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Impact of irrigation level and nutrient management on growth attributes and yield of wheat (*Triticum aestivum* L.)

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Abstract
A field experiment in a split-plot design with three replications was conducted at Agriculture Research Farm, Rabindranath Tagore University, Raisen, Madhya Predesh, during two growing kharif seasons of 2020-21 and 2021-2022 to study the effect of Effect of irrigation level and nutrient management on growth attributes and yield of wheat. 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. The results indicated 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 growth attributes such as plant height, dry weight, grain yield (28.70 and 29.52 q ha^{-1}), straw yield (41.88 and 42.13 q ha^{-1}) and biological yield (70.68 and 71.75 q ha^{-1}) during 2020-21 and 2021-22, respectively, compared to each other treatment combination.

Keywords: Irrigation level, nutrient management, growth attributes, yield, wheat (*Triticum aestivum* L.)

Introduction
Wheat (*Triticum aestivum* L.) is a major crop grown on vertisols of central India during winter season. It occupies nearly 50% of the total cultivable area in the region. In India, wheat is the second most important food crop after rice and account for 36.2% of total food grain reserved of over country. It has been grown under vast agro-climate condition. The total cultivated area of wheat crop in the world was 215.49 million hectares and production of 730.84 million tonnes also and productivity 3390 kg ha^{-1} the maximum producer of wheat in the world is the European Union followed by China, India, Russia and United States of America, Australia (FAOSTAT, 2019) [10]. In India the total cultivated area wheat was 29.65 millon hectares with production of 103.6 millon tonnes and also average productivity is 3507 kg ha^{-1} (ANONYMOUS, 2020) [3]. Water is the most important factor that are necessary for proper growth balanced development and higher yield of all crop. Water deficiency effect plant growth and grain yield Irrigation management is one of the important managerial activities and effect the effective utilization of water by crop. Water is the most important factor that are necessary for proper growth balanced development and higher yield of all crop. Water deficiency effect plant growth and grain yield Irrigation management is one of the important managerial activities and effect the effective utilization of water by crop Maximum grain yield (2.27 t/ha) was obtained with application of 200 mm irrigation treatment Under scarcity of water, four irrigation schedules at crown root initiation, tillering, flowering and milking stage recorded higher grain yield resulting in saving two irrigation for wheat irrigation at jointing and anthesis improved grain yield by an average of 12.70and 18.65% as compared with no irrigation in wheat (Yadav and Niwas, 2022) [21]. The irrigation is the main factor to determining the grain yield of wheat. The advent of high-yielding varieties of cereal in agricultural development irrigation is very essential for wheat production. Total requirement of grain production can be obtained by three way Ist application of balance fertilizer, IInd use high yielding varieties and IIIrd timely irrigated the wheat crop. The role of organic matter is well established in governing the nutrient fluxes, microbial biomass and improvement in soil physical chemical and biological properties. Extra mining of nutrients will have to be resisted in order to maintain the soil health. Maintaining soil health is of utmost important to ensure food and nutritional security of the country. Vermicompost is rich in plant nutrients and contains higher number of microorganisms, which are responsible for decomposition process

Vermicompost has been recognized as a low cost and environmentally sound process for treatment of many organic wastes. vermicompost treated soils had lower pH and increased levels of organic matter, primary nutrients, and soluble salts (Edwards *et al*., 2011) [8].

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 °C with an average of 12.8 °C in 2020-21, and 7.2 to 23.1 °C with an range with an average of 13.6 ^{0}Cin 2021-22 during wheat crop season, respectively. The experiment was laid out in split plot design (SPD) with fifteen treatments combination. 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. Plant height measured five randomly selected plants were recorded at 30, 60, 90 DAS and at harvesting stage from base of the plant to tip of the crop whereas, the number of early bearing tillers was counted at 90 DAS and expressed as number of effective tillers. The treatment means were compared using least significant differences at 5% level of significance (Gomez and Gomez 1984) [12].

Results and Discussion

Plant height (cm)

Plant height significantly differed with irrigation scheduling during both the years (table-1). Data shows that, highest plant height (23.10 cm) was observed in I_2 (One Irrigation at CRI & one irrigation before flowering) and was significantly taller over I_0 and I_1at 30 DAS during 2020-21. Same trend was all so recorded at 60 DAS with highest plant height (64.87 cm) in I_2 treatment, which was at par to I_0 and I_1. At 90 DAS, highest plant height (100.20 cm) was recorded in I_2 (One Irrigation at CRI & one irrigation before flowering) which was at par (97.4 cm) to I_1 treatment. At harvest, highest plant height (103.09 cm) was recorded in I_2 (One Irrigation at CRI & one irrigation before flowering) and it was also at par (99.99 cm) to I_1 irrigation treatment. Same trend was also repeated during second year (2021-22) for plant height at all intervals. Marked variation in plant height was observed due to different organic application treatments during both the years of experiments. During 2020-21, highest plant height (25.15 cm.) at 30 DAS was recorded in N_3 (50% RDF+ FYM @ 5.0t/ha.) which was statistically superior over the other treatments.

Table 1: Effect of irrigation scheduling and nutriment management treatments on plant height (cm)

Treatments	Plant height (cm)							
	30 DAS		60 DAS		90 DAS		At Harvest	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Irrigation Scheduling(I)								
I_0	19.95	15.60	60.19	59.09	89.2	88.15	90.76	89.76
I_1	18.90	18.99	63.68	61.78	97.4	93.62	99.99	94.92
I_2	23.10	19.93	64.87	63.77	100.2	97.27	103.09	100.76
SEm±	1.08	1.03	1.48	1.44	2.9	2.66	3.32	2.49
CD(0.05)	3.08	2.94	4.23	4.12	8.2	7.62	9.50	7.13
Nutrient Management (N)								
No	14.67	12.40	57.40	55.96	86.3	84.56	88.31	87.31
N_1	19.65	17.22	62.73	60.53	94.5	92.88	100.77	95.52
N_2	19.84	17.58	61.44	60.34	93.0	89.35	94.19	93.19
N_3	25.15	21.80	65.59	64.49	102.2	97.85	103.56	100.6
N_4	22.55	21.03	63.32	61.72	92.7	91.59	93.79	92.79
SEm±	1.20	1.15	1.65	1.61	3.2	2.98	3.71	2.78
CD(0.05)	3.44	3.29	4.73	4.60	9.2	8.52	10.62	7.97

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 @ 5.0 t/ha., N_4-50%RDF+ Vermicompost @ 2.5 t/ha.

Same trend was observed at 60 DAS, and highest plant (65.59 cm) was recorded and was at par to N_1, N_2 and N_4. At 90 DAS highest plant height (102.20 cm.) was recorded in N_3 and it was at par with N_1, N_2 and N_4 during and same pattern was also recorded at harvest with highest plant height (103.56 cm). Same trend was influenced by inorganic, organic and biofertilizers applications. During 2021-22, highest plant height (21.80 cm.) at 30 DAS was recorded in N_3 which was at par to N_4 treatment. At 60 DAS, highest plant (64.49 cm) was recorded and was at par to N_1, N_2 and N_3. Highest plant height (97.85 cm.) was recorded in N_3 and it was at par with N_1, N_2 and N_4 at 90 DAS. Highest plant height (100.60 cm) was recorded at harvest. In N_0 (control) showed lowest plant height during all stages in both years of experiments. Rise in plant height in response to watering may be beneficial for maintaining a constant moisture level, which may promote earlier and better root establishment as well as numerous metabolic processes (Ahmad, 2002) [2]. Plant height increased more quickly from 30 to 90 DAS, but at harvest it had either declined or had reached a plateau. This could be as a result of the photosynthetic rate declining after 90 DAS due to the ageing and drying of the leaves. The treatment applied of 50% RDF+ FYM @ 5.0 t/ha was discovered throughout either of the experimental years to result in the considerably highest

plant height (103.56 cm and 100.60 cm, respectively). It might be because growth regulators like gibberellins, kinetin, and indole-3-acetic acid are available to boost growth and give plants the ability to withstand harsh environments (Chakrabarti and Mukherji 2002; Data *et al.*, 2004; Gopal *et al.*, 2012) [6, 7, 13] found a similar outcome.

Dry Weight of Plant

From the data of 2020-21 it was observed that, plant dry weight at 30 DAS was found non-significant (Fig. 2). But at 60 DAS, highest plant dry weight (85.81 g meter^{-1} row length) was found in I_2 (One Irrigation at CRI & one irrigation before flowering) treatment. At harvest, highest plant dry weight (235.23 g m^{-1}row length) was found in I_2 which was superior over other irrigation treatments. Meanwhile, highest plant dry weight at 90 DAS was recorded as a non-significant. However, lowest plant dry weight was recorded in I_0 irrigation treatment at all stages of plant growth. During 2021-22 experiment also, somehow same trend was found. Plant dry weight at 30 DAS was found non-significant. Meanwhile, at 60 DAS, highest plant dry weight (82.61 g m^{-1} row length) was found in I_2 treatment and it was at par (77.21 g m-1 row length) in I_1 (One Irrigation CRI stage). At 90 DAS and harvest, highest plant dry weight (159.23 and 235.37 g m^{-1} row length) was receded in I_2 irrigation treatments. However, lowest plant dry weight was recorded in I_0 irrigation treatment at all. In case of nutriment management practices significantly highest plant dry weight (17.75 g m^{-1} row length) at 30 DAS was recorded in N_3 (50%RDF+ FYM @ 5.0t/ha.). It was statistically at par to N_4, N_2 and N_1 treatments. While same trend was also observed at 60 DAS and highest shoot dry matter accumulation (84.68 g m^{-1} row length) was recorded in N_3, and was at par to N_1. Meanwhile, highest shoot dry matter accumulation (174.83 and 232.11 g m^{-1} row length) were recorded at 90 DAS and harvest respectively, in N_3 treatment. During 2021-22, significantly highest plant dry weight (17.58 g m^{-1} row length) at 30 DAS was recorded in N_3 (50%RDF+ FYM @ 5.0t/ha.). It was statistically at par to N_4, N_2 and N_1 treatments. While same trend was also observed at 60 DAS and highest shoot dry matter accumulation (82.84 g m^{-1} row length) was recorded in N_3, and was at par to N_1. Meanwhile, highest shoot dry matter accumulation (171.13 and233.41 g m^{-1} row length) were recorded at 90 DAS and harvest respectively, in N_3 treatment. In present experiment, the maximum shoot dry matter accumulation (235.23 and 235.37 g m^{-1} row length) were recorded at harvest in irrigation schedule of One Irrigation at CRI & one irrigation before flowering, during successive years of experiments.

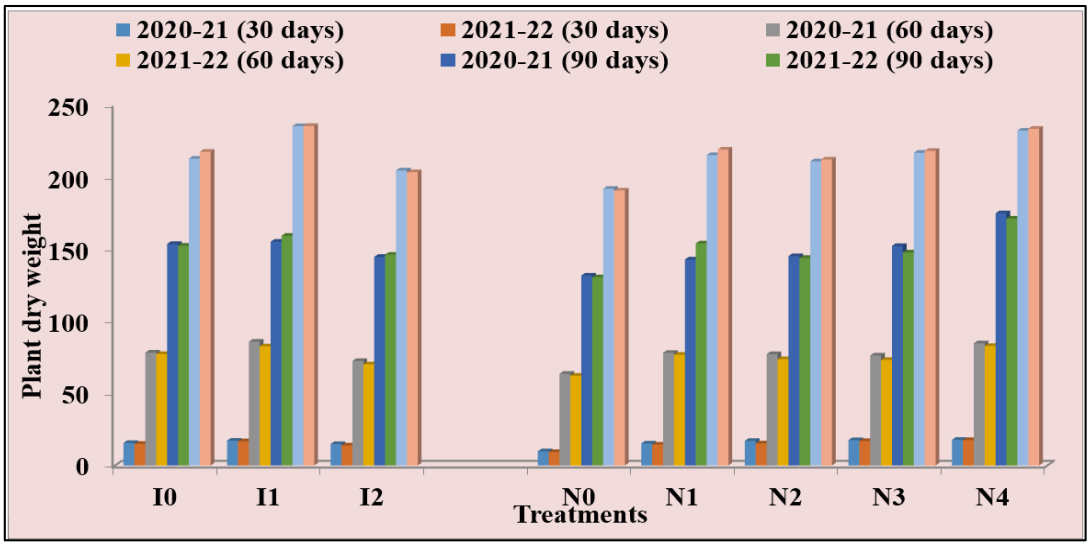

Fig 1: Effect of irrigation scheduling and nutriment management treatments on plant dry weight of wheat.

It might also be due to stimulation for the plants to have quick cell division and cell elongation of nodes and internodes results in higher fresh and dry matter production. Similar result was also reported by (Mandal *et al.*, 2006) [17]. This might also be due to the luxuriant vegetative growth in terms of plant height and number of tillers per plant (Shirazi, 2014) [19]. Lowest shoot dry matter accumulation was recorded in irrigation schedule of One Irrigation at CRI & one irrigation before flowering. The short plant height in other irrigation treatment could be due to water stress at tillering and elongation stages (Ghany, *et al.*, 2012) [11]. Application of organic manures along with inorganic fertilizers and biofertilizers produced highest dry matter accumulation (232.11 and 233.41 g m^{-1} row length, respectively) during successive years. It might be due to crucial role of zinc in protein and carbohydrates synthesis (Welch *et al.*, 2005), stimulates for plants to have quick cell division and cell elongation of nodes and internodes produce more fresh and dry matter, which could contribute to the final growth of dry matter (Karim *et al.*, 2012) [15].

Yield and harvest index

The data regarding to grain yield of wheat a influenced by irrigation scheduling and nutrient management has been presented in (table -2). Irrigation scheduling significantly influenced grain and straw yield. Maximum grain yield (28.70 q ha^{-1}) was recorded in treatment of one Irrigation at CRI & one irrigation before flowering (I_2), followed by I_3. lowest grain yield (24.29 q ha^{-1}) was recorded in I_0 treatment. During next season of experiment, same trend was recorded. In case of nutrient management practices, maximum grain yield (27.65 q ha^{-1}) and straw yield during 2020-21 was recorded in N_3 (50%RDF+ FYM @ 5.0 t/ha) treatment which was statistically at par with N_2 (100% RDF + Vermicompost @ 1.5 t/ha + PSB). Lowest grain yield (23.92 q ha^{-1}) was recorded in N_0 (control).

Table 2: Effect of irrigation scheduling and nutrient management treatments on yield of wheat

Treatments	Grain Yield (q/ha)		Straw yield (q/ha)	
Irrigation Scheduling (I)	**2020 - 21**	**2021 - 22**	**2020 - 21**	**2021 - 22**
I_0	24.29	25.83	35.85	36.58
I_1	25.84	26.83	38.23	41.15
I_2	28.70	29.52	41.78	42.03
SEm±	0.07	0.06	0.07	0.07
CD (0.05)	0.20	0.19	0.19	0.18
Nutrient management (N)				
N_0	23.92	24.99	36.27	37.86
N_1	26.70	27.30	39.17	40.18
N_2	25.63	26.99	37.05	40.31
N_3	27.65	29.02	39.23	40.15
N_4	25.25	26.78	38.85	40.02
SEm±	0.08	0.07	0.11	0.09
CD (0.05)	0.21	0.20	0.24	0.21

Similar trend was recorded during second year of investigation (2021-22). Maximum grain yield (29.02 q ha^{-1}) was found in N_3 treatment. The lowest grain yield (2499 q ha^{-1}) was recorded with control treatment. An increase in grain yield was observed in second year of the experiment compared to first year in respective treatments. The application of one Irrigation at CRI & one irrigation before flowering resulted highest grain straw as well as biological yield during 2020-21 and 2021-22, respectively. It might be primarily due to more number of effective tillers per unit area and complementary findings have been also reported by (Ehsan *et al.*, 2009; Adani & Kumar, 2012) [9, 1]. Under INM practices recommended dose of fertilizers was given with organic manures FYM and fertilizer produced significantly highest grain, straw and biological yields than other treatments. Irrigation scheduling and INM applications had a significant effect on harvest index of wheat during both the years of experiments.

Conclusion

On the basis of our finding it can be concluded that the application of 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 growth attributes such as plant height, dry weight, grain yield and straw yield compared to each other treatment combination.

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