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Yield Attributes and Yield of Wheat Affected by Irrigation Schedules and Varieties under HAT Zone Conditions of Andhra Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: A field experiment was conducted to assess the impact of various irrigation schedules and wheat varieties on yield characteristics and yield of wheat in Andhra Pradesh's high altitude and tribal area (HAT) zone.
Study Design: Split-plot design was used to conduct the research experiment.

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Place and Duration of Study: Regional Agricultural Research Station, Chintapalle, Visakhapatnam, ANGRAU, Andhra Pradesh. The study was conducted during *Rabi* season 2021-22.
Methodology: Split-plot design was used to conduct the experiment in which as main plots, there were three irrigation schedules—irrigation at CRI, maximum tillering, jointing, flowering, and milking stages (M1); irrigation at CRI, flowering, and milking stages (M2); and irrigation at CRI and milking stages (M3)—and four varieties—DBW-252(V1), HI-1544(V2), HI-8759(V3), and HI-8713(V4)—as subplots. The parameters of Spike length, Spike weight, number of productive tillers m^{-2}, number of grains $spike^{-1}$, number of filled grains $spike^{-1}$, 1000 grain weight, grain yield, straw yield, biological yield, and harvest index were found to be superior with five irrigations scheduled at CRI, maximum tillering, jointing, flowering, and milking stages. Among the varieties, HI-8759 recorded the highest values, which were comparable to HI-8713.
Results: Spike length, spike weight, no. of productive tillers m^{-2}, no. of grains $spike^{-1}$, no. of filled grains $spike^{-1}$, 1000 grain weight found superior with five irrigations schedules. The highest values among the variations were achieved by HI-8759 and were comparable to HI-8713.The five irrigation schedule resulted in higher grain and straw yields. Despite the fact that there was a reduced grain yield with two irrigations, the straw yield was statistically equal with three irrigations. With five irrigations, the harvest index (%) was much higher, while with two irrigations, it was significantly lower. However, HI-8759 had a much greater grain and straw production than the other cultivars. The straw yield remained at HI-8713 levels. The HI-8759's harvest index outperformed all other kinds by a wide margin. With HI-1544, the lowest grain and straw yields were noted.
Conclusion: Wheat yield was dramatically increased by five different irrigation regimens applied at various phenological phases. The maximum yield was recorded by variety HI-8759, which was comparable to variety HI-8713 in terms of biological and straw yields.

Keywords: Irrigation schedules; wheat; varieties; grain yield and straw yield.

1. INTRODUCTION

The most common food crop worldwide is wheat. It covers 220.4 million hectares worldwide and produces 765.77 MT [1]. Whereas in India, it is grown to a size of 31.35 M ha, producing 107.86 MT and having a productivity of 3.42 t ha^{-1} [2] and ranking second in terms of area & output among cereals in our nation after rice.

Uttar Pradesh is the most productive state in India in terms of size (9.5 M ha) and output (32.59 MT), although its productivity is substantially lower (3432 kg ha^{-1}) than that of Haryana (4687 kg ha^{-1}) and Punjab (5008 kg ha^{-1}). There are no notable areas in Andhra Pradesh that are planted with wheat [3]. Being the "King of Cereals", it includes 70% carbs and adds an average of 12.2% protein, 1.7% fat, 2.7% minerals, 1.8% lipids, 1.8% ash, 2.0% fiber, and 314 Kcal per 100g of food to a balanced nutritional profile [4].

To attain optimal yields, quality and grain-protein content, wheat crop needs enough available water. Wheat is extremely sensitive to water stress during crown root initiation (CRI) and flowering, but excessive watering can result in excessive vegetative growth, a shorter reproductive time, and a poorer final yield. As a result, aligning the duration of irrigation intervals with the stages of crop growth may result in fewer irrigations and a more profitable crop yield. Selection of right cultivar at the right place is having prime importance for different agro-climatic regions to attain maximum yields.

Due to their relative thermosensitivity, newer high-yielding cultivars thrive in a variety of climatic settings. Warm temperature is needed for the reproductive phase of the wheat crop and cool weather for the vegetative phase. Although the climatic conditions of the high altitude and tribal (HAT) area zone of Andhra Pradesh are favorable for wheat growth, farmers in this region typically produce rice as a main cereal crop during *kharif* and leave the bulk of land fallow during *rabi*. The primary goal of the study was to carry out research on wheat growing at the Regional Agricultural Research Station in Chintapalle using various irrigation schedules and types in order to introduce wheat as an unconventional crop.

2. MATERIALS AND METHODS

2.1 Study Site

At the Regional Agricultural Research Station in Chintapalle, the research project was carried out during the *rabi* season of 2021–2022. It is located in the high altitude and tribal region zone of Andhra Pradesh, India, at an altitude of 839.0 meters above mean sea level, between 17° 52' N latitude and 82° 20' E longitude.

2.2 Weather Parameters

During the experiment, the weekly maximum temperature varied from 25.0°C to 33.9°C, while the lowest temperature varied from 7.8°C to 19.1°C. The 11th standard week in the month of March 2022 saw a maximum temperature of 33.9 °C, while the 51st standard week in the month of December 2021 saw a minimum temperature of 7.8 °C. During the crop growing season, a total of 90.0 mm of rain fell during 7 wet days. The 47th standard week had the greatest amount of rain (70.0 mm). During the trial, the weekly mean relative humidity varied from 75.6% to 91.3%. The 46th standard week of November 2022 saw the highest relative humidity reading.

2.3 Experimental Setup

The experiment was set up using a split-plot design, with four different varieties—DBW-252(V1), HI-1544(V2), HI-8759(V3), and HI-8713(V4)—serving as subplots for each of the main irrigation schedules irrigation at CRI, maximum tillering, jointing, flowering, and milking stages (M1); irrigation at CRI, flowering, and milking stages (M2); and irrigation at CRI, and milking stages (M3) ; On a well constructed experimental plot, wheat was sowed. The crop received the required fertilizer dose of 120 kg N, 60 kg P_2O_5, and 40 kg K_2O ha^{-1}, of which 60 kg of N, the full dose of P_2O_5, and the entire dose of K_2O, were administered as a basal application, and the remaining 60 kg of N, which was divided equally between the two applications at 25 DAS and 45 DAS. Irrigation was applied to the corresponding treatments in the manner prescribed. According to ANGRAU's suggestions, field activities including weeding and plant protection measures were carried out. Data were gathered on the number of productive tillers m^{-2}, the number of grains $spike^{-1}$, the number of filled grains $spike^{-1}$, the weight in grams per 1000 grains, the yield in kilograms per hectare of grain and straw, and the harvest index (%). At the harvest stage, the length and weight of the spike were determined from randomly selected spikes in each plot using meter scales and weighing balances, respectively. Statistical analysis was used to extrapolate from the measured data the average spike length and weight for each plot. With the help of a quadrate of 1.0 square meter, the sampling area was randomly selected and the number of productive tillers at harvest were counted and mean values were recorded. Five randomly chosen spikes were removed from labeled plants, threshed, and their grains tallied. To determine the number of grains spike-1 and the number of filled grains spike-1, the average number of grains and filled grains from all spikes were computed. From the representative sample of each treatment taken from winnowed and clean grain, one thousand grains were counted, and their weight in grams was recorded by an electronic balance.

After threshing, washing, and drying to the ideal moisture content, the grain yield received from each individual net plot was recorded in kilograms. The yield was then translated into kg ha^{-1}. After threshing, the net plot grain yield was subtracted from the net plot bundle weight to get each plot's straw yield, which was then stated in kg ha^{-1}. The net plot's yields of grain and straw were combined to produce the biological yield, which was then stated in terms of kg ha^{-1}. By dividing the economic yield (grain yield) by the biological yield (grain and straw yield), the harvest index of the crop was calculated and shown as a percentage.

$$Harvest\ index(\%) = \frac{Economic\ Yield}{Bilological\ yield(grain+Straw)} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

3.1.1 Spike length (cm)

According to data in Table 1, wheat spike length rose gradually with increasing irrigations from two (M3) to five (M1). Under five watering regimens, the longest spike (8.9 cm) was measured. When five irrigations were planned at the CRI, maximum tillering, jointing, flowering, and milking phases, there may have been enough moisture available for nutrient absorption and the transfer of photosynthates. Such explanations were also stated by Kumar et al*.* [5] and Islam et al*.* [6]. The shortest spike (7.9 cm) was observed with two irrigations schedules and remained at par with three irrigations schedules. When it comes to varieties, DBW-252 recorded the longest spikes (10.6 cm), placing it far ahead of the other types. Its superior ability to other types may be the cause of this. Tyagi et al*.* [7] and Ali et al. [8] also discovered comparable outcomes. Spike length was shown to be unaffected by the interaction effect (M x V) between watering schedules and varieties.

Table 1. Wheat spike length (cm) and weight (g) in relation to various watering regimens and variety

Treatments	Spike length (cm)	Spike weight (g)
Irrigation schedules (M)		
M_1: CRI, Maximum tillering, Jointing, Flowering, and Milking	8.9	3.3
M_2: CRI, Flowering and Milking	8.1	2.8
M_3: CRI and Milking	7.9	2.4
SEm $\pm$	0.16	0.10
CD (P=0.05)	0.6	0.4
CV (%)	6.5	12.1
Varieties (V)		
V_1: DBW - 252	10.6	3.0
V_2: HI - 1544	7.3	2.5
V_3: HI - 8759	7.8	3.0
V_4: HI - 8713	7.5	2.9
SEm $\pm$	0.15	0.11
CD (P=0.05)	0.4	0.3
CV (%)	5.4	11.6
Interaction		
(M×V)	NS	NS
(V×M)	NS	NS

3.1.2 Spike weight (g)

Data pertaining to spike weight (Table 1) revealed that irrigation schedules and varieties significantly influenced the weight of spike but not their interaction. The highest spike weight (3.3 g) was recorded with five irrigations schedules. This was due to availability of water at critical stages of crop growth. The lowest spike weight (2.4 g) was noted with two irrigation schedules and stayed in line with three irrigation regimens (2.8 g). This explanation was in accordance with Abhineet et al. [9]. Maximum spike weight was observed with the variety DBW-252 (3.0 g) and similar weight was observed with HI-8759 (3.0 g). This might be due to the inherent capacity of the variety DBW-252 with longest spike and the variety HI-8759 genetically having bold seeds, individual grains contributed to increase the spike weight. The variety HI-1544 recorded significantly lowest spike weight (2.5 g) between all the different varieties. Ali et al. [8] observed similar outcomes.

3.1.3 Number of productive tillers m^{-2}

The highest number of productive tillers (219.8 m^{-2}) were recorded with five irrigations schedules and found significantly superior over three and two irrigations at different phenological stages. This might be explained by improved nitrogen absorption, which led to reduced or no tiller mortality and optimal moisture delivery when five irrigations were used. The two irrigation regimens produced the fewest productive tillers (192.1 m^{-2}) ever. Similar results were also reported by Ali and Amin [10], Kabir et al. [11], Yadav et al. [12] and Moghaddam et al. [13]. Among the varieties Significantly maximum number of productive tillers (223.6 m^{-2}) were recorded with the variety HI-8759 and followed by the varieties HI-8713 (210.9 m^{-2}) and HI-1544 (202.6 m^{-2}). The variety DBW-252 produced the fewest productive tillers (186.3 m^{-2}). The genetic potential and the environment had a big impact on the productive tillers m^{-2}.Such annotations were also stated by Tomar et al. [14], Sapkota et al. [15], Mubeen et al. [16] and Moghaddam et al. [13]. A non-significant interaction impact (M x V) between irrigation schedules and varieties on the number of productive tillers per square meter was discovered.

3.1.4 Number of grains spike^{-1}

The data analysis (Table 2) clearly showed that the highest number of grains spike^{-1} (52.7) were observed with five irrigation schedules, which was significantly better than three irrigations (48.1) scheduled at CRI, flowering, and milking stages and two irrigations (46.9) scheduled at CRI and milking stages. It was also clear that there was no significant impact on the number of grains spike^{-1} when irrigation was skipped at flowering stage. It might be due to inadequate irrigation supply at the time of jointing and maximum tillering stages and also due to high temperature at grain filling stage, caused forced maturity of the crop and led to less number of grains spike^{-1} which were shrivelled, small and light weighted as apparent from its low test weight. Such explanations were also reported by Ali and Amin [10], Kabir et al. [11], Yadav et al. [12], Ali et al. [17] and Kumar et al. [18]. Among the varieties DBW-252 attained the highest number of grains spike^{-1} (52.3) and was at par with HI-8759 (50.8) and significantly superior over remaining varieties, HI-8713 (47.1) and HI-1544 (46.7). This might be due to highest spike length of the variety DBW-252 and the variety HI-8759 having good genetic potential like more productive tillers and test weight in comparison to other varieties. Mishra et al. [19] and Singh and Singh [20] reported similar results. A non-significant interaction impact (M x V) between irrigation schedules and varieties on the number of grains per spike was discovered.

3.1.5 Number of filled grains spike^{-1}

The number of filled grains spike^{-1} as affected significantly due to different irrigation schedules were presented in Table 2 The most filled grains (48.9 spike^{-1}) were recorded with five irrigations planned at CRI, maximum tillering, jointing, flowering, and milking stages. These were found to be significantly superior to three irrigations planned at CRI, flowering and milking stages (44.9 spike^{-1}) and two irrigations planned at CRI and milking stages (42.3 spike^{-1}) and the data further revealed that number of filled grains spike^{-1} at three and two irrigations were on par to each other. This might be as a result of adequate moisture in the root zone throughout the crop growth period that maintained the chlorophyll content in leaves of plant and crop remained green for longer period of time. This helped in increasing the photosynthetic activity and contributed to higher number of filled grains due to increase in translocation of photosynthates from source to sink. Similar results were observed by Kabir et al. [11] and Maqsood et al. [21]. Perusal of data presented in Table 2 clearly reveals that the various varieties significantly affected the number of filled grains spike^{-1}. The maximum number of filled grains (48.5 spike^{-1}) were recorded with the variety DBW-252 and was significantly superior over rest of the varieties. Lowest number of filled grains (43.0 spike^{-1}) were produced by the variety HI-1544. These results are in accordance with Abhineet et al. [9]. The interaction impact of irrigation schedules and cultivars on the quantity of filled grains spike^{-1} was determined to be insignificant.

3.1.6 1000 grain weight (g)

Examining the data in Table 2 revealed that the test weight was significantly impacted by the various watering regimes. However, the highest test weight (41.4 g) was observed under five irrigations scheduled at the CRI, maximum tillering, jointing, flowering, and milking stages and was found to be significantly better than three irrigations scheduled at the CRI, flowering and milking stages (39.0 g), and two irrigations scheduled at the CRI and milking stages (36.6 g) and the data further revealed that 1000 grain weight at three and two irrigations were on par to each other. This may be because there was enough water available to move photosynthates to the grain during the five irrigations planned at CRI, the peak of tillering, flowering, jointing, and milking periods. These findings were similar to those of Kumar et al. [5], Wang et al. [22] and Ali et al. [17]. 1000 grain weight is also an important yield contributing attribute of wheat crop which was significantly influenced by the prevailing growing condition and genetic potential of a variety. It is clear from data (Table 2) that test weight was significantly affected by various wheat varieties. The highest test weight (41.3 g) was recorded under HI-8759 which was superior over the remaining varieties *i.e.,* HI-8713 (39.1 g), HI-1544 (37.9 g) and DBW-252 (37.6 g). The superiority of HI-8759 seems to be on account of proper grain formation due to translocation of metabolites towards grain development under optimum environmental condition. These findings were in close line to that of Dhiman [23] who also reported significant variations in test weight of varieties. The 1000 grain weight interaction impact between irrigation schedules and cultivars was determined to be insignificant.

3.2 Yield

3.2.1 Grain yield (kg ha^{-1})

In comparison to three irrigation schedules at CRI, flowering and milking stages (3361.3 kg ha^{-1}) and two irrigation schedules at CRI and milking stages (2826.9 kg ha^{-1}) at the maximum tillering, jointing, flowering, and milking stages, five irrigation schedules recorded the maximum grain yield of (4255.9 kg ha^{-1}). Three and two irrigation schedules saw output reductions of 21.02 and 33.57 percent, respectively, as compared to the five irrigations. This might be attributable to the additive effects of the yield parameters of test weight, number of full grains spike^{-1}, and productive tillers m^{-2}. The findings concur with those of Kabir et al. [11], Sarwar et al. [24], and Mubeen et al. [16]. Since wheat yield production is a complex process and is governed by complementary interaction between source (photosynthesis and availability of assimilates) and sink component (storage organs), the grain yield is the total of all different yield contributing factors, which are controlled by genetics and the environment. In this investigation, it was discovered that differing cultivars had a considerable impact on the yield. When compared to the other varieties, HI-8759 produced the highest grain yield (4050 kg ha^{-1}) thanks to its higher biomass accumulation from more tillers and proper partitioning, which was demonstrated by a correspondingly higher harvest index and better yield attributes, including effective tillers m^{-2}, grains spike^{-1}, spike length, and 1000 grain weight. It also outperformed the other varieties by 7.82%, 24.06%, and 24.26% in terms of grain yield over other varieties HI-8713 (3733.1 kg ha^{-1}), DBW-252 (3075.2 kg ha^{-1}) and HI- 1544 (3067.2 kg ha^{-1}) respectively. The findings of Moghaddam et al. [13], Tomar et al. [14], Ram and Gupta [25], Haq et al. [26], and Alam et al. [27] were similar to these findings. The effects of wheat variety and irrigation schedule on grain yield were not determined to be significant.

3.2.2 Straw yield (kg ha^{-1})

In Table 3, information on straw yield is provided. The findings showed that different watering schedules had a considerable impact on wheat straw output. In comparison to three irrigations scheduled at CRI, flowering and milking stages (4526.7 kg ha^{-1}) and two irrigations scheduled at CRI and milking stages (4036.8 kg ha^{-1}) maximum straw yield (5315.9 kg ha^{-1}) was recorded under five irrigations scheduled at CRI, maximum tillering, jointing, flowering, and milking stages. The straw yield was found on par for two and three irrigation schedules. The production of straw reduced as the number of irrigations decreased; this could be because there wasn't enough moisture to support the plant's maximal vegetative development. These findings closely mirrored those of Moghaddam et al. [13] and Islam et al. [6]. However, among the variations, HI-8759 produced the highest amount of straw (4886.9 kg ha^{-1}), outperforming cultivars HI-8713 (4839.1 kg ha^{-1}), DBW-252 (4430.3 kg ha^{-1}), and HI-1544 (4349.1 kg ha^{-1}). This may be because, as shown by its greatest harvest index, biomass is effectively used for both straw and grain formation. These results are consistent with those of Verma et al. [28] and Nagarjuna et al. [29]. Wheat variety and irrigation schedule interactions on straw production were not determined to be statistically significant.

3.2.3 Harvest index (%)

Table 3 provides a summary of the data on harvest index (%) as impacted by irrigation schedules and variety. The analysis of the data made it abundantly evident that the irrigation schedules had a big impact on the harvest index. The highest harvest index (%) was discovered with five irrigations planned at CRI, maximum tillering, jointing, flowering, and milking stages (44.4%), which was comparable to three irrigations planned at CRI, flowering, and milking stages (42.6%). The lowest harvest index was discovered with two irrigations planned at CRI and milking stages (40.9%). This could be the result of the notable variations in grain and straw yields that Ahmad and Kumar [30] and Atikullah et al. [31] also noted as a result of changes in irrigation schedules. In terms of varieties, variation HI-8759 (45.2%) had the greatest harvest index; it was comparable to variety HI-8713 (43.4%) and much better than varieties HI-1544 (41.1%) and DBW-252 (40.7%). Similar findings were also obtained by Sapkota et al. [15]. It was shown that there was no statistically significant interaction between irrigation schedules and variety on harvest index.

3.2.4 Biological yield (kg ha^{-1})

Five irrigations planned at CRI, maximumtillering, jointing, flowering, and milking stages resulted in the highest biological yield (9571 kg ha^{-1}),which was significantly higher than three irrigations planned at CRI, flowering and milking stages (7888 kg ha^{-1}) and two irrigations planned at CRI and milking stages (6863 kg ha^{-1}). This might be due to cumulative effect of vegetative growth attributes, yield attributes, grain yield and straw yield. The magnitude of increase in biological yield over three and two irrigations were 17.59 % and 28.29 %, respectively. Alam et al. [32], Nagarjuna et al. [28] and Ramunaidu et al. [33] have recorded similar findings. Among the varieties HI-8759 produced the highest biological yield (8936 kg ha^{-1}) and significantly superior over rest of the varieties. This might be due to maximum grain and straw yield were produced by this variety and its higher biomass accumulation. The magnitude of increase in biological yield with variety HI-8759 over varieties HI-8713 (8572 kg ha^{-1}), DBW-252 (7505 kg ha^{-1}) and HI-1544 (7416 kg ha^{-1}) was 4.08 %, 16.01 % and 17.01 % respectively. These results were in line with Ram and Gupta [25], Haq et al. [26] and Abhineet et al. [9]. Interaction between irrigation schedules and varieties on biological yield of wheat was found non-significant.

Table 2. Wheat yield attributes as modified by various irrigation regimens and varieties.

Treatments	**Yield attributes**			
	No. of productive tillers m^{-2}	**No. of grains $spike^{-1}$**	**No. of filled grains $spike^{-1}$**	**1000 grain weight (g)**
Irrigation schedules (M)				
M_1: CRI, Maximum tillering, Jointing, Flowering and Milking	219.8	52.7	48.9	41.4
M_2: CRI, Flowering and Milking	205.7	48.1	44.9	39.0
M_3: CRI and Milking	192.1	46.9	42.3	36.6
SEm ±	3.35	1.12	0.98	0.58
CD (P=0.05)	13.2	4.4	3.9	2.3
CV (%)	5.6	7.9	7.5	5.2
Varieties (V)				
V_1: DBW - 252	186.3	52.3	48.5	37.6
V_2: HI - 1544	202.6	46.7	43.0	37.9
V_3: HI - 8759	223.6	50.8	45.6	41.3
V_4: HI - 8713	210.9	47.1	44.3	39.1
SEm ±	3.73	0.99	0.90	0.53
CD (P=0.05)	11.1	2.9	2.7	1.6
CV (%)	5.4	6.0	6.0	4.1
Interaction				
(M×V)	NS	NS	NS	NS
(V×M)	NS	NS	NS	NS

Table 3. Wheat yield (kg ha^{-1}) and harvest index (%) as impacted by various irrigation regimens and varieties.

Treatments	**Yield (kg ha^{-1}) and Harvest index (%)**			
	Grain yield (kg ha^{-1})	**Straw yield (kg ha^{-1})**	**Biological yield (kg ha^{-1})**	**Harvest index (%)**
Irrigation schedules (M)				
M_1: CRI, Maximum tillering, Jointing, Flowering and Milking	4255.9	5315.9	9571.8	44.4
M_2: CRI, Flowering and Milking	3361.3	4526.7	7888.0	42.6
M_3: CRI and Milking	2826.9	4036.8	6863.7	40.9
SEm ±	73.71	197.58	253.34	0.71
CD (P=0.05)	289.8	776.8	996.0	2.8
CV (%)	7.3	14.8	10.8	5.8
Varieties (V)				
V_1: DBW - 252	3075.2	4430.3	7505.6	40.7
V_2: HI - 1544	3067.2	4349.4	7416.7	41.1
V_3: HI - 8759	4050.0	4886.9	8936.9	45.2
V_4: HI - 8713	3733.1	4839.1	8572.2	43.4
SEm ±	75.54	90.44	139.82	0.65
CD (P=0.05)	224.3	268.6	415.2	1.9
CV (%)	6.5	5.9	5.2	4.5
Interaction				
(M×V)	NS	NS	NS	NS
(V×M)	NS	NS	NS	NS

4. CONCLUSION

The following general conclusions can be drawn from the results of the above experiment, which was carried out on wheat during the rabi season: the five irrigation schedules at various phenological stages significantly increased spike length and weight as well as productive tillers, filled grains, 1000-grain weight, and yield of wheat. While, significantly lower values were observed in two irrigation schedules (M3). Among the varieties DBW-252 recorded significantly longest spike and shortest spike was observed under HI-1544 and highest spike weight was observed under DBW-252 and it was statistically on par to HI-8759 and HI-8713. Significantly highest number of productive tillers and test weight were recorded by HI-8759 and lowest values were recorded by DBW-252. Although DBW-252 recorded significantly highest number of grains and filled grains spike^{-1} and remained on a par with HI-8759 in terms of grains spike^{-1}. Wheat yield was dramatically increased by five different irrigation regimens applied at various phenological phases. While two irrigation regimens showed noticeably lesser output. The maximum yield was recorded by variety HI-8759, which was comparable to variety HI-8713 in terms of biological and straw yields.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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