



# Impacts of Different Irrigation Schedules and Nutrients Management Practices on Economics of Wheat

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/IJECC/2023/v13i41705

## **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/97027>

**Original Research Article**

**Received: 29/12/2022**

**Accepted: 01/03/2023**

**Published: 06/03/2023**

## **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 initiation) 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<sup>-1</sup> in 2021 and 29.52 q ha<sup>-1</sup>, 42.13 q ha<sup>-1</sup> 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.

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**Keywords:** 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<sup>-1</sup>. 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<sup>-1</sup> [1]. “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 [2,3]. 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 [4,3]. 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” [5]. “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” [6,7]. “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” [9]. “The role of organic matter is well established in governing the nutrient fluxes, microbial biomass and improvement in soil physical chemical and biological properties” [10]. “Maintaining soil health is of utmost important to ensure food and

nutritional security of the country” [11]. “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” [12]. 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 METHODS

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 field at 23.134273°N latitude and 77.564305°E longitude. 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<sup>o</sup> C with an average of 12.8<sup>o</sup> C in 2020-21, and 7.2 to 23.1<sup>o</sup> C with a range with an average of 13.6<sup>o</sup> C in 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<sub>0</sub> - No irrigation, N<sub>1</sub>- One Irrigation at CRI stage, N<sub>2</sub>- One Irrigation at CRI & one irrigation before flowering were arranged in main plots whereas other treatments of N<sub>0</sub> – Control, N<sub>1</sub>- 100% RDF + FYM @ 2.5 t/ha. + Azotobacter, N<sub>2</sub> - 100% RDF + Vermicompost @ 1.5 t/ha + PSB, N<sub>3</sub> - 50% RDF+ FYM@5.0 t/ha, N<sub>4</sub> -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<sup>-1</sup>. The treatment means were compared using least significant differences at 5% level of significance [13].

**Table 1. Treatments details**

<b>Main plot treatment : 3 irrigation level</b>	
I <sub>0</sub>	No Irrigation.
I <sub>1</sub>	One Irrigation CRI stage
I <sub>2</sub>	One Irrigation at CRI & one irrigation before flowering
<b>Sub plot treatments : 5 Nutrient management practices</b>	
N <sub>0</sub>	Control
N <sub>1</sub>	100% RDF + FYM @ 2.5 t/ha. + Azotobacter
N <sub>2</sub>	100% RDF + Vermicompost @ 1.5 t/ha + PSB
N <sub>3</sub>	50%RDF+ FYM@5.0t/ha.
N <sub>4</sub>	50%RDF+ Vermicompost@2.5 t/ha

**Table 2. Treatment combinations**

Irrigation levels	Nutrient management practices				
	N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	N <sub>4</sub>
I <sub>0</sub>	I <sub>0</sub> N <sub>0</sub>	I <sub>0</sub> N <sub>1</sub>	I <sub>0</sub> N <sub>2</sub>	I <sub>0</sub> N <sub>3</sub>	I <sub>0</sub> N <sub>4</sub>
I <sub>1</sub>	I <sub>1</sub> N <sub>0</sub>	I <sub>1</sub> N <sub>1</sub>	I <sub>1</sub> N <sub>2</sub>	I <sub>1</sub> N <sub>3</sub>	I <sub>1</sub> N <sub>4</sub>
I <sub>2</sub>	I <sub>2</sub> N <sub>0</sub>	I <sub>2</sub> N <sub>1</sub>	I <sub>2</sub> N <sub>2</sub>	I <sub>2</sub> N <sub>3</sub>	I <sub>2</sub> N <sub>4</sub>

### 3. RESULTS AND DISCUSSION

#### 3.1 Yield Attributes

Perusal of the data (Table 3) showed that, highest effective tillers (131.49 m<sup>-1</sup> row length), number of spikelet's per ear (28.06), grains ear<sup>-1</sup> (44.35) and test weight (31.01 g) recorded in I<sub>2</sub> (One Irrigation at CRI & one irrigation before flowering) followed by I<sub>1</sub> (One Irrigation at CRI stage.) and lowest yield attributes was recorded in I<sub>0</sub> (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<sub>3</sub>-50%RDF+ FYM@5.0 t ha<sup>-1</sup>). The results of the present investigation are also in agreement with the findings of [1,14]. 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 [15].

#### 3.2 Yield (Kg ha<sup>-1</sup>)

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<sup>-1</sup>), straw yield (41.88 and 42.13 q ha<sup>-1</sup>), biological yield (70.68 and 71.75 q ha<sup>-1</sup>) 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 [7]. Uddin et al. [16] 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.

### 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<sub>2</sub> (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<sub>3</sub> (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<sub>4</sub> recording a total cost of cultivation of (INR 38368.00 and 41238.29) during both the year, respectively followed by treatments N<sub>2</sub>, N<sub>1</sub> and N<sub>0</sub>. Highest gross return 95626.93 and 97895.25 per ha was recorded in scheduling of irrigation at CRI and

**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)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Irrigation Scheduling								
I <sub>0</sub>	94.33	96.53	19.23	19.74	36.52	39.39	26.40	26.96
I <sub>1</sub>	115.18	117.05	25.74	24.88	41.23	41.30	27.20	27.60
I <sub>2</sub>	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
<b>Nutrient management (N)</b>								
N <sub>0</sub>	97.42	100.37	18.46	17.66	33.29	36.33	24.49	25.43
N <sub>1</sub>	122.22	121.42	21.73	22.85	40.79	40.16	28.54	29.72
N <sub>2</sub>	120.28	122.82	24.58	25.94	39.86	42.23	28.36	28.21
N <sub>3</sub>	126.96	132.83	27.81	27.60	43.86	44.23	31.48	31.62
N <sub>4</sub>	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<sub>0</sub>*-No Irrigation, *I<sub>1</sub>*-One Irrigation CRI stage, *I<sub>2</sub>* -One Irrigation at CRI & one irrigation before flowering, *N<sub>0</sub>*-Control, *N<sub>1</sub>*-100% RDF + FYM @ 2.5 t/ha. + Azotobacter, *N<sub>2</sub>*-100% RDF + Vermicompost @ 1.5 t/ha + PSB, *N<sub>3</sub>*-50%RDF+ FYM@5.0t/ha., *N<sub>4</sub>*-50%RDF+Vermicompost@2.5 t/ha

**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)	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
<b>Irrigation Scheduling (I)</b>								
I <sub>0</sub>	24.3	25.8	35.9	36.6	40.27	41.47	60.2	62.5
I <sub>1</sub>	25.9	26.8	38.3	41.1	40.08	39.23	64.2	68.0
I <sub>2</sub>	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
<b>Nutrient management (N) (N)</b>								
N <sub>0</sub>	24.0	25.0	36.2	37.9	39.60	39.59	60.3	63.0
N <sub>1</sub>	26.7	27.3	39.1	40.2	40.37	40.46	66.0	67.6
N <sub>2</sub>	25.6	27.0	37.0	40.3	40.65	40.04	62.8	67.4
N <sub>3</sub>	27.7	29.0	39.2	40.2	41.48	42.02	66.6	69.1
N <sub>4</sub>	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<sub>0</sub>-No Irrigation, I<sub>1</sub>-One Irrigation CRI stage, I<sub>2</sub>-One Irrigation at CRI & one irrigation before flowering, N<sub>0</sub>-Control, N<sub>1</sub>-100% RDF + FYM @ 2.5 t/ha. + Azotobacter, N<sub>2</sub>-100% RDF + Vermicompost @ 1.5 t/ha + PSB, N<sub>3</sub>-50% RDF+ FYM@5.0t/ha., N<sub>4</sub>-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 <sup>-1</sup> )		Gross return (₹ ha <sup>-1</sup> )		Net return (₹ ha <sup>-1</sup> )		B:C ratio	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
I <sub>0</sub>	31211.4	31342.5	62848.65	64257.26	31637.25	32914.8	1.01	1.05
I <sub>1</sub>	38271.4	39258.25	89270.82	92354.26	50999.42	53096	1.33	1.35
I <sub>2</sub>	38747.4	40284.81	95626.93	99898.25	56879.53	57610.4	1.47	1.48
N <sub>0</sub>	21739	22589.54	40137.74	43256.21	18398.74	20666.7	0.85	0.91
N <sub>1</sub>	34892	34256.24	89490.61	91358.25	54598.61	57102	1.56	1.67
N <sub>2</sub>	35367	36548.32	88933.2	93684.57	53566.2	57136.3	1.51	1.56
N <sub>3</sub>	37251	39125.35	97098.93	105689.25	59847.93	66563.9	1.61	1.70
N <sub>4</sub>	38368	41238.29	88263.2	96845.3	49895.2	55607	1.30	1.35

I<sub>0</sub>- No Irrigation, I<sub>1</sub>- One Irrigation CRI stage, I<sub>2</sub>- One Irrigation at CRI & one irrigation before flowering, N<sub>0</sub>- Control, N<sub>1</sub>- 100 % RDF + FYM @ 2.5 t/ha. + Azotobacter, N<sub>2</sub>- 100% RDF + Vermi compost @ 1.5 t/ha + PSB, N<sub>3</sub>-50%RDF+ FYM@5.0t/ha., N<sub>4</sub>-50% RDF+ Vermicompost@2.5 t/ha

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.

## 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<sup>-1</sup> 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.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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*Peer-review history:*  
*The peer review history for this paper can be accessed here:*  
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