Impacts of different irrigation schedules and nutrients management practices on economics of wheat

ABSTRACT

A field investigation was conducted during two kharif seasons of 2020-21 and 2021-2022 at Agriculture Research Farm, Rabindranath Tagore University, Raisen, Madhya Pradesh, India, to evaluate the effect of different irrigation scheduling and nutrient management practices on yield and economics of wheat crop in split-plot design with three replications. The irrigation level N_0 - No irrigation, N_1- One Irrigation at CRI (crown root inition) stage, N_2- One Irrigation at CRI & one irrigation before flowering were arranged in main plots whereas nutrient management treatments of N_0 – Control, N_1-100% RDF + FYM @ 2.5 t/ha. + Azotobacter, N_2 - 100% RDF + Vermicompost @ 1.5 t/ha + PSB, N_3 - 50% RDF+ FYM@5.0 t/ha, N_4 -50% RDF+ Vermicompost@2.5 t/ha were used in the sub plots. The results shown that one Irrigation at CRI & one irrigation before flowering along with application of 50% RDF+ FYM@5.0 t/ha found to be best in the terms of grain and straw yield 28.70 and 41.88 q ha^{-1} in 2021 and 29.52 q ha^{-1}, 42.13 q ha^{-1} in 2022. Minimum yield and cost benefit ratio recorded under control plot. The study suggests economically combinations of currently used irrigation scheduling and nutrient management practices that may help farmer to obtaining optimum yield.

Key word: irrigation , nutrient management , yield , wheat

1.INTRODUCTION

"Wheat (*Triticum aestivum* L.) is considered one of the most important cereal not only in India but also in the world. Its importance comes from using its grain as a main food source for human and its straw as feed for livestock. In India it occupies an area of about 30.5 million hectare's (mha) with a production of 98.38 mt. and with national productivity of 3216 kg ha^{-1}. In state of Madhya Pradesh, it occupies in total 10.8 million hectare's area with the production of 30.7 mt and average productivity of 2478 kg ha^{-1}" [3]. "Wheat is highly sensitive to water stress during the CRI and flowering but excess irrigation may lead to heavy vegetative growth and shortening of reproductive period and ultimately decrease the yield. Thus, timing the 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. In principle, irrigation should take place while the soil water potential is still high enough to enable soil supply water fast enough to meet the local atmospheric demands without placing the plants under stress that would reduce yield and quality of crop. Wheat grows mainly during dry seasons, where irrigation is necessary because precipitation in the growing season is far less than the crop water requirement. However, water resources are usually limited. Hence, irrigation scheduling is used to allocate irrigation water rationally in crop growing stages in order to maximize crop yield, water productivity and profit under the limited conditions" [15]. "About 30% of wheat production is lost due to lack of irrigation water and 40% yield loss due to lack of nutrient supply and metal contents in soil as

well as their availabilities, pollution status of other environmental parameters in the country" [16,10]. "Proper time of irrigation especially in crown root initiation stage is very important for successful growth of wheat and it has a great impact on higher grain yield" [8]. "Organic manure with inorganic fertilizers may serve as a chelating and complexing agent which prevents the nutrients from precipitation, fixation, oxidation and leaching. Application of organic manures may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers" [13]. "The role of organic matter is well established in governing the nutrient fluxes, microbial biomass and improvement in soil physical chemical and biological properties" [11]. "Maintaining soil health is of utmost important to ensure food and nutritional security of the country" [9]. "For most efficient use of fertilizers, all nutrients must be used in balance proportion. However, there is a lack of information regarding the performance of FYM and nitrogen in relation to productivity and fertility of soil under wheat cultivation" [5]. To bridge the gaps between the targeted and actual yields of wheat, scientific understanding of these responses across the locations is very much required. Therefore, keeping the above facts in the view, the experiment was conducted to see the performance of wheat varieties under various nutrient management and irrigation schedules.

2. MATERIALS AND METHOD

A field experiment was carried out during the Kharif season of 2020- 2021 and 2021-22 at the Agriculture Research Center, Rabindranath Tagore University, Raisen, Madhya Pradesh to study the relative performance of effect of irrigation level and nutrient management on growth and yield of wheat. The geographical position of experimental filed at 23.134273°N latitude and 77.564305°Elatitude. The total rainfall of 131.30 mm was received during the wheat crop growth period of first (2020-21) year, was higher (46.30 mm) than second (2021-22) year. The weekly mean minimum temperature was ranged from 6.2 to 20.9^0 C with an average of 12.8 ^{0} C in 2020-21, and 7.2 to 23.1^0 C with a range with an average of 13.6 ^{0}Cin 2021-22 during wheat crop season, respectively. The soil characteristics of the region are vertisols of various depth from medium to deep and slightly alkaline in soil reaction and low availability of nutrient status in term of nitrogen and phosphorus. The experiment was laid out in split plot design (SPD) with fifteen treatments combination shown in table-2. The irrigation level N_0 - No irrigation, N_1- One Irrigation at CRI stage, N_2- One Irrigation at CRI & one irrigation before flowering were arranged in main plots whereas other treatments of N_0 – Control, N_1-100% RDF + FYM @ 2.5 t/ha. + Azotobacter, N_2 - 100% RDF + Vermicompost @ 1.5 t/ha + PSB, N_3 - 50% RDF+ FYM@5.0 t/ha, N_4 -50% RDF+ Vermicompost@2.5 t/ha were used in the sub plots. Wheat crop variety for experiment was used of SUPER-252. It was suitable for late sown irrigated conditions. The grain and straw yield was weighted in kilogram for each plot after threshing which was then converted in to q ha^{-1}. The treatment means were compared using least significant differences at 5% level of significance [4].

Table 1: Treatments Details

Main plot treatment : 3 irrigation level	
I_0	No Irrigation.
I_1	One Irrigation CRI stage
I_2	One Irrigation at CRI & one irrigation before flowering
Sub plot treatments : 5 Nutrient management practices	

N_0	Control
N_1	100% RDF + FYM @ 2.5 t/ha. + Azotobacter
N_2	100% RDF + Vermicompost @ 1.5 t/ha + PSB
N_3	50%RDF+ FYM@5.0t/ha.
N_4	50%RDF+ Vermicompost@2.5 t/ha

Table 2: Treatment combinations

Irrigation levels	**Nutrient management practices**				
	N_0	**N_1**	**N_2**	**N_3**	**N_4**
I_0	I_0N_0	I_0N_1	I_0N_2	I_0N_3	I_0N_4
I_1	I_1N_0	I_1N_1	I_1N_2	I_1N_3	I_1N_4
I_2	I_2N_0	I_2N_1	I_2N_2	I_2N_3	I_2N_4

3. RESULTS AND DISCUSSION

3.1 Yield attributes

Perusal of the data (Table-3) showed that, highest effective tillers (131.49 m^{-1} row length), number of spikelet's per ear (28.06), grains ear^{-1} (44.35) and test weight (31.01 g) recorded in I_2 (One Irrigation at CRI & one irrigation before flowering) followed by I_1 (One Irrigation at CRI stage.) and lowest yield attributes was recorded in I_0 (No Irrigation), during both of the year of experiment. Whereas, in case of nutrient management practices, maximum yield attributes were recorded under the treatment (N_3- 50%RDF+ FYM@5.0 t ha^{-1}). The results of the present investigation are also in agreement with the findings of [3,14]. Application of nutrient management practices showed varied significant response to different yield attributes parameters, although mostly controlled by genetic factors. Application of (50%RDF + FYM @ 5.0 t/ha) resulted in enhanced test weight of wheat crop [2].

3.2 Yield (Kg ha^{-1})

It is obvious from the data given in Table-4 clearly shows that among the productivity parameters such as grain yield (28.70 and 29.52 q ha^{-1}), straw yield (41.88 and 42.13 q ha^{-1}), biological yield (70.68 and 71.75 q ha^{-1}) and benefit cost ratio was significantly recorded under the treatment combination of one Irrigation at CRI & one irrigation before flowering along with application of 50% RDF+ FYM@5.0 t/ha during 2020-21 and 2021-22 of the experiment, lowest yield and cost benefit ratio recorded under control plot respectively. Similar findings were reported [10].[6] reported that "irrigation at tillering, stem elongation stage, booting and grain filling stage recorded the higher yield of wheat". Irrigation applied at CRI & one irrigation before flowering height resulting into increased source while application of irrigation at milking might have helped to increase the ratio of bold grain to chaffy grains. This might be helped to

increase in test weight, number of grains per spike and harvest index, thus have boosted the final yield.

Table 3: Effect of irrigation scheduling and nutrient management practices on yield attributes in wheat.

Treatments	Number of Effective tillers per meter row length		Number of spikelets per ear		Number of grains per ear head		Test weight (g)	
Irrigation Scheduling	**2020-21**	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**
I_0	94.33	96.53	19.23	19.74	36.52	39.39	26.40	26.96
I_1	115.18	117.05	25.74	24.88	41.23	41.30	27.20	27.60
I_2	131.49	133.69	28.06	27.65	44.35	45.08	31.01	31.04
SEm±	3.19	4.02	1.04	1.06	1.61	1.19	1.20	0.99
CD (0.05)	9.14	11.5	2.15	2.14	4.62	3.42	2.42	2.82
Nutrient management (N)								
N_0	97.42	100.37	18.46	17.66	33.29	36.33	24.49	25.43
N_1	122.22	121.42	21.73	22.85	40.79	40.16	28.54	29.72
N_2	120.28	122.82	24.58	25.94	39.86	42.23	28.36	28.21
N_3	126.96	132.83	27.81	27.60	43.86	44.23	31.48	31.62
N_4	119.14	121.67	25.81	24.42	38.99	41.52	27.30	27.74
SEm±	3.57	4.49	1.12	1.13	1.81	1.33	1.33	1.10
CD (0.05)	10.21	12.86	2.28	2.23	5.17	3.82	3.82	3.16

I_0-No Irrigation, I_1-One Irrigation CRI stage, I_2 –One Irrigation at CRI & one irrigation before flowering, N_0-Control, N_1-100% RDF + FYM @ 2.5 t/ha. + Azotobacter, N_2-100% RDF + Vermicompost @ 1.5 t/ha + PSB, N_3-50%RDF+ FYM@5.0t/ha., N_4-50%RDF+Vermicompost@2.5 t/ha.

4. ECONOMICS ATTRIBUTES

A perusal of the data presented in Table -5 reveals that cost of cultivation was recorded to be maximum under the treatment I_2 (One Irrigation at CRI & one irrigation before flowering) where a total expenditure of INR 38747.4 and 40284.81 was recorded during both the year, respectively. Under nutrient management practices, maximum cost of cultivation was recorded under the treatment N_3 (50%RDF+ FYM@5.0t/ha) a value of INR 37251.00 and 39125.35 during both the year, respectively. This was followed by treatment N_4 recording a total cost of cultivation of (INR 38368.00 and 41238.29) during both the year, respectively followed by treatments N_2, N_1 and N_o. Highest gross return 95626.93 and 97895.25 per ha was recorded in scheduling of irrigation at CRI and before Flowering (I_2) during both the year, respectively. After I_2, maximum gross return was recorded in I_1. Lowest gross return was recorded under treatment I_0. Similar trend was found in grass return and net return. Maximum B:C ratio (1.47 and 1.43 was recorded under the treatment I_2 (One Irrigation at CRI & one irrigation before flowering) during both the year, respectively. Under nutrient management practices, maximum B: C ratio was recorded under the treatment N_3 (50%RDF+ FYM@5.0t/ha.) where a B: C ratio (1.61 and 1.70) was recorded respectively. Least B: C ratio of 0.85 and 0.91 was recorded with N_0 during both the year, respectively.

Table 4: Effect of irrigation scheduling and nutrient management practices on yield of wheat

Treatments	Grain Yield (q/ha)		Straw yield (q/ha)		Harvest Index (%)		Biological yield (q/ha)	
Irrigation Scheduling (I)	**2020-21**	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**	**2020-21**	**2021-22**
I_0	24.3	25.8	35.9	36.6	40.27	41.47	60.2	62.5
I_1	25.9	26.8	38.3	41.1	40.08	39.23	64.2	68.0
I_2	28.7	29.5	41.8	42.0	40.79	41.41	70.5	71.7
SEm±	0.07	0.06	0.07	0.07	0.15	0.17	0.08	0.11
CD (0.05)	0.20	0.19	0.19	0.18	0.45	0.46	0.19	0.25
Nutrient management (N) (N)								
N_0	24.0	25.0	36.2	37.9	39.60	39.59	60.3	63.0
N_1	26.7	27.3	39.1	40.2	40.37	40.46	66.0	67.6
N_2	25.6	27.0	37.0	40.3	40.65	40.04	62.8	67.4
N_3	27.7	29.0	39.2	40.2	41.48	42.02	66.6	69.1
N_4	25.2	26.8	38.9	40.0	39.23	40.42	64.6	67.0
SEm±	0.08	0.07	0.11	0.09	0.14	0.17	0.05	0.07
CD (0.05)	0.21	0.20	0.24	0.21	0.44	0.42	0.13	0.16

I_0-No Irrigation, I_1-One Irrigation CRI stage, I_2 –One Irrigation at CRI & one irrigation before flowering, N_0-Control, N_1-100% RDF + FYM @ 2.5 t/ha. + Azotobacter, N_2-100% RDF + Vermicompost @ 1.5 t/ha + PSB, N_3-50% RDF+ FYM@5.0t/ha., N_4-50% RDF+ Vermicompost@2.5 t/ha.

Table 5: Effect of irrigation scheduling and nutrient management practices on economics attributes in wheat

Treatment combination	Total cost of cultivation (₹ ha $^{-1}$)		Gross return (₹ ha $^{-1}$)		Net return (₹ ha $^{-1}$)		B:C ratio	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
I_0	31211.4	31342.5	62848.65	64257.26	31637.25	32914.8	1.01	1.05
I_1	38271.4	39258.25	89270.82	92354.26	50999.42	53096	1.33	1.35
I_2	38747.4	40284.81	95626.93	99898.25	56879.53	57610.4	1.47	1.48
N_0	21739	22589.54	40137.74	43256.21	18398.74	20666.7	0.85	0.91
N_1	34892	34256.24	89490.61	91358.25	54598.61	57102	1.56	1.67
N_2	35367	36548.32	88933.2	93684.57	53566.2	57136.3	1.51	1.56
N_3	37251	39125.35	97098.93	105689.25	59847.93	66563.9	1.61	1.70
N_4	38368	41238.29	88263.2	96845.3	49895.2	55607	1.30	1.35

I_0- No Irrigation, I_1- One Irrigation CRI stage, I_2 – One Irrigation at CRI & one irrigation before flowering, N_0- Control, N_1-100 % RDF + FYM @ 2.5 t/ha. + Azotobacter, N_2- 100% RDF + Vermi compost @ 1.5 t/ha + PSB, N_3-50%RDF+ FYM@5.0t/ha., N_4-50% RDF+ Vermicompost@2.5 t/ha.

5. CONCLUSION

It was concluded that significantly maximum grain, straw, biological yield and as well as benefit cost ratio was recorded with one Irrigation at CRI & one irrigation before flowering. Whereas,

under nutrient management practices the application of 50% RDF+ FYM@5.0 t ha^{-1} recorded maximum grain yield during the both year of experiment. The study suggests economically combinations of currently used irrigation scheduling and nutrient management practices that may help farmer to obtaining optimum yield.

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