Effect of Irrigation Scheduling Based-IW/CPE Ratio on Soil Qualities, Growth Characteristics and Yield of Wheat (*Triticum aestivum* L.) crop in Eastern Uttar Pradesh

ABSTRACT

Background:

Wheat (*Triticum aestivum*L.) is a crop of Poaceae family and one of the most leading cereals of many countries of the world including India.In IW/CPE approach, a known amount of irrigation water is applied when cumulative pan evaporation (CPE) reaches a predetermined level. The amount of water given at each irrigation ranges from 4 to 6 cm. The most common being 5cm irrigation. Scheduling irrigation at an IW/CPE ratio of 1.0 with 5 cm, the current study aimed to study theEffect of irrigation scheduling based on the IW/CPE ratio on soil qualities, growth characteristics and yield of wheat in Eastern Uttar Pradesh**.**A field experiment was conducted during *rabi* season of the year 2016-17 to study the effect of different levels irrigation scheduling based on the IW/CPE ratio on soil qualities, growth characteristics and yield of wheat in Eastern Uttar Pradesh**.** In this experiment four treatment combinations consisting of five irrigation levels of CRI stage (I_1), 0.6 IW/CPE ratio (I_2), 0.8 IW/CPE ratio (I_3), 1.0 IW/CPE ratio (I_4), and 1.2 IW/CPE ratio (I_5)were tried in randomized block design with four replications. Whereas the initial irrigation of all treatments is done at the CRI stage (21 DAS), and then, according to the IW/CPE ratio treatments, the crop of net plot area was harvested from the individual plot for observation. The final seed weight per plot was recorded in kg and converted to q/ha. The result showed the growth attributes, *viz.,* plant height, dry matter accumulation, number of effective shoots per m^2, and yield-attributing characters, *viz.*, 1000 grain weight, harvest index, grain, straw, and Biological yield by crop was significantly higher at 1.0 IW/CPE ratio (I_4) in the moisture regime, which was at par with 1.2 IW/CPE ratio (I_5) in the moisture regime and significantly higher than at the CRI stage (I_1), 0.6 IW/CPE ratio (I_2), and 0.8 IW/CPE ratio (I_3).

Key words:Moisture regime, Soil properties, Wheat, Growth attributes, Quality and Yield

INTRODUCTION

Wheat (*Triticum aestivum L.*) is a vital food crop that contributes to food security. In 2021-22, wheat was cultivated on around 222.62 million hectares globally, generating 779 million metric tonnes with a productivity of 3.49 Metric tonnes per hectare (Anonymous 2021-22). Water is the scarcest input since it is essential for plant turgidity, nutrient absorption, and the metabolic process, and it has a significant influence on the efficiency of applied inputs and individual component production. When watering rabi crops, surface irrigation methods are utilised, with irrigation efficiency as low as 30-40% due to increased non-beneficial evapo-transpiration (Rajanna *et al.* 2016).Irrigated wheat systems account for more than 40% of wheat output in developing countries (Rajaram *et. al.,* 2007). Additionally, the irrigation schedule is critical for water management. Irrigation failures during the critical development stage may result in significantly decreased grain output because to lower test weight (Kumar *et. al.* 2014). As one of the most successful agronomic management measures, efficient water management not only boosts crop productivity but also reduces sensitivity to disease and insect pests by providing an optimum environment for these biotic stressors to flourish (Singh *et. al.* 2012). The IW/CPE ratio meteorological approach was introduced by Parihar *et al.* (1976), which is a ratio between a constant quantity of irrigation water (IW) and cumulative pan evaporation minus precipitation.This IW/CPE technique is beneficial because of its ease of usage and excellent water efficiency. It is an accepted truth that as water demand for home, industrial, and other reasons increases, less and less water will be available for agriculture in the future. Even if all irrigation potential is realized, it is anticipated that roughly half of all cultivated land would remain rainfed (Vision, 2020).Water for irrigation is a critical restriction for expected crop yield. Evaporation from an open pan is closely related to evapo-transpiration by a complete crop cover. Irrigation is now an extremely expensive input, thus it will be utilized sparingly. As a basis for agricultural irrigation scheduling, Parihar *et al.* (2003) proposed a substantially more feasible meteorological technique of IW/CPE, the ratio between a set volume of irrigation water (IW) and Cumulative Pan Evaporation. Because of its ease of use, the IW/CPE ratio technique deserves special consideration. The IW/CPE ratio is used for watering wheat and comparing treatments at crucial development stages. With this in mind, an attempt was made to investigate the effect of irrigation scheduling based on the IW/CPE ratio on the characteristics of the soil, yield, and water use efficiency of wheat crops. A study by Patel and Upadhyay (1993), better grain production with IW: CPE ratio 1.0 of 6cm irrigation led in enhanced yield parameters such as effective tiller meter^{-2}, number of grains per spike, grain weight per spike, and 1000-grain weight.

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MATERIAL AND METHODS

A Field trials were carried out at the Narendra Deva University of Agriculture and Technology's Student's Instructional Farm at Narendra Nagar, Kumarganj, Ayodhya, during the *rabi* season of 2016-17. The farm sits 42 kilometers away from Faizabad on Raibareily Road, at 26.47 N latitude and 82.12 E longitude, approximately 113 meters above mean sea level. The experimental soil has a pH of 8.20, an EC of 0.30 dSm^{-1}, organic carbon of 4.0 gkg^{-1}, available N of 187, P of 17.25, and K of 269 kg ha^{-1}.

Table 1:Physico-chemical properties of the experimental field

S. No.	Particulars	Experimental value	Methods
A.	**Physical properties**		
	Sand	20.30	Hydrometer method

	Silt	60.50	(Jackson, 1973)
	Clay	19.20	
	Texture	Silt loam	Triangular method (Jackson, 1973)
B.	**Chemical analysis**		
	Soil pH (1:2.5)	8.20	Glass electrode pH meter (Jackson, 1973)
	Electrical conductivity (dSm^{-1})	0.30	Electrical conductivity Bridge (Jackson, 1973)
	Organic carbon ($g\ kg^{-1}$)	4.0	Walkley and Black rapid titration method, (Walkley and Black, 1934)
	Available nitrogen ($kg\ ha^{-1}$)	187.0	Alkaline permanganate method (Subbiah and Asija, 1956)
	Available phosphorus ($kg\ ha^{-1}$)	17.25	Olsen's method (Olsen *et. al.*,1954)
	Available potash ($kg\ ha^{-1}$)	269.0	Flame photometer method (Jackson, 1973)

Table 2: Details of the treatments

A.	**Irrigation schedule**	**Symbol used**
1	T_1=Irrigation at CRI stage.	I_1
2	T_1+Irrigation at 0.6 IW/CPE	I_2
3	T_1+Irrigation at 0.8 IW/CPE	I_3
4	T_1+Irrigation at 1.0 IW/CPE	I_4
5	T_1+Irrigation at 1.2 IW/CPE	I_5

The experiment was laid out in a randomized block design with four replications. Five treatments comprised four levels of irrigation scheduling: (a) I_1; CRI stage, (b) I_2; 0.6 IW/CPE ratio; (c) I_3; 0.8 IW/CPE ratio; (d) I_4; 1.0 IW/CPE ratio; and (e) I_5; 1.2 IW/CPE ratio. The wheat variety PBW-154 was used as a test crop. It was sown at a 20 cm row-to-row distance on December 2nd, 2016 and harvested on April 14th, 2017. Fertilization was done by using inorganic fertilizers and half of the nitrogen and the full dose of phosphorus and potash were applied at the time of sowing as per treatments.After the initial irrigation, the remaining nitrogen was top-dressed according to treatment. Urea, DAP, and muriate of potash were used to apply N, P, and K, respectively. A t-test with a 5% threshold of significance was used to compare the treatments. Whereas the initial irrigation of all treatments is done at the CRI stage (21 DAS), and then, according to the IW/CPE ratio treatments, the crop of net plot area was harvested from the individual plot for observation. The final seed weight per plot was recorded in kg and converted to q/ha.Soil moisture samples were collected from depths of 0-20, 20-40, and 40-60 cm before and after crop sowing and harvesting. Fresh weight of sample was recorded and these soil samples were dried in an oven at 105 ^{0}C till the constant dry weight.

RESULTS AND DISCUSSION

Growth Attributes

Effect on crop growth

Table 3 summarizes data on progressive plant height at several stages of crop growth as impacted. In general, plant height was successfully raised up to the 90 DAS stage. Following that, the rate of increase in plant height was modest until the crop was harvested. The data show that the influence of moisture regimes was not significant at the 30 DAS stage, but it had a substantial effect on plant height at the 60, 90, and harvest stages. The tallest plants had an irrigation practice of I_4 89.50 cm (IW/CPE of 1.0), which was comparable to I_5 85.07 cm (IW/CPE of 1.2), while the lowest plants had I_1 64.50 cm (at CRI stage), I_2 80.70 cm (0.6 IW/CPE ratio) and I_3 83.75 cm (0.8 IW/CPE ratio).The finding were in case close conformity with those of by Deo *et al*. (2017), Jat*et. al*. (2015), Dangar*et. al*. (2017), Nayak *et.al.(*2015) and Kaur & Mahal (2016).Dry matter accumulation is sum of the metabolism process in the plant and is largely related to yield initially. Higher dry matter production was due to increase in plant height and uptake of nutrients through adequate irrigation supply. The total dry matter production of I_4(1.0 IW/CPE ratio) 944.25g which was statistically at parI_5(1.2 IW/CPE ratio) 929.25 g and significant over with I_2(0.6 IW/CPE ratio) 870.40g, I_3 (0.8 IW/CPE Ratio) 915.00 g and I_1 (at CRI stage) 581.25 g which resulted in the lowest dry matter accumulation. The finding were in case close conformity with those of by Deo *et.al*.(2017), Jat*et. al*. (2015), Dangar*et. al.*(2017), Chouhan *et. al*. (2017) and Kumar *et. al*. (2018).

Effect on yield attributing parameters

The yields attributes parameters were significantly influenced by the different moisture regimes presented in Table 3.The yield attributes character like effective shoots m^{2}was under recorded 398m^{-2}with moisture regimeI_4 (1.0 IW/CPE Ratio) which was statistically at parI_5(1.2 IW/CPE ratio) 385m^{-2}significant over with I_1 (at CRI stage) 292.75 m^{-2} I_2 (0.6 IW/CPE ratio) 351.75m^{-2} and I_3 (0.8 IW/CPE Ratio)374.25 m^{-2}. The 1000 grain wt.and harvest index was under recorded 43.22 g and 42.90% with moisture regime I_4 (1.0 IW/CPE Ratio) which was statistically at par I_5

(1.2 IW/CPE ratio) 42.75 g & 42.60% , I_3 (0.8 IW/CPE Ratio) 42.50 g & 42.07% and I_2 (0.6 IW/CPE ratio) 42.00 & 42.04% and significant over with I_1 (at CRI stage) 36.00 g & 38.48%, .It was due to a timely and adequate supply of water at the crop growth and development stages, and this did interfere with crop growth, and profuse tillring continued at an increasing rate at harvest. A similar result has also been reported by Deo *et. al*. (2017),Dangar *et. al*. (2017) and Kumar *et. al*. (2018).

Grain, Straw and Biological yield

The grain, straw and biological yields were significantly influenced by the different moisture regimes presented in Table 4. The highest grain, straw and biological yield (42.67, 56.75 and 99.42 qha^{-1}) were recorded with the levels of irrigation I_4 (1.0 IW/CPE ratio), which was statistically at par with I_5:1.2 IW/CPE (40.87, 55.06 except biological yield q ha^{-1}); however, it was significantly superior over I_1 at CRI stage (22.37, 35.75 and 58.12 q ha^{-1}), I_2 0.6 IW/CPE ratio(34.37, 47.37 & 81.74 q ha^{-1}) and I_3 0.8 IW/CPE Ratio (38.50, 53.00 & 91.50 q ha^{-1}). Considering the progress of yield in percentage(%) higher over the application of irrigation at CRI stage. It was due to timely and adequate supply of water at the crop growth and development stages and this did interfere with crop growth and profuse tillering continued with increasing rate at harvest. Similar result has also been reported by Dangar *et al*. (2017) and Kumar *et al*. (2018).

Table 3: Effect of moisture regimes on the growth attributes and yield attributes of the wheatcrop.

Treatments	Plant height (cm)				Dry matter accumulation (g m^{-2})				Effective of shoots m^{-2}	1000 grains (g)	Harvest Index
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At harvest			
I_1	18.16	35.77	64.12	64.50	68.10	173.13	409.00	581.25	292.75	36.00	38.48
I_2	18.46	39.30	78.99	80.70	67.97	227.17	632.07	870.40	351.75	42.00	42.04
I_3	18.28	41.40	82.60	83.75	66.35	240.91	704.74	915.00	374.25	42.50	42.07
I_4	18.41	46.20	87.95	89.50	66.95	285.68	743.50	944.25	398.00	43.22	42.90
I_5	18.08	43.70	85.07	86.90	68.82	268.30	722.69	959.25	385.00	42.75	42.60
SEm±	0.31	1.02	1.48	1.69	0.63	12.58	11.29	24.64	5.79	0.35	0.32
C.D. P=0.05	NS	3.15	4.57	5.19	NS	38.77	34.78	75.92	17.85	1.40	0.97

Table 4: Effect of moisture regimes on the yields after harvest of the wheat crop.

Treatments	Grain yield(q ha^{-1})	Straw yield (q ha^{-1})	Biological yield(q ha^{-1})
I_1	22.37	35.75	58.12
I_2	34.37	47.37	81.74
I_3	38.50	53.00	91.50
I_4	42.67	56.75	99.42
I_5	40.87	55.06	95.93
SEm±	0.92	0.99	0.52
C.D. P=0.05	2.84	3.06	1.59

Soil Properties

Bulk Density

The Soil Bulk density as affected by different moisture regimes are presented in Table 5. It revealed that the different moisture regimes could not significantly influence the soil Bulk density. However, nominal soil bulk density buildupwere observed at harvest of the crop. The range in soil bulk density were 1.36 (0-20 cm) to 1.43 (40-60 cm)dSm^2respectively. The higher buildup in bulk density was recorded under moisture regime 1.2 IW/CPE (I_5) applied as seven irrigations and the minimum was recorded under moisture regime at CRI stage (I_1), where applied only one irrigation during entire growth period.These findings are supported by Bhattacharyay*et. al*. (2008), Adejumobi*et. al.* (2014) and Yassen *et. al*. (2014).

Soil pH, EC & O C

The Soil pH, EC and organic carbon as affected by different moisture regimes are presented in Table 6. It revealed that the different moisture regimes could not significantly influence the soil pH, Electrical Conductivity an Organic Carbon. However, nominal reduction in soil pH, EC and buildup in organic carbon were observed at harvest of the crop. The range in soil pH and EC and organic carbon were 8.17 to 8.13, 0.20 to 0.29 and 4.1 to 4.8 g kg^{-1} respectively. The higher reduction in pH, EC and buildup in organic carbon was recorded under moisture regime 1.2 IW/CPE (I_5) applied as seven irrigations and minimum was recorded under moisture regime at CRI stage (I_1) where applied only one irrigation during entire growth period. These finding are supported by Bhattacharyay*et al*. (2008), Adejumobi*et al.* (2014) and Yassen *et al*. (2014).

Table 5. Bulk density of before and after harvest at wheat crop as influence by different moisture regimes.

Treatments	**Before sowing**			**After harvest**		
Depth (cm)	0-20 (cm)	20-40 (cm)	40-60 (cm)	0-20 (cm)	20-40 (cm)	40-60 (cm)
I_1	1.37	1.39	1.40	1.36	1.38	1.39
I_2	1.36	1.38	1.39	1.35	1.37	1.38
I_3	1.38	1.40	1.41	1.36	1.39	1.40
I_4	1.39	1.41	1.42	1.37	1.40	1.40
I_5	1.40	1.42	1.44	1.37	1.40	1.43
SEm±	0.02	0.02	0.02	0.02	0.02	0.02
CD at 5%	NS	NS	NS	NS	NS	NS

Table 6: Effect of soil moisture regimes on thepH, EC and organic carbon (O.C.) of soil before and after harvest of wheat crop.

Treatment	**Before sowing**			**After harvest**		
	pH	**EC (dSm^{-1})**	**O.C ($g\ kg^{-1}$)**	**pH**	**EC(dSm^{1})**	**O.C ($g\ kg^{-1}$)**
I_1	8.18	0.30	4.0	8.17	0.29	4.1
I_2	8.19	0.31	4.1	8.16	0.27	4.3
I_3	8.20	0.29	4.2	8.16	0.24	4.4
I_4	8.21	0.32	4.4	8.15	0.26	4.7
I_5	8.22	0.28	4.3	8.13	0.20	4.8
SEm±	0.13	0.01	0.01	0.08	0.01	0.02
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Conclusion

From the results of one year experimentation, it can be concluded that theWheat variety (PBW-154) for whichirrigation scheduling performed at treatment of I_4IW/CPE ratio 1.0 resulted in the highest growth attributes, yield attributes, yield and soil qualityof wheat crop.

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