"Effect of irrigation scheduling and different sowing dates on water productivity and economics of wheat (*Triticum aestivum* L.)"

ABSTRACT:

"Effect of moisture regime under different sowing dates of wheat crop (Triticum aestivum L.)" was investigated at Acharya Narendra Deva University of Agriculture & 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. Irrigation 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. $D_1 1_3$ (15 November planting with irrigation at 1.0 IW/CPE ratio) had the best net return and D_1I_2 (15 November sowing with irrigation at 0.8 IW/CPE proportion) the highest B:C ratio (2.54). Wheat yields were highest when sown on November 15. Under 15th November planting, water use efficiency was highest (9.85 kg ha-1mm-1). Irrigation with 1.0 IW/CPE ratio had the maximum water usage efficiency (9.34 kg ha-1mm-1). The 15 November seeding with irrigation at 1.0 IW/CPE ratio yielded the highest net return (1,17,124.00), making wheat farming profitable. Maximum B:C ratio (2.54) with I_1D_2 therapy.

Keywords: Wheat, Irrigation Scheduling, Moisture Regimes, IW, CPE and B:C ratio.

INTRODUCTION:

Triticum aestivum L., often known as cereal wheat, is a grass in the Poaceae family. It serves as the main source of sustenance for two billion people, or 36% of the world's population. 20% of the calories consumed by more than half of the world's population come from wheat. Wheat has the ability to fertilise itself, unlike other crops. It is the most significant grain crop in India, behind rice. In terms of wheat production, India is ranked second globally, behind China. Globally, wheat is the crop that is grown to the greatest extent.

Every continent in the globe is home to wheat cultivation. Leading wheat producing countries include China, India, Russia, Ukraine, USA, France, Canada, Germany, Pakistan, and Australia. With a 760 million metric tonne yield, a 219 million hectare global area, and a productivity of 3390 kg ha-1, wheat is the second most produced grain behind maize. Expanded across 29.8 million hectares, it yields 109 million tonnes with a productivity of 3424 kg ha-1 when planted in India. According to area and production, the largest wheat-growing states of the nation are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, and Maharashtra. According to area (9.21 million ha) and production (24.51 million tons), Uttar Pradesh is the leader among them, although its productivity (2.7 tons ha^{-1}) is substantially lower than that of Punjab and Haryana **(Anonymous, 2020).**

More than a billion people throughout the world consume wheat in various forms. It is the second most important 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 consumed in a variety of other 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 urban centers.

Unlike other cereals, wheat has a large amount of gluten, a protein that provides the elasticity needed to make quality bread. Hard wheat generates flour with a high gluten concentration (10–17%) and a high protein content, making it perfect for yeast breads.

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.

Three basic methods for scheduling wheat irrigation include soil moisture depletion, climatic (IW/CPE ratio), and physiological development stage. 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. Crop irrigation schedule is based on the ratio of fixed irrigation water (IW) to CPE. This IW/CPE method is worth considering for its simplicity and great water efficiency.

The best crop stand, which in turn affects the yield and returns, is determined by the sowing date, which is of higher significance. Because the growing season is longer when seeds are sown earlier, the yield is larger (as of November 15). However, postponing seeding after November 20 reduces grain production because of extreme cold during the vegetative stage and high temperatures during the reproductive stage. The greatest number of tillers per plant and total biomass were produced by sowing on November 15th.

Dates of sowing had a big impact on test weight, grains ear^{-1}, ear length, and ear weight. The wheat sowed on November 15th, followed by December 5th, had the maximum ear length, ear weight, grains ear^{-1}, and test weight measurements. With a postponement in the sowing date, all these qualities drastically decreased. It could be attributed to a longer and more favorable time of ear formation, which led to more spikelet growth and increased odds of creating long ears with lots of grains.

The sowing timing is the most significant element in crop production. Due to the longer growing season, early seeding has been found to produce higher yields than late sowing **(Tanveer *et al*. 2003)**. Delay sowing from November 20 forward resulted in a 39 kg ha^{-1} day^{-1} decrease in wheat grain production. From an agronomic perspective, sowing time is a crucial element, which is reflected in both high wheat yield and knowledge of early crop establishment elements.

MATERIALS AND METHODS:

The current experiment included twelve treatment combinations: main plot treatment (15 November, 25 November, and 5 December) and sub plot treatment (0.6, 0.8, 1.0, and 1.2 IW/CPE ratio irrigation). Split plot design was used for three replications. The experiment was done at Acharya Narendra Deva University of Agriculture & Technology, Ayodhya (U.P.) Agronomy Research Farm with Wheat cv. PBW 343 during Rabi 2021-22 with 20 cm row spacing in 5.0m x 6.0m plots.The experimental location is situated at 26047" N latitude and 82012" E longitude on an elevation of 113 metres above mean sea level in Indian Gangetic alluvial plains (IGP) with semi-arid subtropical climate and alluvial calcareous soil. Average annual precipitation is 1002 mm, with 80–85% falling during the monsoon season (June–September). During experimentation, 49.6 mm of rain fell. Cold winters may bring frost. Sandy loam with 8.1 pH, 0.32 dSm-1 EC, 0.34 % Organic Carbon, 156.10 kg ha-1 Available N, 15.13 kg ha-1 Available P2O5, and 280.423 kg ha-1 Available K2O was the experimental soil. For optimal germination, experimental field was carefully prepared. Before planting, 120 kg N, 60 kg P2O5, and 40 kg K2O ha-1 were fertilised. Nov 15, 25, and Dec 5, 2021 saw 100 kg ha-1 of quality PBW 343 seed sowed. Applying pre-emergence herbicides using knapsack sprayers with flat fan nozzles and 500 litres per acre. Several agronomic and plant protection measures were used to generate a flawless crop. The IW/CPE ratio are calculated by the formula-

$$\frac{\textbf{IW}}{\textbf{CPE}} = \frac{\textbf{Irrigation water depth (mm)}}{\textbf{Cumulative pan evaporation (mm)}}.$$

Here, water consumption efficiency was calculated and was regarded as such. Grain yield was measured by water expense efficiency (WEE), which was the sum of all applied water and actual rainfall.WUE (kg $ha^{-1}mm^{-1}$) $= \frac{\textbf{Grain yield (kg per ha)}}{\textbf{Evapotranspiration (mm)}}$

By combining experimental crop cultivation and variable treatment costs, cultivation costs were estimated for each treatment. Grains and straw yield after varied treatments were multiplied by market price to compute gross return. By summing grain and straw yield money values, gross return (Rs. ha-1) was estimated. Reduce cultivation expenses from treatment gross returns to calculate net return. Net return/treatment cultivation cost = benefit cost ratio.

$$\text{B:C ratio} = \frac{\textbf{\textit{Net return (Rs. per ha)}}}{\textbf{\textit{Cost of cultivation (Rs.per ha)}}}$$

RESULTS AND DISCUSSION:

Water use efficiency (kg $ha^{-1}mm^{-1}$):

Data analysis reveals that when the number of irrigations rose, water consumption efficiency dramatically decreased. The most water-efficient planting occurred on November 15 (9.85 kg ha-1 mm-1), whereas the least water-efficient sowing occurred on December 5 (7.91 kg ha-1 mm-1). The effects of moisture regimes on water utilisation efficiency were substantial. The best water usage efficiency was achieved after irrigation at 1.0 IW/CPE ratio, 0.8 IW/CPE ratio, and 1.2 IW/CPE ratio treatments (9.34 kg ha-1 mm-1). At a ratio of 0.6 IW/CPE, irrigation enabled the lowest possible water usage efficiency (8.37 kg ha-1mm-1).

Economics:

Any experiment's principal goal is to determine how much can be produced for the greatest possible profit. To determine the economics of various therapies individually, the current market prices were utilized. The treatments that recorded the highest profit are worth adopting as a result. The table below includes both the fixed cost associated with treatments and the average cost of cultivation (Rs. ha^{-1}).

Cost of cultivation (Rs. ha^{-1}):

The combination of the D2I4 treatment with the I4 treatment (irrigation at 1.2 IW/CPE ratio) on November 15th (D_1) resulted in the highest cultivation costs (Rs. 47,861 ha-1). With D_1I_1, D_2I_1, and D_3I^1 treatment combinations, the lowest cultivation cost (Rs. 42,229 ha-1) was noted.

Gross return (Rs. ha^{-1}):

The combinations of treatments demonstrated that under the 15 November date of sowing and irrigation at 1.0 IW/CPE ratio, the greatest gross revenue (Rs. 1,63,577 ha-1) was recorded. On the other hand, the lowest gross revenue (Rs. 1,28,918 ha-1) was reported under the irrigation and 5 December sowing date at 0.6 IW/CPE ratio.

Net returns (Rs. ha^{-1}):

The information shown in Table 2. It is evident from this that the date of sowing on November 15, together with irrigation at a 1.0 IW/CPE ratio, produced the greatest net revenue (Rs. 1,17,124 ha-1), while the date of sowing on December 5, coupled with irrigation at a 1.2 IW/CPE ratio, produced the lowest net income (Rs. 84,767 ha-1). Lower cultivation costs and a larger gross return might be the cause of the highest net return.

Benefit cost ratio:

Examining the data in Table 2 makes it evident that the D1I2 treatment combination (15 November date of planting and irrigation at 0.8 IW/CPE ratio) had the greatest benefit cost ratio (2.54). Under D3I4 treatment combination (5 December date of planting coupled with irrigation at 1.2 IW/CPE ratio), the minimum benefit cost ratio (1.82) was obtained.

When compared to other treatment combinations, irrigation at a 1.2 IW/CPE ratio under delay-sown wheat conditions was not found to be cost-effective due to the high irrigation costs and poor net return (B.C. ratio). The greatest gross revenue in D1I3, which is closely correlated with biological yield, accounts for the best net return. However, compared to D1I3, the treatment combination D1I2 (B:C) ratio had the greatest ratio since fewer irrigations were used..

CONCLUSIONS:

Based on the condensed data, it can be said that November 15th was the best day to plant wheat in terms of growth, yield characteristics, and yield. The moisture regime that was discovered to be best suitable for wheat was irrigation at a ratio of 1.0 IW/CPE (6 irrigations).

The moisture regime and the planting dates did not interact in any way. The treatment combination of 6 cm irrigation at 1.0 IW/CPE ratio moisture regime with planting on November 15th yielded the highest water usage efficiency. A maximum B:C ratio of 2.54 and an IW/CPE ratio of 0.8 are combined with the sowing date of November 15th. Under the 15th November planting of the wheat crop, the maximum net return of Rs. per rupee invested was obtained with 0.8 IW/CPE ratio, or 5 irrigation.

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Table- 1: Water use efficiency as influenced by dates of sowing and moisture regimes in wheat.

Treatments	WaterUseEfficiency(kgha^{-1}mm^{-1})
Main plot- Datesofsowing(3)	
D_1-15 Nov.	9.85
D_2- 25 Nov.	8.81
D_3- 5Dec.	7.91
Subplot- Moistureregime(4)	
I_1- 0.6IW/CPEratio	8.37
I_2- 0.8IW/CPEratio	9.10
I_3- 1.0IW/CPEratio	9.34
I_4- 1.2IW/CPEratio	8.62

Table- 2: Economics of wheat as affected by different treatment combinations.

Treatmentc ombinations	Total cost ofcultivation(Rs.ha^{-1})	Grossreturn(Rs.ha^{-1})	Netreturn(Rs.ha^{-1})	Benefit:Costratio
D_1I_1	42,229.00	1,47,213.00	1,04,984.00	2.48
D_1I_2	45,045.00	1,59,447.00	1,14,402.00	2.54
D_1I_3	46,453.00	1,63,577.00	1,17,124.00	2.52
D_1I_4	47,861.00	1,51,033.00	1,03,172.00	2.15
D_2I_1	42,229.00	1,38,241.00	96,012.00	2.27
D_2I_2	43,637.00	1,54,063.00	1,10,426.00	2.53
D_2I_3	46,453.00	1,50,215.00	1,03,762.00	2.23
D_2I_4	47,861.00	1,42,378.00	94,517.00	1.97
D_3I_1	42,229.00	1,28,918.00	86,689.00	2.05
D_3I_2	43,637.00	1,43,889.00	1,00,252.00	2.29
D_3I_3	45,045.00	1,40,322.00	95,277.00	2.11
D_3I_4	46,533.00	1,31,220.00	84,767.00	1.82