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Effect of Integrated Nutrient Management on Growth, Yield Attributes, Productivity and Profitability of Direct Seeded Rice under Rainfed Conditions

Narendra Kumar [a*], B. K. Tiwari [a], R. K. Twari [a] and Mrinali Gajbhiye [b]

[a] Department of Agronomy, College of Agriculture, Rewa, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur-482004, M. P., India.
[b] Department of Agronomy, College of Agriculture, Jabalpur, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur-482004, M. P., India.

Authors' contributions

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

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ABSTRACT

A field experiment was conducted to evaluate the effect of integrated nutrient management on growth, yield attributes, productivity and profitability of direct seed rice under Rainfed conditions during *Kharif* in 2019-20 at kuthulia farm, JNKVV, Rewa (M.P.). The experiment was laid out in randomized block design with nine treatments and three replications. The results indicated that the treatment 50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter

**Corresponding author: E-mail: narendrakumarpatidar222@gmail.com;*

@ 10 g kg^{-1} seed recorded significantly higher growth, yield attributes and productivity viz. plant height (74.90 cm), number of tillers m^{-2} (387.00), number of productive tillers m^{-2} (340.66), panicle length (23.57 cm) and weight (3.76 g), total grain per $panicle^{-1}$ (82.33), 1000-grain weight (26.69 g), grain yield (3799 kg ha^{-1}), straw yield (6438 kg ha^{-1}) and harvest index (37.11%). The profitability viz. Gross returns (78608 Rs. ha^{-1}), Net returns (65650 Rs. ha^{-1}) and B:C (2.38) of rice was also higher in 50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed. The study concluded that combined use of organic and inorganic sources of nutrients with biofertilizer enhanced crop growth, yield attributes, productivity and profitability of direct seeded rice.

Keywords: Growth parameter; yield attributes; productivity; integrated nutrient management.

1. INTRODUCTION

Rice (*Oryza Sativa* L.) is staple food for more than half of the global population in about 40 countries. In India (2018-19), it has an area, production and productivity of 44.16 Mha, 116.48 Mt and 2650.23 kg ha^{-1} respectively [1], however in Madhya Pradesh it is grown in an area of 2.39 Mha with production of 4.49 Mt and productivity is 1880.46 kg ha^{-1} [1]. It clearly indicates that in Madhya Pradesh the productivity of rice is quite low than national average. Direct seed rice (DSR) is low-cost alternative for transplanted rice as it reduces 35-57% water and 67% labour over transplanted rice. Apart from this, DSR require less mechanical power and decreases methane emissions [2-4]. It has gained popularity as it reduces overall labour, water and time demand for rice culture [5]. Application of chemical fertilizers leads to increase production but when used continuously, it lowers soil fertility and sustainability [6,7]. The moderate application of inorganic fertilizers with organic manure and biofertilizer in agricultural practices not only enhances crop quality but also increases soil health thereby minimizing the utilization of chemical fertilizers and will be more economically viable [8]. Hence, it is required to find out suitable combination of organic and inorganic fertilizer with biofertilizer that will maintain soil fertility to get maximum production and sustainability.

Integrated nutrient management (INM) aims an efficient and judicious use of all major sources of plant nutrients in an integrated manner [9]. It has been reported that it not only meets the nutrients need of the crops but also has been found to sustain wider goals of productivity.

In this context, the present study was carried out to study the effect of integrated nutrient management on growth, yield attributes, productivity and profitability of direct seeded rice under Rainfed conditions.

2. MATERIALS AND METHODS

A field experiment was carried out during *Kharif* in 2019-20 under All India Coordinated Research Project for Dryland Agriculture at Kuthulia farm, JNKVV, Rewa (M.P.). Rewa is situated in North-Eastern part of Madhya Pradesh (24^0 30' N, 81^0 25' E and 365.7 m above the mean sea level) with the average annual rainfall 1140 mm. Total rainfall received during the cropping season was 731 mm distributed in 37 rainy days with temperature 19.63^0C-37.71^0C and humidity 45%-94.14%. Experimental soil was silt-clay loam texture, neutral pH (6.80), medium in organic carbon (0.46%). Available N, P and K was 105.60 kg ha^{-1}, 8.79 kg ha^{-1} and 245.61 kg ha^{-1} in soil, respectively.

The experiment was laid out in randomized block design with nine treatments in three replications, viz. T_1, control; T_2, 100% recommended dose of NPK through fertilizer (100 kg N + 40 kg P_2O_5 + 40 kg K_2O ha^{-1}); T_3, 100% RDN through compost; T_4, 50% RDN through fertilizer + 50% RDN through compost; T_5, 50% RDN through fertilizer + 25% RDN through compost; T_6, 25% RDN through fertilizer + 50% RDN through compost; T_7, 50% RDN through fertilizer + 25% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed; T_8, 25% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed; T_9, 50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed. First drought tolerant rice cultivar DRR Dhan42 (DRT-42) was sown on 20^{th} July 2019 during *Kharif* season. Field was thoroughly prepared by once ploughing with tractor-drawn plough followed by two disking and removing weeds and stubbles manually. Lines were opened at 25 cm row spacing and depth 3-4 cm. The Recommended dose of fertilizer (RDF), Nitrogen (N; 100 kg ha^{-1}); Phosphorus (P_2O_5; 40 kg ha^{-1}) and Potassium

(K_2O; 40 kg ha^{-1}) was applied in each plot except control from different proportions of FYM, Urea (46% N), Diammonium phosphate (18% N and 46% P_2O_5), Single super phosphate (16% P_2O_5) and Muriate of potash (60% K_2O), to fulfil the need on per hectare area basis. All the sources of nutrient were applied as basal after final field preparation except urea, which was applied 50% as basal and remaining in two splits, 25% at tillering and 25% at panicle initiation stage.

The weeds were managed manually once at 25 days after sowing (DAS). No any serious incidence of insect or disease come into view in the cropping season but some adult of rice gundhi bug were seen in the field at milking stage. It is controlled by the application of insecticide lambda cyhalothrin, 5% SC @ 500 ml ha^{-1} with 300 litre of water.

The field data obtained was statistically analyzed using F-test [10]. Significant difference between treatments mean were compared with critical differences at 5% levels of probability.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

Integrated use of inorganic and organic sources of plant nutrients with inclusion of biofertilizer showed statistically significant variation on growth attributes under the present trail except leaf area index which was non-significant at 60 DAS as shown in Table 1.

Taller plants (74.90 cm) were recorded in T_9, 50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed and it was at par with other treatments except control. This might be because of integrated strategies used for major nutrients. FYM and Azotobacter might have improved the physical and biological conditions of soil. As also observed by Banerjee et al. [11], Kumar and Das [12].

The data regarding number of tillers (m^{-2}) as depicted in Fig. 1 revealed that the number of tillers (m^{-2}) increased with the successive increment of days after sowing (30, 60 and 90). At 30, 60 and 90 DAS, number of tillers (m^{-2}) in 50% RDN through fertilizer + 50% RDN through compost + Seed treated with Azotobacter @ 10 g kg^{-1} seed were significantly higher and at par with 100% recommended dose of NPK through fertilizer (100 kg N + 40 kg P_2O_5 + 40 kg K_2O ha^{-1}) and 50% RDN through fertilizer + 50% RDN through compost but in T_9 at 90 DAS also at par with 100% RDN through compost. Significantly maximum number of tillers m^{-2} (387.00) was recorded in T_9 at 90 DAS over other treatments (Table 1). As also reported by Kumar and Das [12], Meena et al. [13] and Ashwini et al. [14].

Leaf area index (LAI) was not significantly influenced at 60 DAS. The treatment T_9, 50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed noticed maximum LAI (9.06) and minimum in control (6.15). The findings agreed with those of Mondal et al. [15].

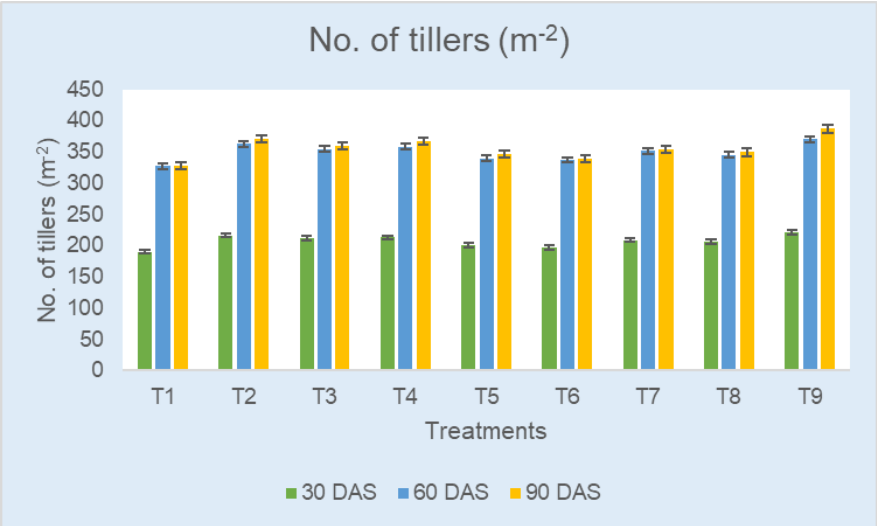

Fig. 1. Effect of integrated nutrient management on number of tillers (m^{-2}) of direct seeded rice under Rainfed conditions

Table 1. Effect of integrated nutrient management on growth attributes of direct seeded rice under Rainfed conditions

Treatment		Plant height (cm)	No. of tillers (m^{-2})	Leaf area index
		90 DAS	**90 DAS**	**60DAS**
T_1	**Control**	62.77	328.33	6.15
T_2	100% recommended dose of NPK through fertilizer (100 kg N + 40 kg P_2O_5 + 40 kg K_2O ha^{-1})	72.70	370.66	8.83
T_3	100% RDN through compost	71.40	359.33	7.64
T_4	50% RDN through fertilizer + 50% RDN through compost	71.66	367.00	8.43
T_5	50% RDN through fertilizer + 25% RDN through compost	70.66	346.66	6.95
T_6	25% RDN through fertilizer + 50% RDN through compost	69.90	339.00	6.64
T_7	50% RDN through fertilizer + 25% RDN through compost + seed treated with Azotobactor @ 10 g kg^{-1} seed	71.80	354.33	7.39
T_8	25% RDN through fertilizer + 25% RDN through compost + seed treated with Azotobactor @ 10 g kg^{-1} seed	71.57	349.66	6.91
T_9	50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobactor @ 10 g kg^{-1} seed	74.90	387.00	9.06
SEm±		**1.83**	**6.76**	**0.63**
CD (5%)		**5.57**	**20.29**	**NS**

Table 2. Effect of integrated nutrient management on yield attributes of direct seeded rice under Rainfed conditions

Treatment		Number of tillers		Panicle length (cm)	Panicle Weight (g)	Number of filled grains Panicle^{-1}	Total Number of grains panicle^{-1}	Grain yield panicle^{-1} (g)	1000-grain weight (g)
		Productive tillers (m^{-2})	Unproductive tillers (m^{-2})						
T_1	Control	274.33	54.00	19.13	2.40	45.00	54.66	0.92	20.63
T_2	100% recommended dose of NPK through fertilizer (100 kg N+40 kg P_2O_5+ 40 kg K_2O ha^{-1})	321.66	49.00	22.33	3.41	73.33	80.66	1.89	25.84
T_3	100% RDN through compost	309.33	50.00	20.96	3.01	68.66	76.66	1.74	25.48
T_4	50% RDN through fertilizer + 50% RDN through compost	317.66	49.33	21.10	3.23	69.66	77.33	1.80	25.91
T_5	50% RDN through fertilizer + 25% RDN through compost	295.00	51.66	18.03	2.71	61.00	70.00	1.51	24.76
T_6	25% RDN through fertilizer + 50% RDN through compost	287.00	52.00	17.9	2.63	60.33	69.66	1.48	24.67
T_7	50% RDN through fertilizer + 25% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed	304.00	50.33	19.53	2.96	66.66	74.66	1.69	25.40
T_8	25% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed	298.33	51.33	19.43	2.92	65.66	73.33	1.66	25.33
T_9	50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed	340.66	46.66	23.57	3.76	75.33	82.33	2.01	26.69
SEm±		**4.22**	**1.24**	**1.03**	**0.20**	**1.22**	**1.22**	**0.10**	**0.70**
CD (5%)		**12.67**	**3.74**	**3.09**	**0.61**	**3.66**	**3.67**	**0.30**	**2.33**

Table 3. Effect of integrated nutrient management on productivity and profitability of direct seeded rice under Rainfed conditions

Treatment		Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Benefit cost ratio
T_1	Control	2503	6006	29.41	54438	28018	26420	2.06
T_2	100% recommended dose of NPK through fertilizer (100 kg N+40 kg P_2O_5+ 40 kg K_2O ha^{-1})	3511	6495	35.08	73466	42450	31016	2.15
T_3	100% RDN through compost	3326	6412	34.15	69985	33565	36420	1.92
T_4	50% RDN through fertilizer + 50% RDN through compost	3347	6250	34.88	70123	37315	32808	2.13
T_5	50% RDN through fertilizer + 25% RDN through compost	2806	5688	33.03	59461	28041	31420	1.89
T_6	25% RDN through fertilizer + 50% RDN through compost	2790	5860	32.25	59428	26945	32483	1.82
T_7	50% RDN through fertilizer + 25% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed	3115	6037	34.03	65592	34022	31570	2.07
T_8	25% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed	3070	6057	33.51	64805	32172	32633	1.98
T_9	50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed	3799	6438	37.11	78608	65650	32958	2.38
SEm±		**9.22**	**8.2**	**1.06**	**-**	**-**	**-**	**-**
CD (5%)		**27.65**	**24.6**	**3.18**	**-**	**-**	**-**	**-**

3.2 Yield Attributes

Yield attributes significantly influenced by various treatments have been summarized in Table 2. Significantly higher number of productive tillers (m^{-2}) were produced with T_9 (340.66) and lower in control (274.33). The number of unproductive tillers (m^{-2}) was significantly maximum in case of control (54.00) but was at par with T_6, T_5, T_8 and T_7. As also reported by Paul et al. [16] that application of organic fertilizer with different dose of NPK significantly increased the number of tillers (m^{-2}) at harvest as compared to control. The treatment had marked influenced on panicle length and weight. T_9, exhibited higher panicle length (23.57 cm) and weight (3.76 g) which was at par with T_2 and T_4 but in case of panicle length, it was also at par with T_3. In present investigation, significantly higher number of filled grain $panicle^{-1}$ (75.33), total number of grain $panicle^{-1}$ (82.33), 1000-grain weight (26.69 g) and grain yield $panicle^{-1}$ (2.01 g) was observed in T_9 as compared to others. However, filled grains $panicle^{-1}$ and total number of grain $panicle^{-1}$ and grain yield $panicle^{-1}$ were at par with T_2 but in case of grain yield $panicle^{-1}$ was also at par with T_4 and T_3. Similar result was also observed by Yadav et al. [17]; Kumar et al. [18] and Alim [19].

3.3 Crop Productivity

All treatments exerted a distinct effect on the grain yield, straw yield and harvest index (HI) of rice as sown in Table 3. The grain yield was found to be significantly different among the treatments. Application of 50% RDN through fertilizer + 50% through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed registered maximum grain yield (3799 kg ha^{-1}) followed by 100% recommended dose of NPK through fertilizer (100 kg N+40 kg P_2O_5+ 40 kg K_2O ha^{-1}) while minimum (2503 kg ha^{-1}) was recorded in control. Similar trends were followed in case of HI, where highest HI (37.11%) was observed at T_9. However, the straw yield (6495 kg ha^{-1}) was observed significantly higher in T_2, 100% recommended dose of NPK through fertilizer (100 kg N+40 kg P_2O_5+ 40 kg K_2O ha^{-1}) and lowest (6006 kg ha^{-1}) in control. Inoculation of biofertilizer shows much beneficial effect to plant growth and development. It is because biofertilizer makes ectophytic bacterial relationship with plant which help in plant growth throughout its life cycle. The study is in line with the finding of Kalhapure et al. [20] and Khambhalkar et al. [21].

3.4 Profitability

Data revealed that economic attributes, i.e., gross returns, net returns, cost of cultivation and B:C had markedly influenced by different treatments. As clear from Table 3, application of 50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed fetched significantly higher gross returns (64805 Rs. ha^{-1}), net returns (25173 Rs. ha^{-1}) and B:C (2.38) as compared to others [22]. But in case of cost of cultivation, it was highest in T_3, 100% RDN through compost followed by T_9. This might be because higher yield obtained from incorporation of inorganic and organic fertilizer + seed treated with bio fertilizer. The results were in close with finding of Mohanty et al. [12], Mondal et al. [15] and Meena et al. [13].

4. CONCLUSION

The study concludes that the application of application of 50% RDN through fertilizer + 50% RDN through compost + seed treated with Azotobacter @ 10 g kg^{-1} seed brought about higher growth, yield attributes, productivity and profitability. It also proves that integrated application of organic and inorganic fertilizers shows sustainability in environment and also improve soil organic matter and nutrient availability.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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