Effect of irrigation scheduling and different sowing dates on growth and yield of wheat (*Triticum aestivum* L.)

Abstract

The study was conducted at Acharya Narendra Deva University of Agriculture and Technology, Ayodhya (U.P.) Agronomy Research Farm in rabi season 2021-22. Twelve main plot treatments included 15th November, 25th November, and 5th December sowing dates, while four sub plot treatments included irrigation at 0.6, 0.8, 1.0, and 1.2 IW/CPE ratios. Split plot design was used for three replications. Under 15th November sowing, all growth, yield, and characteristics rose dramatically. Irrigating at 1.0 IW/CPE ratio increased wheat shoot m^{-2}, plant height (cm), dry matter accumulation (g m^{-2}), yield characteristics, grain and straw yield (q ha^{-1}) considerably. Wheat yields were highest when sown on November 15. Under 15th November planting, water use efficiency was highest (9.85 kg ha^{-1}mm^{-1}). Out of all treatments, 15th Nov planting had the highest biological (128.21 q ha^{-1}) and seed yield (51.43 q ha^{-1}) and irrigation on 1.0 IW/CPE had the highest biological (127.18 q ha^{-1}) and seed yield (50.83 Maximum Harvest Index was 40.11 percent with 15th November planting and 1.0 IW/CPE ratio irrigation (39.96%).

Keywords: Wheat, Irrigation Scheduling, Moisture Regimes, IW, CPE and leaf area index.

INTRODUCTION:

One of the most important cereal crops, wheat (*Triticum aestivum* L.), is a member of the Poaceae family. Two billion people, or 36 percent of the global population, follow this diet as their primary way of eating. Wheat is the source of 20% of the caloric intake for 55% of the world's population. Wheat, sometimes known as the “King of cereals” has the ability to self-pollinate. The country’s second most important source of grain after rice. India comes in at number two in terms of wheat output. Wheat is the cereal that is grown around the globe the more than any other type. In 1967 and 1968, dwarf Mexican wheat completely altered the production of wheat in India.

Wheat grows on all continents. China, India, Russia, Ukraine, the US, France, Canada, Germany, Pakistan, and Australia produce the most wheat. Wheat is the second most produced crop after maize with 219 million ha, 760 million metric tonnes, and 3390 kg ha^{-1} productivity. India grows 29.8 million hectares of it, generating 109 million tonnes at 3424 kg ha^{-1}. **(Anonymous,2020).** Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, and Maharashtra grow the most wheat by area and output. Uttar Pradesh leads in acreage (9.21 million ha) and output (24.51 million tonnes), but its productivity (2.7 tonnes ha^{-1}) is much lower than Punjab and Haryana. **(Anonymous,2020).**

More than a billion people throughout the world consume wheat in various forms. It is the second most significant crop grown as a staple meal in India, behind rice. Wheat is consumed as "chapatis" in regions where it is the main source of cereal food. Wheat is consumed in the form of "puris" or "upma" in regions where rice is the main grain crop. Additionally, wheat is used in a variety of different dishes like "Dalia," "halwa," etc. The consumption of baked leavened bread, flakes, cakes, biscuits, etc. is rising quickly throughout the majority of the nation's metropolitan centers.

India has ample land and ideal weather for agriculture cultivation. Thus, wheat output ranks second globally. Many factors contribute to this country's poor wheat production. Environmental variables like late planting reduce wheat output. Another issue is the unavailability of improved varieties with quick maturity and appropriate for late sowing due to the crop's shorter growth cycle. Late-sown cultivars vary in yield and nutrient absorption.

According to more recent and thorough studies on the consequences of climate change, temperatures in South Asia are expected to rise by up to 3–4°C by the end of the century **(DEFRA, 2005)** and rainfall is expected to increase significantly. Reduced grain yield is one of the predicted implications on wheat output, with the worst effects occurring in low-potential locations like the eastern plains.

Physiological growth stage, climatic (IW/CPE ratio), and soil moisture depletion are the three fundamental techniques for scheduling wheat irrigation. The climatological technique is scientific and practical, and scientists and researchers worldwide acknowledge it. It is generally established that complete crop cover evapotranspiration is linked to open pan evaporation. Crop irrigation schedule is based on the ratio of fixed irrigation water (IW) to CPE. Soil measurements and crop monitoring inform irrigation schedule. Irrigation scheduling involves choosing the time and amount of water. Knowing the plant's initial soil water allows intelligent scheduling. This allows determining the earliest date for subsequent irrigation for optimal irrigation using the system before water stress impairs crop performance. Improved irrigation timing lowers expenses and boosts crop quality. The scientific and beneficial climatological irrigation scheduling technique is generally acknowledged by scientists and researchers. This IW/CPE method is worth considering for its simplicity and great water efficiency.

MATERIALS AND METHODS:

The current experiment contained twelve treatment combinations: main plot (15 November, 25 November, and 5 December) and sub plot (0.6, 0.8, 1.0, and 1.2 IW/CPE ratio irrigation). Three replications utilised split plots. Acharya In Rabi 2021-22, Narendra Deva University of Agriculture & Technology, Ayodhya, sponsored the experiment at its Agronomy Research Farm in Wheat cv. PBW 343 with 20 cm row spacing in 5.0m x 6.0m plots. The experimental site is at 26047" N latitude and 82012" E longitude, 113 metres above sea level. It is part of the Indo-Gangetic alluvial plains (IGP), which have a semi-arid subtropical climate and alluvial calcareous soil. About 1002 mm of precipitation fall on average each year, 80 to 85 percent of which fall between June and September during the monsoon season. 49.6 mm of rain fell altogether during the trial. The winter months are chilly, and there may be some frost at this time.The experimental soil was sandy loam with a pH of 8.1, EC of 0.32 dSm^{-1}, organic carbon content of 0.34%, nitrogen availability of 156.10 kg ha^{-1}, P_2O_5 availability of 15.13 kg ha^{-1}, and potassium availability of 280.42 kg ha^{-1} The test location was primed for germination. The field was fertilised with 120 kg N, 60 kg P_2O_5, and 40 kg K_2O ha^{-1} before planting. Quality PBW 343 seed was seeded at 100 kg ha^{-1} on November15, 25, and December5, 2021. The best pre-emergence herbicide application method was a Knapsack sprayer with a flat fan nozzle and 500 litres of water per hectare. To grow a good harvest, several agronomical and plant protection measures were employed.

The IW/CPE ratio are calculated by the formula of $\frac{\text{IW}}{\text{CPE}} = \frac{\text{Irrigation water depth (mm)}}{\text{Cumulative pan evaporation (mm)}}$.

Each plot has five randomly selected plants tagged. Height (cm), tillers, and leaves were measured at 30, 60, 90 DAS and maturity mean values were calculated. Yield traits like from planting to 50% blooming, wheat plant productive tillers per m^2, spike length, spikelet count, grain count, and test weight of tagged plants from each plot replication wise were recorded.

RESULTS AND DISCUSSION

Initial plant population (m^{-2}):

Dates of sowing and moisture regimes statistically affect plant population (m^{-2}). Planting dates and moisture regimes did not has affect initial plant population (m^{-2}). However, wheat sown on November 15th had the most plants (157.75), followed by November 25th and December 5th. The moisture regime with the highest plant population was 1.0 IW/CPE ratio (159.33), followed by 0.8IW/CPE ratio (156.87), 1.2IW/CPE ratio (154.4), and 0.6IW/CPE ratio (154.2).

Plant height (cm):

Beginning on November 15th, when the wheat crop is sown, plant height rises at every stage of crop growth. The date of seeding had no effect on the plant's height at 30 DAS, according to the data. On November 15th, the wheat plant reached its maximum height of 83.98 cm, which corresponded to November 25 at 60 and 90 DAS. The plant height with the lowest value was observed when the planting date was set for December 5. The moisture regime did not appear to have a substantial impact on plant height at 30 DAS. When it came to plant height, the response to irrigation was better at 1.0 IW/CPE ratio, similar at 0.8 IW/CPE ratio, and much better at 60 and 90 DAS.

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

Tillers rose gradually up to 60 DAS, when they began to decline in spite of treatments. At the 30-day mark, there was no appreciable difference in the influence of different sowing dates on the growth of wheat crops. However, at the 60, 90, and harvest stages, the differences in sowing dates were significant and equivalent to the sowing date of November 25. Variable moisture regimes had significant impacts on wheat crop growth stages at 30, 60, and 90 days later as well as at harvest; these effects were equivalent to 0.8 and 1.2 IW/CPE ratios. It might be accounted for by the fact that better planting dates and increased moisture availability in well-managed plots produced more shoots (m^{-2}) than in other treatments.

Leaf area index:

Except for the 30 DAS growth stage, sowing and watering regimes affected wheat leaf area index. The leaf area index decreased after 30 days but grew and peaked after 60 and 90 days of crop development. A small study found that 30 DAS sowing dates did not affect leaf area index. The greatest leaf area index was 4.90 at 60 DAS and 5.04 at 90 DAS on November 15. November 25 and December 5 readings were comparable. Different moisture regimes did not significantly impact the leaf area index at 30 DAS, but at 60 and 90 days into wheat crop growth, they did, reaching 1.0 IW/CPE ratio. The greatest leaf area index (5.05) at 90 DAS was achieved with moisture regime 1.0 IW/CPE ratio, equal to irrigation at 0.8 at 60 and 90 DAS.

Dry matter accumulation (g m^{-2}):

The dry matter output of the wheat crop rose with growth, in line with growth parameters. Wheat crops had the greatest dry matter content during harvest. Dry matter rose more quickly between 30 and 60 DAS, then between 60 and 90 DAS, and finally from 90 until harvest. Table scans reveal that on November 15, November 25, and December 5, respectively, there was a rise in dry matter accumulation in the latter phases (60, 90 DAS, and harvest). At 60, 90 DAS, and harvest stage, the IW/CPE ratio under irrigation was 1.0, which was noticeably better than 0.8, 1.2, and 0.6. When it came to dry matter production at harvest stage, irrigation at 1.0 IW/CPE ratio generated the most (1271.84 g m^{-2}), whereas irrigation at 0.6 produced the least (1143.21 g m^{-2}).

Biological yield (q ha^{-1}):

Irrigation at 1.0 IW/CPE ratio (I3) produced the maximum biological production (127.18 q ha^{-1}), which was followed by 0.8 (I_2), 1.2 (I_4), and 0.6 (I_1). In comparison to 25 November and 5 December, which produced biological yields of 120.962 and 112.583 q ha^{-1}, respectively, the 15 November sowing produced the greatest yield (128.213 q ha^{-1}).

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

Statistics on average grain production are significantly impacted by planting dates and moisture regimes. The data indicates that grain yield is significantly impacted by moisture regime. The highest grain yield (51.43 q ha^{-1}) was recorded on November 15, and it was subsequently reached on November 25, and December 5. Irrigation at 1.0 IW/CPE ratio was the moisture regime with the maximum grain production (50.83 q ha^{-1}), which was considerably superior than I_2 (0.8), I_4 (1.2), and I_1 (0.6).

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

The table 2. demonstrates how different moisture regimes greatly increased straw production. The highest straw output was recorded on November 15, 25, and December 5 at 76.79 q ha^{-1}. The straw yield with I3 (1.0 IW/CPE ratio) was the greatest, at 76.35 q ha^{-1}.

Harvest index (%):

Harvest index was highest on November 15, sowing (40.11%), and lowest on December 5, sowing (39.71%). The harvest index for moisture regimes ranged from the lowest (40.05%) at 0.6 to the greatest (40.16%) at 1.0 IW/CPE ratio.

CONCLUSIONS:

Based on the overall findings, it can be said that November 15th was the best day to sow wheat for growth and production. Wheat responded best to irrigation at a 1.0 IW/CPE ratio (6 irrigations), according to research on moisture regimes. No correlation was seen between the dates of sowing and the moisture regime.

Conference disclaimer:

Some part of this manuscript was previously presented in the conference: "International Conference on Emerging Trends in Agriculture & Allied Sector for Sustainable Developments" organized by Faculty of Agricultural Sciences & Allied Industries, Rama University, Kanpur Nagar, U.P., India on 8th and 9th December, 2023. Web Link of the proceeding: https://www.ramauniversity.ac.in/news-rama-university-hosts-successful-international-conference-on-emerging-trends-in-agriculture-12-49-5706

REFERENCES:

Ahmad, A. and Kumar, R., (2015). Effect of irrigation scheduling on the growth and yield of wheat genotypes. *Agric. Sci. Digest*. (3): 199- 202.

Anonymous 2020. Agriculture statistics at a glance, Directorate of Economics and Statistics, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi.

Aslam, H., Ansari, M.A., Baloch, S.K., Baloch, S.U., and Baloch, A.S. (2014). Effect of irrigation scheduling on the growth and harvest index of wheat (*Triticum aestivum* L.) varieties. *Persian Gulf Crop Protection* **3**(2): 15-29.

Dhaka, A.K., Bangarwa, A.S., Pannu, R.K., Malik, R.K. and Garg, R. (2006). Phenological development, yield and yield attributes of different wheat genotypes as influenced by sowing time and irrigation. *Agricultural Science Digest.* **26**(3): 174-177.

Kumar, S., Dhindwal, A.S. and Arya, R.K. (2013). Dry matter and straw yield in wheat as influenced by preceding crops, planting methods and irrigation levels. *Forage Research,* **39**(2): 88-92.

Ngwako, S. and Mashiqa, P.K. (2013). The effect of irrigation on the growth and yield of winter wheat (*Triticum aestivum L.)* cultivars. *Int. J. of Agric. and Crop Sci.* **5**(9): 976-982.

Prahalad Singh, Ravikesh Kumar Pal, Naveen Kumar Maurya, Vineet Dheer, Mahendra Yadav, Rajat Yadav, Divyansh Mishra, Ankit Kumar (2023). Effect of different herbicidal weed management practices in wheat (Triticum aestivum L.). Pharma Innovation;12(7):2872-2878.

Singh N, Singh SS, Singh G, Singh R, Yadav SK (2021). Effects of interaction (Date of sowing X varieties) on wheat (Triticum aestivum L.). *International Journal of Chemical Studies*. ;9(2):201-203.

Singh, G. Kumar, S., Sidhu, G.S. and Kaur, R. (2018). Effect of integrated nutrient management on yield of wheat (*Triticum aestivum* L.) under irrigated conditions. *International Journal of Chemical Studies*, **6(**2): 904-907.

Throat, T.N., Bhan, M. and Agrawal, K.K. (2015). Effect of sowing date on weed infestation and yield of wheat (*Triticum aestivum*L.) varieties under different irrigation schedules. *Jawaharlal Nehru Krishi Vishwa Vidyalaya Research Journal,* **49** (1): 41-45.

Verma, H.P., Sharma, O.P., Kumar, R., Yadav, S.S., Shivran, A.C. and Balwan (2017). Yield Attributes and Yield of Wheat (*Triticum aestivum* L.) as Influenced by Irrigation Scheduling and Organic Manures. *Chem Sci Rev Lett.* **6**(23):1664-1669.

Vineet Dheer, Mohit Yadav, Rohit Yadav (2021). Effect of post emergence herbicides on weed density in wheat (Triticum aestivum L.). *Pharma Innovation*;10(10):440-443.

Vineet Dheer, RA Yadav (2021). Comparative efficacy of paddy straw and polythene sheet mulching on weed infestation in wheat (Triticum aestivum L.). *Pharma Innovation* 10(9):1516-1519.

Table 1. Effect of dates of sowing and moisture regimes on growth of wheat at different growth stage.

Treatments	Initial Plant population m^{-2}	Plant height (cm)			No. of tillers m^{-2}				Leaf area index			Dry matter accumulation (g m^{-2})			
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	30 DAS	60DAS	90DAS	At harvest
Date of sowing															
D_1: 15 November	157.75	24.45	73.03	83.98	189.30	349.53	356.21	359.81	1.75	4.90	5.04	94.65	630.81	1051.35	1282.13
D_2: 25 November	156.20	23.98	69.38	79.78	187.44	326.15	332.38	335.74	1.71	4.65	4.79	93.72	595.13	991.89	1209.62
D_3: 05 December	154.65	23.48	63.55	73.08	185.58	312.09	318.06	321.27	1.68	4.27	4.39	92.79	551.74	920.19	1121.66
SEm±	3.93	0.60	1.67	1.92	4.72	8.12	8.27	8.35	0.043	0.112	0.116	2.36	14.34	19.86	30.17
CD at 5%	NS	NS	6.57	7.56	NS	31.88	32.49	32.82	NS	0.441	0.454	NS	56.31	77.98	118.47
Moisture regime															
I_1: 0.6 IW/CPE ratio	154.20	23.37	64.33	73.98	185.04	314.33	320.34	323.58	1.67	4.31	4.45	92.52	562.46	937.43	1143.21
I_2: 0.8 IW/CPE ratio	156.87	24.30	71.33	82.03	188.24	335.10	341.51	344.96	1.74	4.78	4.92	94.12	610.36	1017.26	1227.64
I_3: 1.0 IW/CPE ratio	159.33	24.70	73.13	84.10	191.20	345.98	352.60	356.16	1.76	4.90	5.05	95.60	619.23	1042.91	1271.84
I_4: 1.2 IW/CPE ratio	154.40	23.50	65.80	75.67	185.28	321.61	327.75	331.07	1.68	4.42	4.55	92.64	578.20	953.63	1175.19
SEm±	4.16	0.64	1.86	2.14	5.01	8.87	9.04	9.13	0.046	0.125	0.129	2.50	14.69	25.85	30.00
CD at 5%	NS	NS	5.43	6.26	NS	25.90	26.40	26.67	NS	0.366	0.377	NS	42.89	75.45	87.58

Table 2. Effect of dates of sowing and moisture regimes on yield of wheat.

Treatments	**Grain yield(qha^{-1})**	**Strawyield (qha^{-1})**	**Biologicalyield(qha^{-1})**	**Harvestindex (%)**
Datesofsowing				
D_1:15 November	51.43	76.79	128.21	40.11
D_2:25 November	48.28	72.69	120.96	39.91
D_3:05December	44.93	67.66	112.58	39.71
SEm±	1.19	1.65	1.03	1.01
CDat5%	4.68	6.47	2.94	NS
Moistureregime				
I_1:0.6 IW/CPEratio	45.57	68.75	114.32	39.85
I_2:0.8 IW/CPEratio	49.53	74.52	124.05	39.92
I_3:1.0 IW/CPEratio	50.83	76.35	127.18	39.96
I_4:1.2 IW/CPEratio	46.90	69.88	116.78	39.90
SEm±	1.20	1.81	2.08	1.06
CDat5%	3.51	5.28	4.41	NS