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Ram Sahu
M.Sc. Final Year, Department of
Agronomy, BTC College of Agriculture and
Research Station, Bilaspur, Chhattisgarh,
India

Dinesh Pandey
Principal Scientist, Department of
Agronomy, BTC College of Agriculture and
Research Station, Bilaspur, Chhattisgarh,
India

RB Tiwari
Professor, Department of Agronomy, BTC
College of Agriculture and Research
Station, Bilaspur, Chhattisgarh, India

Awaneet Kumar
Assistant Professor, Department of
Genetics and Plant Breeding, BTC College
of Agriculture and Research Station,
Bilaspur, Chhattisgarh, India

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

Pragya Tiwari
Guest Scientist (Agronomy), Indira Gandhi
Krishi Vishwavidyalaya, Raipur,
Chhattisgarh, India

Shikha Kumari
M.Sc. Final Year, Department of
Agronomy, BTC College of Agriculture and
Research Station, Bilaspur, Chhattisgarh,
India

Bhimraj Sahu.
M.Sc. Final Year, Department of
Agronomy, BTC College of Agriculture and
Research Station, Bilaspur, Chhattisgarh,
India

Laxminarayan Sahu.
M.Sc. Final Year, Department of
Agronomy, BTC College of Agriculture and
Research Station, Bilaspur, Chhattisgarh,
India

Corresponding Author:
Ram Sahu
M.Sc. Final Year, Department of
Agronomy, BTC College of Agriculture and
Research Station, Bilaspur, Chhattisgarh,
India

Effect of restricted irrigation on new genotypes of wheat (*Triticum aestivum* L.)

Ram Sahu, Dinesh Pandey, RB Tiwari, Awaneet Kumar, NK Chaure, Pragya Tiwari, Shikha Kumari, Bhimraj Sahu and Laxminarayan Sahu

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Abstract

The present investigation entitled “Effect of restricted irrigation on new genotypes of wheat (*Triticum aestivum* L.)” was conducted during the *rabi* season of 2025-26 at the Instructional Cum Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.). The experiment was laid out in a split-plot design with three replications. Three irrigation regimes were assigned to the main plots, namely I_1 - no irrigation, I_2 - one irrigation at the crown root initiation (CRI) stage (18-20 DAS), and I_3 - two irrigations, one at CRI (18-20 DAS) and another at the boot leaf stage (60-65 DAS). Five wheat genotypes were evaluated in the sub-plots, viz., V_1 - NIAW 4533, V_2 - DBW 110 (C), V_3 - DBW 359 (C), V_4 - CG 1040 (C) and V_5 - HI 1700. The results indicated that irrigation regimes had a significant influence on the growth, yield attributes, yield, phenological development, water utilization and economic returns of wheat. Among the irrigation treatments, I_3 (two irrigations at CRI and boot leaf stages) resulted in superior growth performance, recording the highest plant height, number of tillers, dry matter accumulation and crop growth rate. The maximum ear length (9.06 cm) was also recorded under I_3 . This treatment consequently produced the highest grain yield (36.68 q ha⁻¹) and straw yield (41.43 q ha⁻¹). The maximum number of ears head m⁻² (405.00), grains ear head⁻¹ (23.59) and test weight (40.43 g) were recorded under the irrigation treatments, with the respective highest values occurring under I_3 , while the minimum performance was generally observed under I_1 (no irrigation). Harvest index was not significantly influenced by different irrigation regimes. Irrigation scheduling also affected the phenological development and accumulation of thermal units in wheat. The longest duration of crop stages, including crown root initiation, flag leaf, booting, heading and anthesis, was observed under I_3 . Similarly, the highest accumulation of growing degree days (4964.10 °C) and photo-thermal units (41258.8 °C day hrs) was recorded with two irrigations at the CRI and boot leaf stages. Water use increased with an increase in the number of irrigations, reaching a maximum of 181.80 mm under I_3 . In contrast, water expense efficiency was highest under I_1 (no irrigation), with a value of 39.01 kg ha⁻¹ mm⁻¹. Significant differences among the genotypes were observed with respect to growth characteristics, yield attributes, yield, thermal indices and economic returns. Among the genotypes, V_4 - CG 1040 (C) performed superiorly and recorded the highest plant height, number of tillers, dry matter accumulation and yield attributes. It produced the maximum ear length (9.17 cm), number of ears head m⁻² (418.00), grains ear head⁻¹ (21.29) and test weight (42.47 g). The highest grain yield (33.62 q ha⁻¹) and straw yield (38.35 q ha⁻¹) were also obtained from V_4 , followed by V_1 - NIAW 4533. Considerable genotypic variation was also observed in phenological behaviour and thermal indices. The genotype V_4 recorded the highest accumulation of photo-thermal units (41488.3 °C day hrs) and growing degree days (5000.00 °C), along with the highest water expense efficiency (27.59 kg ha⁻¹ mm⁻¹). Economic evaluation revealed that I_3 , consisting of two irrigations at the CRI and boot leaf stages, resulted in the highest gross return (₹ 92,617.00 ha⁻¹), net return (₹ 61,989.00 ha⁻¹) and benefit-cost ratio (2.02). Among the genotypes, V_4 - CG 1040 (C) proved to be the most economically advantageous, recording the maximum gross return (₹ 84,865.25 ha⁻¹), net return (₹ 55,529.25 ha⁻¹) and benefit: cost ratio (1.89). The interaction between irrigation regimes and genotypes was found to be non-significant for most of the parameters studied.

Keywords: Wheat, booting, growing degree days, photo-thermal units and genotypes

Introduction

Wheat [*Triticum aestivum* L.] is one of the world's important staple cereal crops and has played a crucial role in human civilization for thousands of years. It is believed to have originated in South Western Asia and subsequently spread throughout Asia, Europe, Africa, and the Americas. Wheat quickly spread globally due to its adaptability to diverse climates. It is consumed in various forms such as bread, cakes, biscuits, bakery products and confectionery products. The high nutritive value of wheat flour (65-75% carbohydrates, 8-13% protein, 0.8-1.5% oil, 0.3-0.5% mineral matter and 0.2% cellulose) has made the crop more valuable for human consumption

(Thakur *et al.*, 2000) ^[21]. Wheat is one of the most important cereal crops in the world. It occupies an area of 224.05 M ha in the world with a production of 793.37 Mt. Whereas in India, it is cultivated to an extent of 31.82 M ha with a production of 112.74 Mt and a productivity of 3543 kg ha⁻¹ and it ranks second after rice in terms of area & production among the cereals in our country. Wheat is grown on around 127 thousand ha of land in Chhattisgarh, with a production of 191 thousand tonnes and a productivity of 1501 kg ha⁻¹ during the year 2023-24 (Anonymous, 2023-24) ^[4].

The lack of improved varieties suitable for late-sowing conditions, along with their comparatively shorter growing periods, remains a major constraint on wheat production. Additionally, in late-sown conditions, cultivars differ in yield potential and nutrient uptake (Singh *et al.*, 1998) ^[19]. Wheat varieties with a preference for photoperiod and thermo-insensitive traits are typically more suited to a wider variety of sowing times in an irrigation system because they can still produce satisfactory grain yield even when planted late. In recent years, several wheat varieties have been developed with improved temperature tolerance, increased yield potential even with delayed sowing and resistance to diseases and insect pests. Sowing time significantly influences crop growth, yield attributes, and grain and straw yields. To achieve maximum yield, it is critical to select the right cultivar at the right place. Being a thermo-sensitive crop, the choice of a suitable cultivar for different agro-climatic regions is of prime importance. As a result of concerted and persistent effort, several high-yielding wheat varieties have been developed. Newer high-yielding varieties, being relatively thermotolerant, perform better even under variable climatic conditions.

Water is required throughout the crop growth period, from seed germination to plant maturity. The frequency of irrigation and grain yield has a favourable relationship (Pereira *et al.*, 2002) ^[14]. Moisture stress during a critical growth stage may significantly reduce grain yield by lowering test weight. Efficient water management is an effective agronomic strategy that not only improves crop yield but also reduces susceptibility to disease and insect pests, while providing a favourable environment for these biotic constraints to thrive (Singh *et al.*, 2020) ^[18]. However, water resources are limited; the effects of restricted irrigation on crop yield and WUE depend on growth stage, which is fundamentally dependent on irrigation water, and the most sensitive growth stage differs from region to region. Compared with more irrigation for wheat, restricted irrigation achieves the highest water-use efficiency and saves water (Yusuf *et al.*, 2019) ^[24]. Wheat is sensitive to both excess and deficit water conditions. Restricted irrigation helps in optimising water use by providing the crop with the necessary amount of water at the right time. Over-irrigation can lead to excessive vegetative growth and reduced grain quality, including lower protein content and increased susceptibility to lodging. Restricted irrigation promotes better partitioning of resources towards grain development, resulting in higher grain quality. Chhattisgarh, like many other regions in India, faces water scarcity issues in the Rabi season, particularly during the month of October. The limited availability of water resources requires optimal use of water in agricultural activities. Restricted irrigation helps conserve water and use it more efficiently. Restricted irrigation can also provide economic benefits for farmers by reducing water costs and potentially increasing crop yields through improved water management. Overall, the practice of restricted irrigation in wheat cultivation in Chhattisgarh aims to address water scarcity, promote environmental sustainability, optimise resource use, and ensure the long-term viability of agriculture in the region.

Materials and methods

A field experiment entitled “Effect of restricted irrigation on new

genotypes of wheat (*Triticum aestivum* L.)” was conducted during the *rabi* season 2025-26 at Instructional Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Sarkanda, Bilaspur (C.G.). The treatment consisted of three irrigation levels as main-plot treatments viz., I₁ - no irrigation, I₂ - one irrigation at CRI (18-20 DAS) and I₃ - two irrigations at CRI and boot leaf stage (60-65 DAS), with five wheat genotypes as sub-plot treatments viz., V₁ - NIAW 4533, V₂ - DBW 110 (C), V₃ - DBW 359 (C), V₄ - CG 1040 (C) and V₅ - HI 1700, which were laid out in a split plot design with three replications. The crop was grown using recommended agronomic practices and fertilizer management as per the standard recommendation for wheat under the experimental conditions. Observations regarding the effect of restricted irrigation and genotypes on growth and phenological parameters of wheat were recorded at different stages of crop growth. The observations included plant population, plant height, number of tillers, dry matter accumulation and other growth parameters, along with phenological stages such as days to CRI, flag leaf stage, booting, heading and anthesis. Thermal indices including growing degree days (GDD), photo-thermal units (PTU) and other relevant indices were calculated at different phenological stages. Water-related parameters, including water expense (mm) and water expense efficiency (kg ha⁻¹ mm⁻¹), were also determined to assess the efficiency of water utilization under different irrigation regimes. Yield and yield-attributing characteristics were recorded, including ear length, number of grains ear head⁻¹, test weight (g), grain yield, straw yield and harvest index. Economic parameters, namely cost of cultivation (₹ ha⁻¹), gross return (₹ ha⁻¹), net return (₹ ha⁻¹) and B:C ratio, were also worked out to determine the profitability of wheat cultivation under different irrigation regimes and genotypes.

Results and discussions

Effect of irrigation levels

- In comparison with I₁ (no irrigation) and I₂ (one irrigation at CRI, 18-20 DAS), I₃ (two irrigations at CRI, 18-20 DAS and boot leaf stage, 60-65 DAS) resulted in the highest values of growth parameters, including plant height (cm), number of tillers (m⁻²), plant dry matter accumulation (g plant⁻¹) and crop growth rate (g day⁻¹ plant⁻¹). However, the relative growth rate (g g⁻¹ day⁻¹) showed variation among irrigation treatments across different growth intervals.
- The yield-attributing traits were considerably influenced by irrigation scheduling. I₃ (two irrigations at CRI and boot leaf stages) recorded the maximum ear length (9.06 cm) and number of grains ear head⁻¹ (23.59). In contrast, the highest number of ears (405 m⁻²) and test weight (40.43 g) were observed under I₂ (one irrigation at CRI, 18-20 DAS). The lowest values of these yield attributes were generally recorded under I₁ (no irrigation).
- I₃ (two irrigations at CRI, 18-20 DAS and boot leaf stage, 60-65 DAS) produced the highest grain yield (36.68 q ha⁻¹) and straw yield (41.43 q ha⁻¹), which were significantly superior to those obtained under I₁ (no irrigation) and I₂ (one irrigation at CRI, 18-20 DAS). The lowest grain yield (24.11 q ha⁻¹) and straw yield (30.11 q ha⁻¹) were recorded under I₁. Harvest index remained statistically non-significant among irrigation treatments, although the highest numerical value (48.00%) was observed under I₃ and the lowest (46.93%) under I₁.
- Irrigation regimes significantly influenced the phenological development of wheat. The maximum duration to crown root initiation (21.00 days), flag leaf stage (61.07 days), booting (64.73 days), heading (81.04 days) and anthesis (87.10 days) was recorded under I₃, while the corresponding minimum values were generally observed under I₁. The highest accumulation of growing degree days (4964.10 °C) and photo-thermal units (41258.8 °C day hrs) was also recorded

under I₃. In comparison, the lowest GDD (4559.15 °C) and PTU (38275.1 °C day hrs) were observed under I₁.

- Water consumption increased progressively with an increase in the number of irrigations. The maximum water expense (181.80 mm) was recorded under I₃ (two irrigations at CRI, 18-20 DAS and boot leaf stage, 60-65 DAS), whereas the minimum (61.80 mm) was observed under I₁ (no irrigation). Conversely, water expense efficiency was highest under I₁ (39.01 kg ha⁻¹ mm⁻¹) and lowest under I₃ (20.17 kg ha⁻¹ mm⁻¹).
- Economic analysis indicated that I₃ (two irrigations at CRI, 18-20 DAS and boot leaf stage, 60-65 DAS) was the most profitable irrigation regime, recording the highest gross return (₹ 92,617.00 ha⁻¹), net return (₹ 61,989.00 ha⁻¹) and benefit-cost ratio (2.02). In contrast, I₁ (no irrigation) recorded the lowest gross return (₹ 60,877.75 ha⁻¹), net return (₹ 32,833.75 ha⁻¹) and B:C ratio (1.17).

Effect of genotypes

- Among the evaluated genotypes, V₄ (CG 1040 (C)) exhibited superior growth performance, recording the highest plant height, number of tillers and plant dry matter accumulation at different growth stages, followed by V₁ (NIAW 4533). In contrast, V₃ (DBW 359 (C)) recorded the lowest values for these growth parameters. Significant differences among genotypes were also observed in crop growth rate and relative

growth rate.

- Significant genotypic differences were observed for yield-attributing characters. V₄ (CG 1040 (C)) recorded the maximum ear length (9.17 cm), number of ears (418.00 m⁻²), number of grains ear head⁻¹ (21.29) and test weight (42.47 g). The lowest values of these yield attributes were recorded under V₃ (DBW 359 (C)).
- Grain and straw yields differed significantly among the genotypes. V₄ (CG 1040 (C)) produced the highest grain yield (33.62 q ha⁻¹) and straw yield (38.35 q ha⁻¹), followed by V₁ (NIAW 4533). The lowest grain yield (28.20 q ha⁻¹) and straw yield (34.44 q ha⁻¹) were obtained from V₃ (DBW 359 (C)). However, harvest index remained statistically non-significant among the genotypes.

Considerable genotypic variation was observed in phenological development and thermal indices. V₄ (CG 1040 (C)) exhibited the longest duration of different phenological stages and accumulated the highest growing degree days (5000.00 °C) and photo-thermal units (41488.3 °C day hrs), indicating its comparatively better adaptation and utilization of available environmental resources. The genotype V₄ also recorded the highest water expense efficiency (27.59 kg ha⁻¹ mm⁻¹) and superior economic performance, with maximum gross return (₹ 84,865.25 ha⁻¹), net return (₹ 55,529.25 ha⁻¹) and benefit-cost ratio (1.89).

Table 1: Effect of restricted irrigation and genotypes on plant height of wheat

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
A. Irrigation levels (Main-plot): 03				
I ₁ - No irrigation	27.57	71.02	81.09	79.04
I ₂ - One irrigation at CRI (18-20 DAS)	29.04	73.19	83.03	81.01
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	30.72	75.98	84.91	82.95
SEm (±)	0.54	0.75	0.49	0.51
CD (5%)	2.12	2.97	1.93	2.01
B. Genotypes (Sub-plot): 05				
V ₁ - NIAW 4533	29.64	75.46	85.77	84.04
V ₂ - DBW 110 (C)	29.07	73.88	83.71	81.56
V ₃ - DBW 359 (C)	26.97	68.99	77.62	75.28
V ₄ - CG 1040 (C)	31.89	78.28	88.72	86.49
V ₅ - HI 1700	27.97	70.39	79.22	77.64
SEm (±)	0.69	1.47	0.93	0.91
CD (5%)	2.03	4.29	2.72	2.66
Interaction				
SEm (±)	1.21	2.55	1.61	1.58
CD (5%)	NS	NS	NS	NS

Table 2: Effect of restricted irrigation and genotypes on number of tillers of wheat.

Treatments	Number of tillers (m ⁻²)			
	30 DAS	60 DAS	90 DAS	At harvest
A. Irrigation levels (Main-plot): 03				
I ₁ - No irrigation	233.82	342.12	387.33	384.13
I ₂ - One irrigation at CRI (18-20 DAS)	250.69	359.13	408.06	406.40
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	256.39	365.48	410.80	407.60
SEm (±)	2.55	4.24	2.88	3.18
CD (5%)	10.03	16.68	11.33	12.51
B. Genotypes (Sub-plot): 05				
V ₁ - NIAW 4533	252.55	366.53	410.77	408.55
V ₂ - DBW 110 (C)	246.81	358.08	400.11	396.88
V ₃ - DBW 359 (C)	237.36	337.49	388.33	384.88
V ₄ - CG 1040 (C)	256.99	375.44	420.66	418.22
V ₅ - HI 1700	241.12	340.34	390.44	388.33
SEm (±)	2.89	4.17	4.57	3.88
CD (5%)	8.44	12.19	13.34	11.35
Interaction				
SEm (±)	5.01	7.23	7.91	6.73
CD (5%)	NS	NS	NS	NS

Table 3: Effect of restricted irrigation and genotypes on plant dry matter accumulation of wheat

Treatments	Plant dry matter accumulation (g plant ⁻¹)			
	30 DAS	60 DAS	90 DAS	At harvest
A. Irrigation levels (Main-plot): 03				
I ₁ - No irrigation	0.62	7.07	17.20	21.86
I ₂ - One irrigation at CRI (18-20 DAS)	0.65	8.02	19.48	23.93
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	0.68	8.41	21.21	25.98
SEm (±)	0.01	0.17	0.42	0.61
CD (5%)	0.02	0.69	1.67	2.39
B. Genotypes (Sub-plot): 05				
V ₁ - NIAW 4533	0.68	8.27	20.44	25.92
V ₂ - DBW 110 (C)	0.67	8.10	20.12	24.88
V ₃ - DBW 359 (C)	0.62	7.37	18.01	22.01
V ₄ - CG 1040 (C)	0.72	8.58	21.35	27.63
V ₅ - HI 1700	0.63	7.60	18.61	22.88
SEm (±)	0.02	0.30	0.82	1.05
CD (5%)	0.06	0.86	2.38	3.07
Interaction				
SEm (±)	0.04	0.51	1.42	1.82
CD (5%)	NS	NS	NS	NS

Table 4: Effect of restricted irrigation and genotypes on length of ear, number of ear head (m⁻²), number of grains ear head⁻¹ and test weight (g) of wheat

Treatments	Ear length (cm)	Number of ear head (m ⁻²)	Number of grains ear head ⁻¹	Test weight (g)
A. Irrigation levels (Main-plot): 03				
I ₁ - No irrigation	7.70	381.00	16.73	38.02
I ₂ - One irrigation at CRI (18-20 DAS)	8.34	405.00	20.26	40.43
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	9.06	404.00	23.59	38.87
SEm (±)	0.25	3.04	0.84	0.79
CD (5%)	1.00	9.17	2.53	NS
B. Genotypes (Sub-plot): 05				
V ₁ - NIAW 4533	8.78	407.00	19.77	41.05
V ₂ - DBW 110 (C)	8.57	395.00	20.33	38.85
V ₃ - DBW 359 (C)	7.34	379.00	20.77	35.77
V ₄ - CG 1040 (C)	9.17	418.00	18.81	42.47
V ₅ - HI 1700	7.98	384.00	21.29	37.41
SEm (±)	0.28	3.69	0.88	0.95
CD (5%)	0.82	8.93	2.12	2.31
Interaction				
SEm (±)	0.48	6.40	1.52	1.65
CD (5%)	NS	NS	NS	NS

Table 5: Effect of restricted irrigation and genotypes on grain yield, straw yield and harvest index of wheat

Treatments	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)	Harvest index (%)
A. Irrigation levels (Main-plot): 03			
I ₁ - No irrigation	24.11	30.11	46.93
I ₂ - One irrigation at CRI (18-20 DAS)	32.96	37.18	47.18
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	36.68	41.43	48.00
SEm (±)	0.83	0.48	0.59
CD (5%)	2.50	1.89	NS
B. Genotypes (Sub-plot): 05			
V ₁ - NIAW 4533	33.08	37.19	47.60
V ₂ - DBW 110 (C)	30.99	36.19	47.46
V ₃ - DBW 359 (C)	28.20	34.44	46.81
V ₄ - CG 1040 (C)	33.62	38.35	48.31
V ₅ - HI 1700	30.38	35.03	47.00
SEm (±)	0.91	0.74	0.36
CD (5%)	2.20	2.17	NS
Interaction			
SEm (±)	1.57	1.29	0.63
CD (5%)	NS	NS	NS

Table 6: Effect of restricted irrigation and genotypes on crown root initiation, Flag leaf stage and days to booting of wheat

Treatments	Crown root initiation	Flag leaf stage	Days to booting
A. Irrigation levels (Main-plot): 03			
I ₁ - No irrigation	19.00	56.24	61.40
I ₂ - One irrigation at CRI (18-20 DAS)	20.06	57.02	62.18
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	21.00	61.07	64.73
B. Genotypes (Sub-plot): 05			
V ₁ - NIAW 4533	20.66	59.27	65.08
V ₂ - DBW 110 (C)	19.88	57.57	62.84
V ₃ - DBW 359 (C)	18.88	55.34	58.66
V ₄ - CG 1040 (C)	21.33	61.83	66.74
V ₅ - HI 1700	19.33	56.55	60.52

Table 7: Effect of restricted irrigation and genotypes on days to heading and days to anthesis of wheat

Treatments	Days to heading	Days to anthesis
A. Irrigation levels (Main-plot): 03		
I ₁ - No irrigation	74.06	79.10
I ₂ - One irrigation at CRI (18-20 DAS)	75.05	81.19
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	81.04	87.10
B. Genotypes (Sub-plot): 05		
V ₁ - NIAW 4533	78.20	84.16
V ₂ - DBW 110 (C)	75.96	81.74
V ₃ - DBW 359 (C)	73.02	78.58
V ₄ - CG 1040 (C)	81.78	87.54
V ₅ - HI 1700	74.62	80.30

Table 8: Effect of restricted irrigation on growing degree days of wheat

Treatments	Growing degree days (°C)					
	Crown root initiation	Flag leaf stage	Booting stage	Heading stage	Anthesis stage	Total
A. Irrigation levels (Main-plot): 03						
I ₁ - No irrigation	325.50	890.90	967.80	1148.30	1226.65	4559.15
I ₂ - One irrigation at CRI (18-20 DAS)	344.30	905.09	984.20	1161.60	1260.45	4655.64
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	363.10	967.80	1011.00	1260.45	1361.75	4964.10
B. Genotypes (Sub-plot): 05						
V ₁ - NIAW 4533	344.30	935.30	1023.30	1208.35	1309.05	4820.30
V ₂ - DBW 110 (C)	325.50	905.09	984.20	1161.60	1260.45	4636.84
V ₃ - DBW 359 (C)	307.90	876.40	920.40	1135.70	1208.35	4448.75
V ₄ - CG 1040 (C)	363.10	976.90	1037.80	1260.45	1361.75	5000.00
V ₅ - HI 1700	325.50	890.90	951.10	1148.30	1244.95	4560.75

Table 9: Effect of restricted irrigation on Photo thermal units of wheat

Treatments	Photo thermal units (°C day hrs)					
	CRI	Flag leaf stage	Booting stage	Heading stage	Anthesis stage	Total
A. Irrigation levels (Main-plot): 03						
I ₁ - No irrigation	2671.38	7414.95	7995.35	9619.07	10274.36	38275.11
I ₂ - One irrigation at CRI (18-20 DAS)	3114.26	7557.45	8077.35	9749.41	10573.91	39072.38
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	3227.06	7995.35	8325.70	10573.91	11136.82	41258.84
B. Genotypes (Sub-plot): 05						
V ₁ - NIAW 4533	3114.26	7824.95	8429.02	10159.07	10904.17	40431.47
V ₂ - DBW 110 (C)	2971.38	7557.45	8077.35	9749.41	10573.91	38929.50
V ₃ - DBW 359 (C)	2828.82	7269.95	7690.85	9495.59	10159.07	37444.28
V ₄ - CG 1040 (C)	3227.06	7995.35	8555.17	10573.91	11136.82	41488.31
V ₅ - HI 1700	2971.38	7414.95	7911.85	9619.07	10439.06	38356.31

Table 10: Effect of restricted irrigation on water expense and water expense efficiency of wheat

Treatments	Water expense (mm)	Water expense efficiency (kg ha ⁻¹ mm ⁻¹)
A. Irrigation levels (Main-plot): 03		
I ₁ - No irrigation	61.80	39.01
I ₂ - One irrigation at CRI (18-20 DAS)	121.80	27.06
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	181.80	20.17
B. Genotypes (Sub-plot): 05		
V ₁ - NIAW 4533	121.80	27.15
V ₂ - DBW 110 (C)	121.80	25.44
V ₃ - DBW 359 (C)	121.80	23.15
V ₄ - CG 1040 (C)	121.80	27.59
V ₅ - HI 1700	121.80	24.94

Table 11: Effect of restricted irrigation on economics of wheat cultivation

Treatments	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B:C ratio
A. Irrigation levels (Main-plot): 03				
I ₁ - No irrigation	28044.00	60877.75	32833.75	1.17
I ₂ - One irrigation at CRI (18-20 DAS)	29336.00	83224.00	53888.00	1.84
I ₃ - Two irrigations at CRI and Boot leaf stage (60-65 DAS)	30628.00	92617.00	61989.00	2.02
B. Genotypes (Sub-plot): 05				
V ₁ - NIAW 4533	29336.00	83501.75	54165.75	1.85
V ₂ - DBW 110 (C)	29336.00	78249.75	48913.75	1.67
V ₃ - DBW 359 (C)	29336.00	71205.00	41869.00	1.43
V ₄ - CG 1040 (C)	29336.00	84865.25	55529.25	1.89
V ₅ - HI 1700	29336.00	76709.50	47373.50	1.61

Conclusion

The study concluded that I₃ (two irrigations, one at CRI stage (18-20 DAS) and another at boot leaf stage (60-65 DAS)) was the most effective irrigation regime for wheat, resulting in superior growth, yield-attributing characters, grain yield (36.68 q ha⁻¹) and overall economic performance. Among the tested genotypes, V₄ - CG 1040 (C) exhibited the best performance with respect to growth characteristics, dry matter accumulation, yield attributes, grain yield and straw yield, and remained statistically superior to the other evaluated genotypes. From an economic perspective, I₃ recorded the highest gross return (₹ 92,617.00 ha⁻¹), net return (₹ 61,989.00 ha⁻¹) and benefit-cost ratio (2.02). Among the genotypes, V₄ - CG 1040 (C) proved to be the most economically promising, registering the maximum gross return (₹ 84,865.25 ha⁻¹), net return (₹ 55,529.25 ha⁻¹) and benefit-cost ratio (1.89), followed by V₁ - NIAW 4533. Thus, under the conditions of the present investigation, irrigation at the CRI and boot leaf stages along with genotype V₄ - CG 1040 (C) may be considered a promising combination for achieving higher productivity and profitability in wheat.

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