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Effect of irrigation scheduling on growth and yield of late sown wheat (*Triticum aestivum* L.)

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Abstract

A field experiment entitled Effect of irrigation scheduling on growth and yield of late sown wheat (*Triticum aestivum* L.)'' was conducted during *Rabi* season of 2020-21 at Agricultural Research Farm of Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur Nagar, U.P. The soil of experimental site was clay loam in texture, low in organic carbon (0.40%), available nitrogen (166.53 kg ha^{-1}) and medium in available phosphorus (18.73 kg ha^{-1}) and potash (266.27 kg ha^{-1}) with slightly alkaline in reaction (8.2 p^{H}). The conducted field experiment was comprised 9 treatments of irrigation scheduling *viz.* 0.8 IW/CPE ratio (I_1), 1.0 IW/CPE ratio (I_2), One irrigation at CRI stage (I_3), Two irrigations at CRI & Late jointing stage (I_4), Two irrigations at CRI & Tillering stage (I_5), Three irrigations at CRI, Late jointing & Milking stage (I_6), Three irrigations at CRI, Late jointing & Flowering stage (I_7), Four irrigations at CRI, Maximum tillering, Late jointing & Milking stage (I_8), Five irrigations at CRI, Maximum tillering, Late jointing, Flowering & Milking stage (I_9). The experiment was framed in randomized block design with three replications. All plots of experiment was equally fertilized with recommended dose of fertilizers (150:60:40 kg ha^{-1} NPK). The source of nitrogen, phosphorus and potassium were urea, di-ammonium phosphate and murate of potash respectively. The result of conducted field experiment revealed that among all the irrigation schedules 1.0 IW/CPE ratio found significantly superior in all terms of plant characters *viz.* growth, yield attributing and yield characters. The significantly maximum grain yield 2450 kg ha^{-1} and straw yield 2842 kg ha^{-1} were recorded under the irrigation schedule of 1.0 IW/CPE ratio (I_2). The maximum gross monetary return (Rs.66,248 ha^{-1}) and net monetary return (Rs.34748 ha^{-1}) and benefit cost ratio (1.10:1) were recorded under the irrigation schedule of 1.0 IW/CPE ratio (I_2).

Keywords: Irrigation scheduling, IW/CPE ratio, yield, wheat

Introduction

Wheat (*Triticum aestivum* L.) is the most important crop among all cereals used as a food grain in the world. It provides nearly 55% of the carbohydrate and 20% of calories which is consumed by two billion people (36% of the world population) as staple food. Globally, wheat covers an area of 220.4 million ha with production of 766.4 million tonnes (FAO, 2019). In India, wheat is cultivated in almost all part of the country and occupied 30.22 million ha (14% of global area) with the production of 99.71 million tonnes, (13.64% of world production) in 2018-19 (USDA/FAS, 2019). Among wheat cultivated states, Uttar Pradesh rank first with respect to area (9.65 million ha) and production (26.87 Mt) but the productivity is much lower (2786 kg ha^{-1}) than Punjab (4491 kg ha^{-1}) and Haryana (4574 kg ha^{-1}) (Anonymous, 2019) [1]. The demand of wheat in the country by this year (2020) has been anticipated to be between 105-109 million tonnes as against 101.20 million tonnes production of present day. There are many factors responsible for low yield of wheat crop but inadequate irrigation and poor crop nutrition are the most important. Water is essential at every developmental phase starting from seed germination to plant maturation for harvesting the maximum yield of wheat. There is a positive correlation between grain yield and irrigation frequencies. Irrigation missing at some critical growth stage sometime drastically reduced grain yield due to lower test weight. Efficient water management, being one of the good agronomic management practices, it not only leads to improve crop productivity but also minimize susceptibility from disease and insect pest under favourable environment for flourishing these biotic stress. Water is a limited resource which availability is declining with each passing year. In respect of per capita water availability in 2001 was 1820 m^3 per year and it is projected that by 2025, the per capita water availability will further reduce significantly to 1341 m^3 and to 1140 m^3 in 2050 (Bhatacharya *et al.*, 2015) [2]. Going by Falkenmark criteria, most of the Indian states will have touched the water stress condition by 2025 and almost water scarcity condition by 2050. Water scarcity is a global concern in context of increasing population and increasing competitive demand from agriculture, industry and urban in habitants. The problem is further aggravated by fast changing climate. It has been predicted that 2/3rd of the world will experience water scarcity by the year 2025. India has already entered into the shadow of the zone of physical and economic water scarcity. Irrigation has been revealed to increase crop yield in arid and semi-arid climates. Water stress interrupts crop phenology, leaf area development and results in low yield. The rate and duration of crop growth, consequently, needs to be synchronized to water availability to achieve high grain Introduction yield. It has been considered that soil nutrition can be a constraint under different soil moisture conditions.

Materials and Methods

A field experiment was conducted during *Rabi* season of 2020-21 at the Agricultural Research Farm of Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur Nagar, U.P. The conducted field experiment was comprised 9 treatments of irrigation scheduling *viz.* 0.8 IW/CPE ratio (I_1), 1.0 IW/CPE ratio (I_2), One irrigation at CRI stage (I_3), Two irrigations at CRI & Late jointing stage (I_4), Two irrigations at CRI & Tillering stage (I_5), Three irrigations at CRI, Late jointing & Milking stage (I_6), Three irrigations at CRI, Late jointing & Flowering stage (I_7), Four irrigations at CRI, Maximum tillering, Late jointing & Milking stage (I_8), Five irrigations at CRI, Maximum tillering, Late jointing, Flowering & Milking stage (I_9). The experiment was framed in randomized block design with three replications. All plots of experiment was equally fertilized with recommended dose of fertilizers (150:60:40 kg ha^{-1} NPK). The source of nitrogen, phosphorus and potassium were urea, di-ammonium phosphate and murate of potash respectively. The soil of the experimental site was clay loamy in texture, low in organic carbon (0.40%), available nitrogen (166.53 kg ha^{-1}) and medium in available phosphorus (18.73 kg ha^{-1}) and potash (266.27 kg ha^{-1}) with slightly alkaline in reaction (8.2 p^H). The wheat variety 'Halna (K-7903)' was sown in line at 20 cm row to row distance and seed rate 120.0 kg ha^{-1} was used for sowing of experimental crop and before sowing seed was treated with vitavax @ 2.5 g kg^{-1} of seed. Experimental crop was irrigated as per treatments.

Results and Discussion

Growth & yield attributing parameters

All growth and yield attributing parameters of experimental crop of wheat were influenced significantly due to irrigation scheduling except test weight and presented in Table 1. Among the nine treatments of irrigation scheduling, 1.0 IW/CPE ratio(T_2) was found significantly superior for increasing growth (plant height and number of tillers) and yield attributing parameters (length of spike, number of grains $spike^{-1}$ and test weight). Significantly maximum growth parameters *viz.* plant height (92.00 cm), and number of tillers (379.40 m^{-2}) and similarly yield attributing parameters *viz.* length of spike (9.90 cm), number of grains $spike^{-1}$ (47.60) and test weight (40.80 g) were recorded at irrigation schedule of 1.0 IW/CPE ratio (I_2) as compared to rest of treatments. While, all growth and yield attributing characters were recorded minimum at irrigation schedule of one irrigation at CRI stage (T_3). Similar finding also reported by Shorna *et al.*, (2020).

Table 1: Effect of irrigation scheduling on growth and yield attributes of late sown wheat

Symbols	Treatments	Plant height (cm)	Number of tillers (m^{-2})	Length of spike (cm)	Number of grains $spike^{-1}$	Test weight (g)
I_1	0.8 IW/CPE ratio	83.610	374.600	9.300	44.500	40.500
I_2	1.0 IW/CPE ratio	92.000	379.400	9.900	47.600	40.800
I_3	One irrigation at CRI stage	71.000	347.200	7.200	38.800	38.500
I_4	Two irrigations at CRI & Late jointing stage	73.500	364.700	8.900	41.200	39.500
I_5	Two irrigations at CRI & Tillering stage	73.200	362.500	8.600	40.500	39.200
I_6	Three irrigations at CRI, Late jointing & Milking stage	85.200	371.300	9.020	42.300	39.800
I_7	Three irrigations at CRI, Late jointing & Flowering stage	84.800	368.600	9.000	41.600	39.700
I_8	Four irrigations at CRI, Maximum tillering, Late jointing & Milking stage	90.600	373.400	9.200	43.800	40.200
I_9	Five irrigations at CRI, Maximum tillering, Late jointing, Flowering & Milking stage	91.400	375.500	9.500	45.800	40.600
	S.E(d)$^{+}$-	1.82	6.14	0.19	0.57	0.70
	CD at 5%	3.90	13.14	0.41	1.23	NS

Yield parameters

All yield parameters of experimental crop of wheat were influenced significantly due to irrigation scheduling except harvest index and presented in Table 2. Significantly maximum grain, straw and biological yield and harvest index 2450 kg ha^{-1}, 2842 kg $ha^{-1}$and 5292 kg ha^{-1} and 46.29% respectively were recorded at irrigation schedule at 1.0 IW/CPE ratio (I_2) while, 1850 kg ha^{-1}, 2220 kg ha^{-1} and 4070 kg $ha^{-1}$and 45.45% grain, straw and biological yield and harvest index respectively were recorded minimum at one irrigation at CRI stage (T_3). Similar research finding were also reported by Khatri *et al.* (2002) [4], Nadeem *et al.* (2007) [5] and Behera and Sharma (2014) [3].

Table 2: Effect of irrigation scheduling on yield of late sown wheat

Symbols	Treatments	Grain Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Biological Yield (kg ha^{-1})	Harvest Index (%)
I_1	0.8 IW/CPE ratio	2190	2562	4752	46.08
I_2	1.0 IW/CPE ratio	2450	2842	5292	46.29
I_3	One irrigation at CRI stage	1850	2220	4070	45.45
I_4	Two irrigations at CRI & Late jointing stage	1980	2356	4336	45.76
I_5	Two irrigations at CRI & Tillering stage	1960	2332	4292	45.66
I_6	Three irrigations at CRI, Late jointing & Milking stage	2050	2419	4469	45.87
I_7	Three irrigations at CRI, Late jointing & Flowering stage	2030	2395	4425	45.87
I_8	Four irrigations at CRI, Maximum tillering, Late jointing & Milking stage	2150	2515	4665	46.08
I_9	Five irrigations at CRI, Maximum tillering, Late jointing, Flowering & Milking stage	2270	2633	4903	46.29
	S.E(d)$^{+}_{-}$	0.41	0.62	0.77	1.08
	CD at 5%	0.89	1.33	1.65	NS

Economics

The economics of treatments was affected with numbers of irrigations given under different irrigation schedules which increased cost of treatments accordingly and presented in Table 3. The maximum grass return (Rs.66248.0 ha^{-1}) and net return (Rs. 34748.0 ha^{-1}) were calculated under the treatment of (1_2) with 1.0 IW/CPE ratio. The data on B:C ratio revealed that irrigation schedule at 1.0 IW/CPE ratio (1_2) has been noticed more remunerative in terms of benefits of Rs. 1.10 by investing Rs. 1.00 compared to rest of treatments similarly reported by Pandey *et al.* (2017) [6].

Table 3: Effect of irrigation scheduling on economics of late sown wheat

Symbols	Treatments	Gross Return (Rs. ha-1)	Net Return (Rs. ha-1)	B:C ratio
I1	0.8 IW/CPE ratio	59358.0	29858	1.01:1
I2	1.0 IW/CPE ratio	66248.0	34748	1.10:1
I3	One irrigation at CRI stage	50505.0	24005	0.90:1
I4	Two irrigations at CRI & Late jointing stage	53924.0	26424	0.96:1
I5	Two irrigations at CRI & Tillering stage	53378.0	25878	0.94:1
I6	Three irrigations at CRI, Late jointing & Milking stage	55698.5	27198.5	0.95:1
I7	Three irrigations at CRI, Late jointing & Flowering stage	55660.0	27160	0.95:1
I8	Four irrigations at CRI, Maximum tillering, Late jointing & Milking stage	58272.5	28772.5	0.97:1
I9	Five irrigations at CRI, Maximum tillering, Late jointing, Flowering & Milking stage	61379.5	30879.5	1.01:1

Conclusion

Based on above findings of results it is concluded that maximum yield of wheat obtained when crop irrigated at 1.0 IW/CPE ratio (T_2)

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