	1.58
CD (5%)	NS

Table 2. Effect of dates of sowing and genotypes on plant height of barley.

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)	30.10	67.01	86.06	104.30
D ₂ - Late sown (4 th Dec)	26.32	57.05	82.31	97.40
SEm ($\pm$)	0.60	0.78	1.45	0.40
CD (5%)	3.68	4.72	8.78	2.42
B. Genotypes (Sub- plot): 05				
V ₁ - PL 891(C)	28.67	62.66	83.14	100.02
V ₂ - RD 3088	26.50	59.09	80.52	98.44
V ₃ - KARAN 16 (C)	29.44	65.80	86.78	103.04
V ₄ - K 1149 (C)	30.85	66.04	91.44	105.01
V ₅ - RD 3089	25.59	56.56	77.47	96.63
SEm ($\pm$)	0.76	1.85	2.39	1.78
CD (5%)	2.28	5.54	7.15	5.34
Interaction				
SEm ($\pm$)	1.08	2.61	3.38	5.18
CD (5%)	NS	NS	NS	NS

Table 3. Effect of dates of sowing and genotypes on number of tillers of barley.

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)	198.69	351.86	390.10	380.26
D ₂ - Late sown (4 th Dec)	182.05	325.20	368.42	375.61
SEm ($\pm$)	0.66	3.84	2.22	0.67
CD (5%)	3.98	23.32	13.48	4.05
B. Genotypes (Sub- plot): 05				
V ₁ - PL 891(C)	189.27	339.56	384.34	378.52
V ₂ - RD 3088	186.45	334.28	370.47	373.68
V ₃ -KARAN16 (C)	194.20	343.42	387.76	385.48
V ₄ - K 1149(C)	198.22	348.54	390.84	387.86
V ₅ - RD 3089	183.71	326.85	362.90	364.13
SEm ($\pm$)	3.05	8.39	9.93	6.64

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Treatments	Number of tillers (m ⁻²)			
	30 DAS	60 DAS	90 DAS	At Harvest
CD (5%)	9.13	25.17	29.78	19.91
Interaction				
SEm (±)	9.23	11.87	14.05	17.67
CD (5%)	NS	NS	NS	NS

Table 4. Effect of dates of sowing and genotypes on dry matter accumulation of barley .

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)	0.84	7.66	18.15	25.48
D ₂ - Late sown (4 th Dec)	0.74	6.90	15.47	20.10
SEm (±)	0.03	0.12	0.14	0.26
CD (5%)	0.11	0.73	0.87	1.59
B. Genotypes (Sub- plot): 05				
V ₁ - PL 891(C)	0.79	7.55	16.79	22.56
V ₂ - RD 3088	0.76	6.95	16.16	21.44
V ₃ - KARAN 16 (C)	0.82	7.78	17.22	23.95
V ₄ - K 1149(C)	0.86	8.03	18.99	25.87
V ₅ - RD 3089	0.73	6.11	14.87	20.12
SEm (±)	0.02	0.21	0.34	0.56
CD (5%)	0.07	0.63	1.01	1.68
Interaction				
SEm (±)	0.03	0.30	1.07	0.79
CD (5%)	NS	NS	NS	NS

Table 5. Effect of dates of sowing and genotypes on Length of ear, number of grains ear head-1 and test weight of barley.

Treatments	Length of ear (cm)	Number of grains (ear head ⁻¹)	Test weight (g)	Number of ear head (m ⁻²)
A. Date of sowing (Main plot): 02				
D ₁ – Timely sown (12 th Nov)	9.68	27.24	37.76	412
D ₂ – Late sown (4 th Dec)	7.26	26.54	36.79	386
SEm (±)	0.24	0.83	0.46	7.64
CD at 5%	1.47	NS	NS	NS
B. Genotypes (Sub- plot): 05				
V ₁ - PL 891(C)	8.31	27.30	37.03	390
V ₂ - RD 3088	7.32	30.06	35.26	356
V ₃ - KARAN 16 (C)	9.29	25.35	36.89	443
V ₄ - K 1149 (C)	10.74	25.53	40.39	429
V ₅ - RD 3089	6.77	26.22	36.80	379
SEm (±)	0.27	1.16	0.69	7.94
CD at 5%	0.82	NS	2.08	23.80
Interaction				
SEm (±)	0.39	1.64	2.94	11.23
CD at 5%	NS	NS	NS	NS

Table 6. Effect of dates of sowing and genotypes on grain yield, straw yield and harvest index of barley.

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)	42.01	44.79	52.57
D ₂ - Late sown (4 th Dec)	37.40	37.47	43.77
SEm (±)	0.43	0.18	1.22
CD (5%)	2.61	1.11	7.40

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Treatments	Grain Yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest Index (%)
B. Genotypes (Sub- plot): 05			
V ₁ - PL 891(C)	39.36	41.74	48.50
V ₂ - RD 3088	37.65	39.65	46.53
V ₃ - KARAN 16 (C)	41.00	43.85	49.84
V ₄ - K 1149(C)	44.03	44.09	51.70
V ₅ - RD 3089	36.49	36.68	44.28
SEm (±)	1.06	1.37	1.47
CD (5%)	3.17	4.11	4.41
Interaction			
SEm (±)	1.49	1.94	2.94
CD (5%)	NS	NS	NS

Conclusion

Timely sowing of barley on 12 November was found to be the most suitable sowing time, resulting in higher grain yield and better economic returns compared with delayed sowing. Among the genotypes evaluated, V₄ K1149 (C) exhibited superior performance with respect to crop growth parameters, yield attributes, and economic returns. Its performance was statistically at par with V₃ KARAN 16 (C) and V₁ PL 891 (C). The highest gross returns, net returns, and benefit–cost (B:C) ratio were recorded under D₁ (timely sowing), indicating the economic advantage of timely sowing of barley.

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