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Effect of Graded Levels of Fertilizer and Irrigation on Growth of Bio-fortified Wheat (*Triticum aestivum* L.) Variety DBW 187 under Rice-Wheat Cropping System in Jharkhand

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A B S T R A C T

A field experiment entitled "Effects of graded levels of fertilizers and irrigation on yield and yield attributes of wheat variety DBW-187 in rice-wheat cropping system in Jharkhand'' was conducted during rabi season (November-April) in both years 2024-2025 and 2025-2026 at the instructional research farm, Jharkhand Rai University, Ranchi, Jharkhand. The experiment consisting of sixteen treatment with three replication viz., T_1 50% RDF (NPK) with 3 irrigation, T_2 50% RDF(NPK) with 4 irrigation, T_3 50% RDF (NPK) with 5 irrigation,T_4 50% RDF (NPK) with 6 irrigation, T_5 100% RDF (NPK) with 3 irrigation, T_6 100% RDF (NPK) with 4 irrigation, T_7 100% RDF (NPK) with 5 irrigation, T_8 100% RDF (NPK) with 6 irrigation, T_9 150% RDF (NPK) with 3 irrigation, T_{10} 150% RDF (NPK) with 4 irrigation, T_{11} 150% RDF (NPK) with 5 irrigation, T_{12} 150% RDF (NPK) with 6 irrigation, T_{13} soil test fertilizer with 3 irrigation, T_{14} soil test-based fertilizer with 4 irrigation, T_{15} soil test-based fertilizer with 5 irrigation, T_{16} soil test-based fertilizer with 6 irrigations in Randomised Block Design (RBD). The fertilizers doses i.e., RDF (NPK) were 50, 100, 150 and soil test based fertilizers and irrigation levels was maximum irrigations were given at six irrigation i.e., CRI, tillering stage, late jointing stage, booting stage, milking stage and at dough stage. The growth parameters namely plant height, dry matter accumulation, crop growth rate, LAI and no. of tillers per m^2 were maximum in T12 i.e., 150% RDF (NPK) with six irrigations and lowest were observed in T1 i.e., 50% RDF (NPK) with 3 irrigations. Result revealed that application of 150% RDF (NPK) with 6 irrigations significantly improved crop performance.

Introduction

Wheat is considered as the 'King of Cereals' as of its nutritional value and use as a staple food, an essential cereal for food security, poverty alleviation and as a livelihood. Since the start of green revolution in 1967, the area under wheat has expanded as production and productivity. The area under wheat has expanded from 12.8 million hectare in the year of 1966-67 to 31.4 million hectare (Department of Agriculture & Farmers Welfare, 2024) now. Wheat is an extensively cultivated crop which seed is a grain used all over the world as a

staple food and straw of wheat is mainly used as fodder for livestock. In Indian, it is eaten in the form of chapattis, puris, noodles, macaroni, vermicelli, spaghetti and upma. In addition to this wheat is also consumed in various other preparation such as dalia, halwa and sweet meals. In India, wheat is grown in over 32 million hectares (20% of total arable area) to produce the all-time highest output of 112.18 million tonnes of wheat (14.46% of world production) with a record average productivity of 3.5 tonnes/ha. (Ministry of Agriculture & Farmers Welfares, 2023).

In order to enhance the nutritional value in wheat the Government of India through Indian Council of Agricultural Research (ICAR) has been making efforts for bio fortification in wheat. Bio fortification is the technique of breeding crops to increase their nutritional value in an economic and sustainable manner (Valenca *et al.,* 2017). Although most of the wheat varieties today are rich in important nutrients, they lack content of Iron (Fe) and Zinc (Zn). The declining quantities of micronutrients in food crops is one of the major reasons for hidden hunger in people which has affected over 2 billion population all over the world (Straeten *et al.,* 2020). The DBW187 variety of wheat, also known as 'Karan Vandana' developed by ICAR- Indian Institute of Wheat and Barley Research, Karnal which was released for irrigated timely sown conditions of North Eastern Plains Zone comprising of Eastern Uttar Pradesh, Bihar, Jharkhand, Assam and West Bengal possesses better resistance against the local diseases like leaf rust and leaf blight.

Material and Methods

The field experiment was conducted during rabi season of 2024-25 and 2025-26 at research farm of Jharkhand Rai University, Ranchi. The Jharkhand state falls under the Agro-climatic zone VII (Eastern Plateau and hilly region) which has been further divided into 3 sub zones and Ranchi comes under zone IV i.e., Central and North eastern Plateaus zone. The soil is primarily red in colour, falling under the red-yellow-light grey category association group, which corresponds to the main soil order (Alfisols) found in Jharkhand. The soil was slightly acidic in reaction (pH 6.38), low in organic carbon (0.17%) and available nitrogen (10.4 kg/ha), medium in available phosphorus (21.57 kg/ha) and potassium (168.3 kg/ha). The experiment was laid out in Randomised block design with three replication and sixteen treatment viz., T_1 50% RDF(NPK) with 3 irrigation, T_2 50% RDF(NPK) with 4 irrigation, T_3 50% RDF(NPK) with 5 irrigation,T_4 50% RDF(NPK) with 6 irrigation, T_5 100% RDF (NPK) with 3 irrigation, T_6 100%RDF (NPK) with 4 irrigation, T_7 100% RDF (NPK) with 5 irrigation, T_8 100% RDF (NPK) with 6 irrigation, T_9 150%RDF (NPK) with 3 irrigation, T_{10} 150% RDF (NPK) with 4 irrigation, T_{11} 150% RDF (NPK) with 5 irrigation, T_{12} 150% RDF (NPK) with 6 irrigation, T_{13} soil test fertilizer with 3 irrigation, T_{14} soil test-based fertilizer with 4 irrigation, T_{15} soil test-based fertilizer with 5 irrigation, T_{16} soil test-based fertilizer with 6 irrigation. The wheat varieties DBW 187 was sown during the experimentation using 100kg/ha, seed rate with the spacing row-row 22.5cm. The recommended dose of fertilizers was 120kg nitrogen, was applied in split doses, 60kg/ha phosphorus, 40 kg/ha potassium was applied at basal doses. Split doses of urea was applied at the time of sowing and at tillering stage.

Growth parameters

Plant height (cm)

Plant height increased with advancement of crop age and reached maximum height at 90 DAS and decreased at harvest stage as shown in Table 1. Plant height increased gradually till 90DAS after which plant height slow down gradually. This slower initial growth of plant height was followed by more rapid due to increased photosynthesis rate, better utilisation of resources and enhanced rate of nutrient uptake from soil. Irrigation levels also differed from one another in affecting plant height. At 30 DAS, the plant height was not significantly influenced by the different levels of fertilizers and irrigations. This lack of impact may be due to the fact that, to that point, no differential irrigation was applied however, the plant height was significantly affected by the different levels of fertilizers and irrigation frequency throughout the experiment at 60 DAS, 90 DAS and at harvest stage. The tallest plant height was observed in T_{12} i.e., 150%RDF (NPK) with 6 irrigation is 18.50cm and lowest was observed in T_1 i.e., 50% RDF (NPK) with 3 irrigations. At 60DAS, the tallest plant height was observed in T_{12} i.e., 150% RDF (NPK) with 6 irrigation is 68.76 and lowest was observed in T_1 i.e., 50%RDF (NPK) with 3 irrigations is 42.37. Pal *et al.,* 2001 also observed yield reduction in wheat with irrigation compared with the crop raised with four irrigation.

Table.1 Effects of graded levels of fertilizers and irrigation on plant height (cm) as influenced by different treatments (Pooled Data)

Treatments	Plant height (cm)			
	30DAS	60DAS	90DAS	At maturity
T1 (50% RDF(NPK) with 3 irrigation)	12.81	42.37	62.20	80.86
T2 (50% RDF(NPK) with 4 irrigation)	13.29	45.36	71.48	90.89
T3 (50% RDF(NPK) with 5 irrigation)	13.74	47.51	75.84	85.97
T4 (50% RDF(NPK) with 6 irrigation)	13.68	48.89	77.27	98.74
T5 (100%RDF (NPK) with 3 irrigation)	14.86	48.87	66.38	85.39
T6(100%RDF (NPK) with 4 irrigation)	15.89	54.62	75.38	92.38
T7(100%RDF (NPK) with 5 irrigation)	15.23	56.65	80.96	94.76
T8(100%RDF (NPK) with 6 irrigation)	15.23	58.19	83.86	99.43
T9(150%RDF (NPK) with 3 irrigation)	16.55	61.88	78.99	93.17
T10(150%RDF (NPK) with 4 irrigation)	17.92	64.41	87.46	101.76
T11(150%RDF (NPK) with 5 irrigation)	18.00	66.87	90.23	105.21
T12(150%RDF (NPK) with 6 irrigation)	18.84	68.76	93.10	107.56
T13(Soil test fertilizer with 3 irrigation)	15.50	52.70	69.06	87.69
T14(Soil test fertilizer with 4 irrigation)	15.26	56.10	76.89	98.52
T15(Soil test fertilizer with 5 irrigation)	15.69	58.37	81.23	100.14
T16(Soil test fertilizer with 6 irrigation)	16.32	60.25	84.22	101.06
SEm ±	0.73	2.43	3.44	2.72
C. D. (P = 0.05)	2.07	6.89	9.73	7.70
CV (%)	5.05	4.68	4.70	3.07

Table.2 Effects of graded levels of fertilizers and irrigation on growth attributes as influenced by different treatments (Pooled Data)

Treatments	Dry matter accumulation (g/m^2)	Crop growth rate	Leaf area index	No. of tillers /m^2
T1 (50% RDF(NPK) with 3 irrigation)	745.84	9.45	2.54	385.41
T2 (50% RDF(NPK) with 4 irrigation)	849.04	11.45	2.90	413.52
T3 (50% RDF(NPK) with 5 irrigation)	915.99	12.94	2.98	430.97
T4 (50% RDF(NPK) with 6 irrigation)	956.22	13.49	3.13	438.75
T5 (100%RDF (NPK) with 3 irrigation)	860.67	9.03	2.79	393.80
T6(100%RDF (NPK) with 4 irrigation)	1083.65	13.41	3.07	415.19
T7(100%RDF (NPK) with 5 irrigation)	1176.74	15.62	3.19	430.74
T8(100%RDF (NPK) with 6 irrigation)	1191.89	15.71	3.30	427.51
T9(150%RDF (NPK) with 3 irrigation)	913.12	8.58	3.01	401.29
T10(150%RDF (NPK) with 4 irrigation)	1214.61	15.42	3.90	453.80
T11(150%RDF (NPK) with 5 irrigation)	1298.05	16.98	3.99	482.08
T12(150%RDF (NPK) with 6 irrigation)	1325.67	17.15	4.09	494.95
T13(Soil test fertilizer with 3 irrigation)	874.21	9.12	2.93	397.10
T14(Soil test fertilizer with 4 irrigation)	1027.10	10.84	3.13	439.76
T15(Soil test fertilizer with 5 irrigation)	1121.94	12.74	3.30	452.31
T16(Soil test fertilizer with 6 irrigation)	1187.28	14.18	3.37	487.88
SEm ±	53.58	2.10	0.03	17.86
C. D. (P = 0.05)	151.51	5.93	0.08	50.51
CV (%)	5.49	17.46	0.93	4.41

Dry matter accumulation (g/m^2)

Dry matter accumulations increased significantly with the increase in doses of fertilizers and levels of irrigations during both the years due to more available of water and fertilizer doses. At higher dose of fertilizers and maximum levels of irrigations showed maximum dry matter accumulation in T_{12} i.e., 150%RDF (NPK) with 6 irrigations is 1325.67 and minimum was observed in T_1 i.e., 50% RDF (NPK) with 3 irrigations is 462.47 at harvest stage than other doses of RDF (NPK) and irrigation levels due to under nourishment of the plant and low availability of water and nutrients. Similar findings were reported in Rehman *et al.,* (2010) and Shahzad *et al.,* (2013).

Crop growth rate

Crop growth rate (CGR) was at its lowest between 30-60 days, increased till 90 days, reached its highest point between 90-120 days, and then gradually increased until crop maturity (Table 1). At later stages of crop growth, including 90–120 DAS and 120 DAS-maturity, the CGR significantly increased with an increase in irrigations in both years. The CGR at 90-120 DAS in both the years had increased in higher doses of fertilizers and irrigation levels i.e., T_{12} (150% RDF NPK with 6 irrigations) and decreased in T_1 (50% RDF NPK with 3 irrigations levels) it may be due to the maximum doses of fertilizers and levels of irrigations. Similar results were also found in Shirza *et al.,* (2014).

Leaf area index

LAI increased up to 90DAS then decreased after, during both the years. (Table 2). The maximum LAI was recorded when the maximum number of fertilizers and irrigations were applied i.e., 150% RDF (NPK) with six irrigations were used at 90 DAS. The efficient water supply, during the growing season increased the leaf area of the crops; this increased leaf area of the crop allowed the crop to intercept most of the radiations. The maximum LAI was observed in T_{12} i.e., 150%RDF (NPK) with 6 irrigation is 4.09 and lowest was observed in T_1 i.e., 50% RDF (NPK) with 3 irrigations is 2.54 and T11 i.e., 150% RDF (NPK) with 5 irrigations was statistically at par with T_{12} i.e., 150% RDF (NPK) with 6 irrigation. The increase in leaf area index with higher doses of fertilizers and levels of irrigations is might be due to more leaf area on account of more accumulations of assimilates. Similar findings were reported at Asif *et al.,* (2012) that enhanced LAI by applications of higher levels of fertilizers doses.

No. of tillers per m^2

The no. of tillers per m2 was increased at 90 DAS during both the years in Table 2 due to improved water availability for the crop and maximum doses of fertilizers. The maximum no. of tillers per m^2 was observed at T_{12} i.e., 150% RDF (NPK) with six irrigation levels is 494.95 and lowest was observed at T_1 i.e., 50% RDF (NPK) with 3 irrigations is 385.41. T_{14} was statistically at par with T_{14} i.e., soil test based fertilizer at 4 irrigations. There was more water available, the turgor potential remained greater, which increased the rate of photosynthesis by causing more stomata to open for longer periods of time. Similar findings were reported in Pannu and Sharma (2004) and Shirazi *et al.,* (2014).

Author Contributions

Archana Kumari: Investigation, formal analysis, writing—original draft. Ashok Kumar: Validation, methodology, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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