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Original Research Article

Effect of Irrigation Management (IW/CPE Ratio & Critical Growth Stages) on Yield and Quality of Wheat (*Triticum aestivum* L.)

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A B S T R A C T

An experiment was conducted during *rabi* season of 2017-18 at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India, situated at 260.47^0 North latitude, 80.120^0 East longitude at an altitude of about 113.0 meter from mean sea level. Irrigation management on the basis of soil moisture regimes and critical growth stages was used as strategy in this quest to harness water use efficiency, water productivity and yield of wheat crop. The experiment was comprised of eight (8) treatments of moisture regimes viz. (i) 0.8 IW/CPE ratio (ii) 1.0 IW/CPE ratio (iii) 1.2 IW/CPE ratio (iv) two irrigations each at CRI & LJS (v) three irrigations each at CRI, LJS & MKS (vi) four irrigations each at CRI, TRS, LJS, & FRS (vii) five irrigations each at CRI, TRS, LJS, FRS & MKS (viii) six irrigations each at CRI, TRS, LJS, FRS, MKS & DS. The experiment was laid out in Randomized Block Design (RBD) with four replications. The wheat variety PBW-502 was used for sowing. The crop was fertilized with recommended dose of NPK and other cultural operations were performed accordingly. The result revealed that irrigations provided in the crop either at soil moisture regimes (IW/CPE ratio) or at critical growth stages of crop did not recognized any significant difference. The treatment provided six irrigations either at 1.0 IW/CPE ratio or at critical growth stages (CRI, TRS, LJS, FRS, MKS & DS) recorded maximum yield potential (45.40 to 46.00 q ha^{-1} grain yield and 65.83 to 66.29 q ha^{-1} straw yield), enhanced nutrient uptake (Nitrogen 72.68 kg ha^{-1}, Phosphorus 18.03 kg ha^{-1} and Potassium 16.97 kg ha^{-1}) in grain of wheat. Five irrigations were applied at CRI, TRS, LJS, FRS & MKS recorded significantly at par.

Keywords

Critical growth stage, Irrigation management, Moisture regimes, Nutrient uptake, Wheat, Yield

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important staple food in both developing and developed nations across the globe. It is an excellent health-building food containing approximately, 78% carbohydrates, 12% protein, 2% fat and minerals each and considerable amount of vitamins (Kumar *et al.*, 2011). It is cultivated under diverse growing conditions of soil and climate. Wheat ranks first in the world among the cereals both in respect of area (225.07 m ha) and production (736.98 mt) (USDA, 2017). In India, total area under wheat is

29.57 m ha, with the production of 99.70 mt and productivity of 3.37 t ha^{-1}, during the year 2017-18 (DAC&FW, India, 2018-19). In India, wheat crop is grown mainly in the Uttar Pradesh being the top most contributors with a total production of 30.06 mt and average productivity of 2.69 t ha^{-1}. The average productivity of Uttar Pradesh is low in comparison of Punjab (4.53 t ha^{-1}) and Haryana (4.07 t ha^{-1}). Water is an important factor for realizing high wheat productivity, however, it is becoming the most limiting factor for crop production in most of the north western parts of India (Hira, 2009). As irrigation water is scarce and costly input, its economic and scientific utilization and optimal allocation among the different crops grown becomes quite imperative. Wheat is highly sensitive to water stress during the crown root initiation (CRI) and flowering but excess irrigation may lead to decrease in reproductive period which ultimately decrease the yield. Thus, time and length of irrigation interval with the stages of crop growth might bring about a reduction in the number of irrigations and results in an economic crop yield. Our current situation emphasizes the need for use of scientifically sound method for scheduling of irrigation to field crops. Irrigation in wheat can be scheduled mainly by three approaches viz., soil moisture depletion approach, climatological approach (IW/CPE ratio) and critical growth stages. Among them the climatological approach is very scientific and useful being recognized widely among the scientist and research workers throughout the word. It is well known fact that evapo-transpiration by a full crop cover is closely associated with evaporation from an open pan (Dastane, 1967). From above point in view, the present study was under taken to assess suitable moisture regime on growth and to maximize the production and quality of wheat.

Materials and Methods

A Field experiment was conducted during *rabi* season of 2017-18 at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India. The experimental site belongs to sub humid and sub tropical climate of indo-gangetic plains (IGP) having alluvial calcareous soil and located at 260.47^0 North latitude, 80.120^0 East longitude at an altitude of about 113.0 meter from mean sea level. The field experiment was comprised of eight (8) treatments of moisture regimes viz. (i) 0.8 IW/CPE ratio (ii) 1.0 IW/CPE ratio (iii) 1.2 IW/CPE ratio (iv) two irrigations each at CRI & LJS (v) three irrigations each at CRI, LJS & MKS (vi) four irrigations each at CRI, TRS, LJS, & FRS (vii) five irrigations each at CRI, TRS, LJS, FRS & MKS (viii) six irrigations each at CRI, TRS, LJS, FRS, MKS & DS were laid out in a Randomized Block Design (RBD) and replicated four times. The soil of experimental field was silt loam in texture (25.53% sand, 52.22% silt and 22.25% clay) with pH of 8.23. The soil was moderately fertile being medium in organic carbon (0.42%), low in nitrogen (165.53 kg ha^{-1}), medium in phosphorus (17.78 kg ha^{-1}) and high in potassium (265.27 kg ha^{-1}). The wheat variety PBW-502 was sown timely on 15 November, 2017. The other cultural practices were performed as per standard recommendations. The mean weekly meteorological weather observations recorded during the crop period characterized with average maximum temperature (39.2^0C), average minimum temperature (4.7^0C), average maximum relative humidity (86.8%), and average minimum relative humidity (41.9%) with winter rainfall recorded negligible (1.0 mm) during 22- 28 January 2018. The crop experienced an average maximum wind speed (7.3 km hr^{-1}) and average minimum wind speed (1.0 km hr^{-1})

with average evaporation rate 5.34 mm week^{-1} during the crop growing season. Crop responses to the treatments were measured in terms of predetermined quantitative and qualitative indices. The observations recorded were subjected to statistical analysis. Valid comparisons between various treatments were drawn using the respective critical difference values.

Results and Discussions

Growth and yield attributing characteristics

Irrigation water management under different treatments either on the basis of moisture regime (IW/CPE ratio) or critical growth stages exhibited significant response in growth characters and yield attributes except test weight. The irrigation management on 1.0 IW/CPE ratio recorded maximum plant height (92.0 cm), LAI (5.78), number of spike (405 m^{-2}), length of spike (9.5 cm), number of grain spike^{-1} (44.8) and test weight (41.0 g) in wheat, while minimum plant height (71.0 cm), LAI (4.83), number of spike (227 m^{-2}), length of spike (7.10 cm), number of grain spike^{-1} (34.0) and test weight (37.5 g) was recorded under only two irrigations at CRI and LJS. The moisture availability at critical growth stages provides proper balance in nutrient absorption from soil and movement towards different parts of plant, accelerate metabolic activities and production of food material, which ultimately increase growth of plant. Similar research findings were reported by Prashar and Thaman (2005), Idnani and Kumar (2012) (Table 1).

Yield

Irrigation management on 1.0 IW/CPE ratio moisture regime was recorded maximum grain yield (46.00 q ha^{-1}) and straw yield (66.29 q ha^{-1}). This treatment was found significantly at par with 1.2 IW/CPE ratio, five irrigations at CRI, TRS, LJS, FRS & MKS and six irrigations at CRI, TRS, LJS, FRS, MKS & DS treatments. Irrigation provided on the basis of 0.8 IW/CPE ratio (four irrigations) moisture regime as well as four irrigations at critical growth stages also found significantly at par but significantly inferior with 1.0 IW/CPE ratio. The minimum grain yield (27.0 q ha^{-1}) and straw yield (40.50 q ha^{-1}) were recorded under only two irrigations treatment. The improvement in yield may be due to better growth and yield attributing characters recorded when irrigations increased up to six irrigations either at 1.0 IW/CPE ratio moisture regime or at critical growth stages. This envisages that improvement in yield is the resultant of better growth which is correlated with proper moisture availability to the crop plant at proper time with appropriate quantity. The data on harvest index was found non-significant.The findings of Behera and Sharma (2014) found in similar trend.

NPK content and uptake

The NPK content in grain and straw of wheat though increased with increasing number of irrigations at different growth stages but found non-significant while, NPK uptake by grain and straw were recorded significant difference. The maximum uptake of nitrogen by grain (72.68 kg ha^{-1}) and straw (33.80 kg ha^{-1}) were recorded under 1.0 IW/CPE ratio moisture regime followed by six irrigations at critical growth stages, 1.2 IW/CPE ratio and five irrigations at critical growth stages. The minimum nitrogen uptake by grain (39.42 kg ha^{-1}) and straw (19.03 kg ha^{-1}) were recorded under only two irrigations at CRI & LJS. Almost similar trend in phosphorus and potassium uptake by grain and straw was recorded (Table 2).

Table.1 Effect of irrigation management on growth characters, yield attributes and yield of wheat

Treatments	Plant height (cm)	LAI (at 90 DAS)	No. of spike (m^{-2})	Length of spike (cm)	No. of grains $spike^{-1}$	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
0.8 IW/CPE ratio moisture regime	83.61	4.49	371.5	8.60	40.30	39.00	41.80	60.55	40.84
1.0 IW/CPE ratio moisture regime	92.00	5.78	405.0	9.50	44.80	41.00	46.00	66.29	40.96
1.2 IW/CPE ratio moisture regime	91.60	5.73	396.0	9.15	43.60	40.25	45.20	65.58	40.80
Two Irrigations at CRI & LJS	71.00	4.83	227.0	7.10	34.00	37.5	27.00	40.50	40.00
Three Irrigations at CRI, LJS & MKS	73.20	5.05	321.0	7.50	35.00	38.5	35.00	52.15	40.16
Four Irrigations at CRI, TRS, LJS & FRS	83.20	4.38	370.1	7.90	36.90	38.75	40.40	60.10	40.20
Five Irrigations at CRI, TRS, LJS, FRS & MKS	90.80	5.61	395.0	9.05	42.90	39.75	44.00	63.80	40.81
Six Irrigations at CRI, TRS, LJS, FRS, MKS & DS	91.60	5.74	400.0	9.40	43.80	40.75	45.40	65.83	40.81
SEM $\pm$	2.21	0.12	10.78	0.26	1.15	1.46	1.25	1.86	1.10
CD at 5%	6.49	0.35	31.69	0.75	3.37	**NS**	3.69	5.46	NS

IW- Irrigation water (Depth of water); CPE- Cumulative pan evaporation; LAI- Leaf area index; CRI- Crown root initiation; TRS-Tillering stage; LJS- Late jointing stage; FRS- Flowering stage; MKS- Milking stage; DS- Dough stages.

Table.2 Effect of irrigation management on nutrient content and nutrient uptake (NPK) by grain and straw of wheat

Treatments	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)		Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
0.8 IW/CPE ratio moisture regime	1.55	0.49	0.378	0.102	0.352	1.39	64.79	29.66	94.45	15.80	6.17	21.97	14.71	84.16	98.87
1.0 IW/CPE ratio moisture regime	1.58	0.51	0.392	0.107	0.369	1.45	72.68	33.80	106.48	18.03	7.09	25.12	16.97	96.12	113.09
1.2 IW/CPE ratio moisture regime	1.58	0.50	0.383	0.105	0.362	1.43	71.41	32.79	104.20	17.31	6.88	24.19	16.36	93.77	110.13
Two Irrigations at CRI & LJS	1.46	0.47	0.325	0.089	0.335	1.32	39.42	19.03	58.45	8.77	3.60	12.37	9.04	53.46	62.50
Three Irrigations at CRI, LJS & MKS	1.48	0.47	0.345	0.093	0.357	1.34	51.80	24.51	76.31	12.07	4.84	16.91	12.49	69.88	82.37
Four Irrigations at CRI, TRS, LJS & FRS	1.54	0.49	0.374	0.101	0.341	1.41	62.21	29.44	91.65	15.10	6.07	21.17	13.77	84.74	98.51
Five Irrigations at CRI, TRS, LJS, FRS & MKS	1.56	0.50	0.388	0.103	0.358	1.41	68.64	31.90	100.54	17.07	6.57	23.64	15.75	89.95	105.70
Six Irrigations at CRI, TRS, LJS, FRS, MKS & DS	1.58	0.50	0.391	0.106	0.368	1.44	71.73	32.91	104.64	17.75	6.97	24.72	16.70	94.79	111.49
SEM $_{-}^{+}$	-	-	-	-	-	-	1.94	0.86	2.46	0.57	0.22	0.69	0.43	2.51	2.94
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	5.70	2.52	7.24	1.68	0.66	2.02	1.27	7.37	8.64

IW- Irrigation water (Depth of water); CPE- Cumulative pan evaporation; CRI- Crown root initiation; TRS- Tillering stage; LJS- Late jointing stage; FRS- Flowering stage; MKS- Milking stage; DS- Dough stages.

The data on nutrient status (content & uptake) of wheat exhibited closed relations with better growth, yield attributes and yield of wheat as well as irrigation management either through moisture regimes (IW/CPE ratio) or critical growth stages. Similar findings were reported by Pandey *et al* (2017).

In conclusion, the perusal data on quantitative and qualitative characters of wheat revealed that irrigation management either through moisture regimes (IW/CPE ratio) or at critical growth stages showed significant impact on wheat crop. Irrigations increased up to six irrigations on the basis of moisture regimes or at critical growth stages recorded significantly maximum improvement in quantitative characters (growth, yield attributes and yield) and qualitative characters (NPK content & uptake) in wheat crop. The moisture regime 1.0 IW/CPE ratio was found most suitable for improvement in growth, yield as well as quality (NPK content & uptake) of wheat.

References

Anonymous (2017). United States Department of Agriculture (USDA). *World Agriculture Production*.1- 30. Anonymous (2018-19). Department of Agriculture Cooperation & Farmers Welfare (DAC&FW), India. *Annual report*, 4.

Behera, U. K. and Sharma, A. R. (2014). Productivity and water use efficiency of wheat (*Triticum aestivum* L.) under different resource conservation techniques and irrigation regimes. *Cereal Research Communications*, 42 (3):439-49.

Dastane, N.G. (1967). A Practical manual for water use research in agriculture. *Navbharat Prakashan*, Poona, 120, 2nd Edition.

Hira, G.S. (2009). Water management in northern states and the food security India. *Journal of Crop Improvement* 23: 136–157.

Idnani, L. K. and Kumar, A. (2012). Relative efficiency of different irrigation schedules for conventional, ridge and raised bed seeding of wheat (*Triticum aestivum* L.). *Indian Journal of Agronomy*, 57 (2): 148-51. Kumar, P., Yadav, R.K., Gollen, B., Kumar, S., Verma, R.K. and Yadav, S. (2011). Nutritional contents and medical properties of wheat. A review; *Life Sciences and Medicinal Research*, 47 (2): 145-149.

Prashar, A. and Thaman, S. (2005). Studies on irrigation requirements of late sown wheat (*Triticum aestivum* L.). *Progressive Agriculture*, 5 (1/2): 10-12

Pandey, N., Kumar, S., Raghuvansi, N., and Singh, R.A. (2017). Effect of sulphur nutrient and moisture regimes on economics of wheat (*Triticum aestivum* L.) varieties. *Journal of Pharmacognosy and Phytochemistry*, 6 (6): 2294- 2297.