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Impact of integrated nutrient management on growth and yield of rice (*Oryza sativa* L.)

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Abstract

The present investigation entitled "Impact of Integrated Nutrient Management on Growth of Rice (*Oryza Sativa* L.)" was conducted at Research farm of Sardar Patel University, Balaghat (M.P.) during Kharif season of 2025 in Randomized Block Design with three replications and nine treatments which include integration of inorganic fertilizer with organic (FYM and Vermicompost) and bio-fertilizers (*Azotobacter*). The Study revealed that the characters Days to 50% flowering, Days to maturity, Plant height, Number of productive tillers plant⁻¹, Panicle length, Number of filled spiklets panicle⁻¹, Test weight and Grain yield (qha⁻¹) reported significant variation between different integrated nutrient treatments. Pooled data revealed that the maximum grain yield (q ha⁻¹) was recorded by T₈ (42.33 q ha⁻¹), which was at par with T₉ (42.13 q ha⁻¹) and T₂ (40.32 q ha⁻¹), whereas minimum grain yield was reported by T₁: Control (33.56 q ha⁻¹) which suggest that inorganic nutrient applied in integration with organic nutrient increases the yield.

Keywords: United, FYM, bio-fertilizer, *Azotobacter*, etc.

Introduction

Rice (*Oryza sativa* L.) serves as a main food source for more than half of the world's population, especially in Asia and Africa. More than 100 countries cultivate this crop, in which Asia contributes the majority in area and production. In tropics as well as parts of temperate regions of the world, rice is one of the most significant cereal crops. The United Nations designated 2004 as the International Year of Rice with the theme "Rice is life" to highlight the significance of the rice crop as a source of food, for trade, and the tight ties between rice-based systems and many cultures and people worldwide, especially in developing countries. After maize and sugarcane, rice is the agricultural product with the third-highest global production. For small-scale farmers in particular, rice is crucial as an income-producing crop because it offers a source of revenue.

Rice is an essential crop for food security, eradicating poverty, and promoting rural development since it is an abundant supplier of carbohydrates, proteins, and other vital nutrients. Rice includes 87% carbohydrates, 7-8% proteins, and very little fat (Selvakumar *et al.*, 2014) [26]. One-fifth of all calories consumed by humans worldwide, or 80% of calories consumed in Asia, come from rice. In comparison to other food crops, only rice is cooked and eaten as a whole grain, hence quality considerations are of the utmost importance (Hossain *et al.*, 2009) [12]. Poor people in some parts of Asia depend largely on rice.

De Candolle (1886) [10] recognized south India as the origin of rice. Vavilov stated that the origin of rice cultivation should be attributed to India and Myanmar. The crop is grown in various agro-ecological zones, from irrigated highlands to rainfed lowlands. There are a total of 24 species in the genus *Oryza*, of which 22 are wild and two, *Oryza sativa* and *Oryza glaberrima*, are cultivated (D. Chatterjee (1948) [8]. All rice-growing regions cultivate *Oryza sativa*, but only West Africa grows *Oryza glaberrima*. As a result, it suggests that West Africa and South-eastern Asia (India, Myanmar, and Thailand) may have served as the 1 origins of modern cultivated rice. These days, *Oryza sativa indica* and *Oryza sativa japonica* are the two most popular rice species cultivated all over the world. The rice plant is a self-pollinating annual crop and a member of the Poaceae (ancient Gramineae) family. A cluster of spikelets in rice inflorescence is referred to as a panicle.

India is the world's second-largest producer and consumer of rice after China. Over the past few decades, as a result of the use of modern technology including irrigation, fertilizers, pesticides, and improved varieties there has been a tremendous increase in rice production. In the year 2021 around the world, it was grown over an area of 165.25 million hectares, with a total production of 787.29 million tons and yield of 4.76 tons per hectare (FAOSTAT, 2021) [11].

The Indian economy places rice in a special position. In India, rice is raised on an area of 46.38 million ha with an annual yield of 130.29 million tons and a productivity of 2.809 tons/ha (Anonymous, 2023a) [12]. However, productivity is poor because India has the largest rainfed lowland rice area (45%) in the world (Pradhan *et al.*, 2022) [23].

Imbalanced nutrient management under intensive cropping system and decreased soil organic matter are the key factors responsible for decline in soil quality parameters (Kang *et al.*, 2006) [15] such as deterioration of the physical, chemical and biological health of soils, and declined factor productivity, due to much higher annual removal of nutrients by crops and cropping systems than the amount added through fertilizers and resulted negative nutrient balance. In the recent past, Indian farmers showed a tendency to apply more nitrogenous fertilizers to maximize rice yield. Fertilizer N and bio-sources are the major sources of nitrogen supply for crops. Inorganic fertilizer is not a complete substitute for organic matter and vice-versa and their role is complementary to each other. Either organic manures or chemical fertilizers alone can achieve the sustainability of the production system under intensive farming.

The increasing cost of chemical input, pollution, soil health and sustainability of the production system had generated interest in the integrated nutrient management. The integrated nutrient supply system is the most logical concept for managing long term soil fertility and productivity (Ramesh *et al.*, 2009) [24]. Use of chemical fertilizers and organic manures has been found promising in arresting the decline trend in soil-health and productivity through the correction of marginal deficiencies of some secondary and micro-nutrients, micro-flora and fauna and their beneficial impact on physical and biological properties of soil. Integrated nutrient management systems can bring about equilibrium between degenerative and restorative activities in the soil ecosystem (Upadhyay *et al.*, 2011) [33]. Organic manures regulate supply of N by releasing it slowly resulting in increased yield of rice and nutrient use efficiency (Sharma 2002) [28]. Crop residues have potential for improving the soil and water conservation, sustaining soil productivity and enhancing crop yields (Das *et al.*, 2003) [9].

Integrated use of inorganic fertilizers, organic manures, green manures and crop residue are the only alternatives which may help in improving soil health and sustained productivity. Use of organic manures, green manures, crop residues along with inorganic fertilizers not only reduces the demand of inorganic fertilizers but also increases the efficiency of applied nutrients due to their favorable effect on physical, chemical and biological properties of soil (Pandey *et al.*, 2007) [21], as organic manure provide a good substrate for the growth of microorganism and maintain a

favorable nutrient supply to crop and achieve sustainable crop production. However, due to the above point the main purpose of this research is to study the effect of INM on growth and yield parameters of rice.

Materials and Methods

The investigation entitled "Impact of Integrated Nutrient Management on Growth and Yield of Rice (*Oryza Sativa* L.)" was conducted in Kharif, 2025 at Student Research farm, Department of Agronomy, School of Agriculture Science Tech and Research, Sardar Patel University, Dongariya, Balaghat. The present chapter deals with a brief description of materials used and methods employed during the course of investigation. Details of experiment:-Crop: Rice, Variety: Kranti, Planting Materials: Seed, Experimental Design: Randomized Block Design, Number of replications: 3, Number of treatments: 9 Treatments detail:-T₁: Control, T₂: 100% RDF, T₃: 75% RDF + FYM @ 5 t/ha, T₄: 50% RDF + FYM @ 10 t/ha, T₅: 75% RDF + Vermicompost @ 2 t/ha, T₆: 50% RDF + Vermicompost @ 4 t/ha, T₇: 50% RDF + *Azotobacter* culture @ 15 g/kg seed, T₈: 50% RDF + FYM @ 5 t/ha + *Azotobacter* culture @ 15 g/kg seed, T₉: 50% RDF + Vermicompost @ 2 t/ha + *Azotobacter* culture @ 15 g/kg.

Observations recorded:-Days to 50 percent flowering:-The number of days taken from the date of sowing to the 50 percent flowering was measured as days to 50 percent flowering., Days to maturity:-The number of days from sowing to physiological maturity of plants in each plot of genotype taken as days to maturity. Turning 80% spikelets from green to golden yellow in the panicle is an indication of physiological maturity. Plant height (cm):-Plant height was measured at 30, 60, 90 DAS and at harvest from base of the plant to the tip of the panicle excluding awn if present and expressed in centimeter., Numbers of tillers per plant:-The total number of tillers per plant which produced healthy panicles was counted on each selected plant at the time of maturity. Panicle length (cm):-It was measured in centimeters at the time of maturity from the base of the panicle to the tip of the last spikelet. Number of filled spikelets per panicle:-Total numbers of filled grains in the panicle were recorded from all the selected panicles. Test weight (g):-1000 dried and well filled grains were weighed from a random sample of each genotype in each replication and noted in grams using an electronic balance. Grain yield (q/ha):-Mature panicles from each randomly selected plant were harvested, threshed, cleaned and dried separately. Total seed yield of each randomly selected plant was recorded in grams and grain yield ha⁻¹ calculated.

Results & Discussion

Days to 50% flowering: Data pertaining to days to 50% flowering of rice as impact by integrated nutrient treatments are presented in Table. Days to fifty percent flowering is one of the important characters which suggest whether the genotype is early or late and significant variation was observed for this trait. The number of days to 50% flowering were recorded in a range of 89 days in T₁: Control to 92 days in T₉: 50% RDF + VC @ 2 t/ha + AC @ 15 g/kg with a general mean of 90 days. Same kind of results were obtained by Shanthi and Rao (2017) [27], Singh *et al.*, (2017) [30] and Singh *et al.*, (2018) [29] which support the present findings.

Days to maturity: Days to maturity is important trait as early maturity or late maturity is desirable for scheduling cropping patterns. A significant variation was observed for trait days to maturity as impact by integrated nutrient treatments and given in Table. The number of days to maturity were measured from 118 days (T₁: Control) to 122 days (T₉: 50% RDF + VC @ 2 t/ha + AC @ 15 g/kg) with the average mean of 120 days. These results are in conformity with Singh *et al.*, (2017)^[30] and Singh *et al.*, (2018)^[29].

Plant height (cm): Plant height recorded at 30 DAS, 60DAS, 90DAS and at harvest of rice as impacted by various treatments are presented in Table. Plant height varied significantly due to various treatments at all stages of growth of rice. The maximum plant height was recorded in T₉: (50% RDF + VC @ 2 t/ha + AC @ 15 g/kg) 45.33 cm, 75.33 cm, 96 cm and 104.67 cm at 30, 60, 90 DAS and at harvest respectively. While minimum plant height was recorded in T₁: Control 42 cm, 72.67 cm, 93.33 cm and 101 cm at 30, 60, 90DAS and at harvest respectively.

The data on plant height showed that sole inorganic nutrient (100% RDF) and when integrated with organic fertilizers (FYM and Vermicompost) and bio-fertilizer at 50% and 75% of RDF significantly increased plant height of rice as compared to control. The results were in conformity with those reported Baishya *et al.*, (2015)^[4], Mondal *et al.*, (2015)^[20], Sahu *et al.*, (2015)^[25], Kandeshwari *et al.*, (2016)^[14], Marzia *et al.*, (2016)^[18], Shanthi and Rao (2017)^[27], Imade *et al.*, (2017)^[13], Kumar *et al.*, (2017)^[17], Singh *et al.*, (2017)^[30], Singh *et al.*, (2018)^[29], Balasu bramanian (2019)^[5], Ajay Kumar and Siva kumar (2020)^[3], Chakraborty *et al.*, (2020)^[7], Dongre *et al.*, (2022)^[36], Mangaraj *et al.*, (2022)^[35] and Kumar *et al.*, (2023)^[34]. But Tomar *et al.*, (2018)^[32] reported non-significant at 30 DAS and significant at 60, 90 DAS and at harvest.

Number of productive tillers plant⁻¹: Number of productive tillers plant⁻¹ is an important character which is closely associated with grain yield and showed significant variation among studied different in tegrated nutrient treatment and given in Table. The number of productive tillers plant⁻¹ varied from 7.00 (T₁: Control) to 9.67 (T₉: 50% RDF + VC @ 2 t/ha + AC @ 15 g/kg) with a general mean of 8.22. The results obtained forth is character are in conformity with Baishya *et al.*, (2015)^[4], Sahu *et al.*, (2015)^[25], Kandeshwari *et al.*, (2016)^[14], Marzia *et al.*, (2016)^[18], Shanthi and Rao (2017)^[27], Imade *et al.*, (2017)^[13], Singh *et al.*, (2017)^[30], Kumar *et al.*, (2019)^[16], Ajaykumar and Sivakumar (2020)^[3], Chakraborty *et al.*, (2020)^[7] and Dongre *et al.*, (2022)^[36].

Panicle length (cm): Panicle length is an important yield-related trait, strongly affects yield components, such as grain number, grain density and rice quality. A significant variation was observed for panicle length among various nutrient treatments studied and recorded in Table. The general mean of panicle length was recorded 18.57 cm with the lowest panicle length observed was 17.00 cm in T₁: Control and highest panicle length observed was 20.00 cm in T₉: 50% RDF + VC @ 2 t/ha + AC @ 15 g/kg. Same results were observed by Baishya *et al.*, (2015)^[4], Mondal *et al.*, (2015)^[20], Sahu *et al.*, (2015)^[25], Marzia *et al.*, (2016)^[18], Imade *et al.*, (2017)^[13], Kumar *et al.*, (2017)^[17], Tiwari

et al., (2017)^[31], Aasif *et al.*, (2018)^[1], Singh *et al.*, (2018)^[29], Ashem and Roy (2022)^[37], Dongre *et al.*, (2022)^[36] and Kumar *et al.*, (2023)^[34].

Number of filled grain panicle-1: The number of filled grains panicle-1 is yield related component and strongly affect the yield potential. It exhibited significant variation within studied various integrated nutrient treatments and given in Table. Number of filled grains panicle-1 varied from 151 (T₁: Control) to 167.67 (T₈) with a general mean of 159.81. The treatment with the few estfilled grains per panicle was T₁ (151) followed by T₇ (153.33), T₆ (155.67) While, the treatments the Treatments T₈ (167.67), T₉ (167.33) and T₂ (167), recorded the highest number of filled grains per panicle. Mondal *et al.*, (2015)^[20], Sahu *et al.*, (2015)^[25], Marzia *et al.*, (2016)^[18], Shanthi and Rao (2017)^[27], Imade *et al.*, (2017)^[13], Tiwari *et al.*, (2017)^[31], Aasif *et al.*, (2018)^[1], Singh *et al.*, (2018)^[29], Ganguly *et al.*, (2019), Ashem and Roy (2022)^[37], Dongre *et al.*, (2022)^[36], Mangaraj *et al.*, (2022)^[35] and Kumar *et al.*, (2023)^[34] also recorded similar results for number of filled grains panicle-1 and support the current results. But non-significant variation between various treatments for this character was recorded by Chakraborty *et al.*, (2020)^[7].

Test weight (g): The data on test weight (g) of rice is presented in Table 1. The significant difference for test weight due to different nutrient treatments was reported. Among nutrient treatments, maximum test weight was recorded in T₉: 50% RDF + VC @ 2 t/ha + AC @ 15 g/kg (25.33 g), which was at par with T₈: 50% RDF + FYM @ 5 t/ha + AC @ 15 g/kg (24.67 g) and T₂: 100% RDF (24.47 g), whereas minimum test weight was reported by T₁ (22.57 g) and T₇ (22.97 g). All the integrated nutrient treatments when applied as sole inorganic nutrient (100% RDF) and with organic fertilizers (FYM and Vermi compost) and bio-fertilizer (*Azoto bacter*) proved significantly superior to T₁: Control in respect to test weight. Similar results for test weight are reported by I made *et al.*, (2017)^[13], Kumar *et al.*, (2017)^[17], Singh *et al.*, (2018)^[29], Kumar *et al.*, (2019)^[16], Chakraborty *et al.*, (2020)^[7] and Kumar *et al.*, (2023)^[34]. Non-significant variation between various treatments for test weight was recorded by Mondal *et al.*, (2015)^[20], Sahu *et al.*, (2015)^[25], Marzia *et al.*, (2016)^[18], Shanthi and Rao (2017)^[27], Tiwari *et al.*, (2017)^[31], Ashem and Roy (2022)^[37] and Dongre *et al.*, (2022)^[36].

Grain yield per plant (g): The grain yield per plant (g) impacted by integrated nutrients practices are presented in Table 2. The grain yield per plant (g) differed significantly among all the treatments under investigation. The range of average grain yield per plant was from 12.93 g (T₁) to 24.97 g (T₉), with a general mean 21.16 g. The treatments T₉ (24.97 g), T₈ (24.83 g) and T₂ (23.93 g) recorded highest grain yield per plant. Hence these treatments can be included for getting higher yield. Same results for grain yield per plant recorded by Mondal *et al.*, (2015)^[20], Sahu *et al.*, (2015)^[25], Kandeshwari *et al.*, (2016)^[14], Marzia *et al.*, (2016)^[18], Shanthi and Rao (2017)^[27], Imade *et al.*, (2017)^[13], Kumar *et al.*, (2017)^[17], Mishra *et al.*, (2017)^[30], Tiwari *et al.*, (2017)^[31], Aasif *et al.*, (2018)^[1], Patra *et al.*, (2017)^[22], Singh *et al.*, (2018)^[29], Tomar *et al.*, (2018)^[32], Balasubramanian (2019)^[5], Kumar *et al.*, (2019)^[16], Bordoloi and Islam (2020)^[6], Chakraborty *et al.*, (2020)^[7].

Table 1: Impact of Integrated Nutrient Management on Growth and Yield of Rice (*Oryza sativa* L.)

Tr. No	Treatments	Days to 50% flowering	Days to maturity	Plant Height (cm)			
				30 DAS	60 DAS	90 DAS	AT HARVEST
T ₁	Control	89	118	42.00	72.67	93.33	101.00
T ₂	100% RDF	91	121	45.00	75.00	95.33	104.00
T ₃	75% RDF + FYM @ 5 t/ha	89	119	44.33	74.33	94.00	103.67
T ₄	50% RDF + FYM @ 10 t/ha	89	119	43.67	73.67	93.33	102.33
T ₅	75% RDF + VC @ 2 t/ha	89	120	44.33	74.33	94.67	103.33
T ₆	50% RDF + VC @ 4 t/ha	89	118	43.33	73.33	93.33	103.00
T ₇	50% RDF + AC @ 5 g/kg	88	118	43.00	73.00	93.00	102.33
T ₈	50% RDF + FYM @ 5 t/ha + AC @ 15 g/kg	91	122	45.00	75.33	96.00	104.33
T ₉	50% RDF + VC @ 2 t/ha + AC @ 15 g/kg	92	122	45.33	75.33	96.00	104.67
	S.Em =	0.75	0.61	0.61	0.57	0.67	0.59
	CD(5%) =	2.24	1.82	1.82	1.72	2.00	1.76
	CV =	1.44	0.88	2.40	1.34	1.22	0.99

Tr. No	Treatments	Number of productive tillers plant ⁻¹	Panicle length (cm)	No. of filled grains/panicle	Test weight (g)	Grain yield plant ⁻¹ (g)
T ₁	Control	7.00	17.00	151.00	22.57	12.93
T ₂	100% RDF	9.33	19.67	167.00	24.47	23.93
T ₃	75% RDF + FYM @ 5 t/ha	8.33	18.67	160.00	23.43	22.40
T ₄	50% RDF + FYM @ 10 t/ha	7.33	18.00	156.67	23.07	20.83
T ₅	75% RDF + VC @ 2 t/ha	8.00	18.17	159.67	23.53	22.00
T ₆	50% RDF + VC @ 4 t/ha	7.67	18.00	155.67	23.03	21.97
T ₇	50% RDF + AC @ 5 g/kg	7.33	17.83	153.33	22.97	16.53
T ₈	50% RDF + FYM @ 5 t/ha + AC @ 15 g/kg	9.33	19.83	167.67	24.67	24.83
T ₉	50% RDF + VC @ 2 t/ha + AC @ 15 g/kg	9.67	20.00	167.33	25.33	24.97
	S.Em =	0.41	0.30	1.74	0.50	0.39
	CD(5%) =	1.22	0.91	5.23	1.50	1.16
	CV =	8.60	2.83	1.89	3.67	3.16

Conclusion

The following conclusions were drawn on the basis of results obtained from the present investigation. Application of organic fertilizer (farm yard manure, vermi-compost) and bio-fertilizer (*Azotobacter*) in integration with inorganic fertilizers has resulted in improvement in growth, yield and quality of crops. Integration of inorganic nutrient with vermicompost and *Azotobacter* was found superior to all other treatments. The maximum grain yield was observed when in organic fertilizer in tegrated with vermicompost and *Azotobacter* which was at par with when inorganic fertilizer integrated with FYM and *Azotobacter* and when nutrient applied as sole inorganic fertilizer. The maximum net monetary return was recorded when nutrient applied as inorganic fertilizer integrated with FYM and *Azotobacter* which was at par with when nutrient applied as sole inorganic fertilizer. In term of monetary parameter, highest benefit cost ratio observed when nutrient applied as sole inorganic fertilizer.

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