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Assess of Integrated Nutrient Management Practices on the Performance of Direct Seeded Rice in Terms of Economic, Nutrient content and Uptake

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ABSTRACT: The prognosis of increasing water scarcity under climate crisis and escalation of labor shortages in agriculture have brought a paradigm swing in rice cultivation from conventionally flooded transplanting to direct-seeded rice. Furthermore, rice being an exhaustive crop leads to nutrient depletion. Therefore, integrated nutrient management can be an effective way to sustain soil health and increase in crop productivity. This study evaluates the impact of INM practices on the performance of direct seeded rice in terms of economic, nutrient content and uptake at the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University in Randomized Block Design with 3 replications and 12 treatments during the kharif season of 2019 and 2020. Higher nutrient content and uptake by grains and straw was observed T_5 (100% RDF + FYM @ 2 t ha^{-1} + PSB) followed by T_4 which showed parity with each other and significantly higher than the rest of the treatments. Significantly minimum value was noted in T_1 (Control). Furthermore, integrated application of nutrients (T_5) fetched maximum gross return, net return and B:C ratio.

Keywords: INM, nutrient content, nutrient uptake, economic, direct seeded rice.

INTRODUCTION

Rice is the lifeline for almost half of the world's population particularly in Asia and Africa which is found in a wide variety of cuisines and provides a significant portion of dietary intake (Fukagawa and Ziska 2019). As our population soars, achieving sustainability of rice which is affordable, sufficient and stable towards the demand of poor rice consumers in future has become an important challenge.

Since Indian agriculture continues to be a gamble in monsoon, the scarcity of water for rice production as well as reduction for labor force has become a major problem. Therefore, dry direct-seeded rice has emerged as a simplified and sustainable cultivation technology to deal with water and labor shortage. The direct seeded rice cultivation system is practice of sowing seeds in unsaturated and puddled soil which greatly improve water and environment sustainability (Sandhu *et al.,* 2021).

Rice, being a heavy feeder, leads to the depletion of soil nutrients. Therefore, sustainable productivity of rice cropping system greatly depends on appropriate nutrient management in accordance with the inherent soil fertility. Use of inorganic fertilizers increases the nutrient content for a short period but in the long run had their unpropitious effect on soil properties (Patra *et al.,* 2020). Therefore, the integration of synthetic fertilizers, organic manures and biofertilizer in proper proportions can be a beneficial and sustainable practice for better production and soil quality improvement.

Biofertilizers are cheap, eco-friendly and provide nutrients to the crop for a prolonged period. Farmyard manure acts as soil conditioners by providing a congenial environment for the growth of the microbial population. Organic sources, apart from improving intrinsic properties of soil, help in enhancing the use efficiency of fertilizers (Midya *et al.*, 2021). Amalgamation of mineral fertilizers with organic manures proved to be environmentally safe and cost-effective ideal farming system that uses remunerations from all probable sources of nutrition in a careful, effective and conjunctive way (Sharma *et al.,* 2019). Therefore, this study outlines the performance of direct seeded rice with integrated nutrient management practices in terms of economic, nutrient content and uptake to understand the necessity of nutrient supplementation to avoid long-term nutrient deficiencies.

MATERIAL AND METHODS

The survey was carried out at the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus during the kharif season of 2019 and 2020. The soil was sandy clay loam in texture situated at 20°45′43″N latitude and 93°53′04″E longitude with an

altitude of 310 m above mean sea level. The experimental site lies in the humid sub-tropical zone with hot and humid summer and mild winter.
The mean temperature varies from 21°C to 32°C during summer and barely goes below 8°C in winter with an annual precipitation ranges from 1500-2500 mm with high humidity and moderated temperature which is illustrated in Fig. 1 and 2.

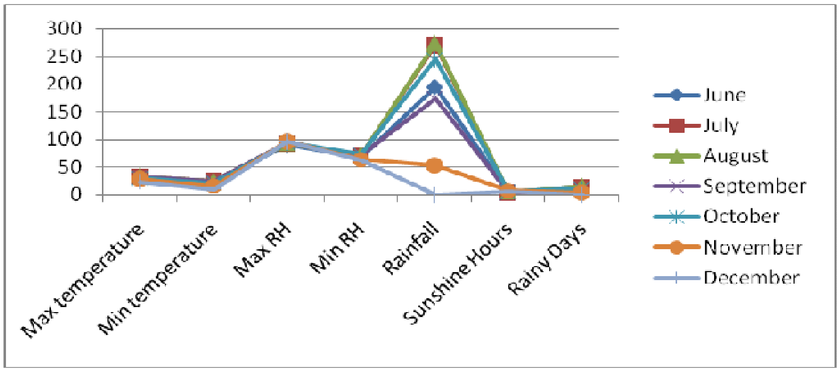

Fig. 1. Monthly meteorological data during the period of investigation (2019).

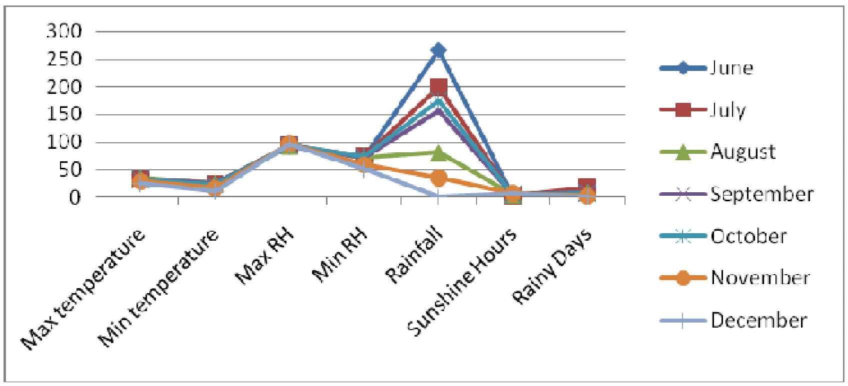

Fig. 2. Monthly meteorological data during the period of investigation (2020).

The experimental treatments comprised of 12 treatments: T_1: Control, T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 ha^{-1} + 30 kg K_2O ha^{-1}), T_3: 100% RDF +PSB, T_4: 100% RDF + FYM @ 2 t ha^{-1}, T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB, T_6: 75% RDF + PSB, T_7: 75% RDF + FYM @ 2 t ha^{-1}, T_8: 75 % RDF + FYM @ 2 t ha^{-1} + PSB, T_9: 50% RDF + PSB, T_{10}: 50% RDF + FYM @ 2 t ha^{-1}, T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB, T_{12}: 109 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 46 kg K_2O ha^{-1} (SSNM). These treatments combinations were laid out in randomized block design and replicated thrice.
The collected grains and straw from the designated plots were sun dried separately and put to oven for drying at 60-70°C to attain a constant weight. The dried samples such as grains and straw were then grinded to powder and stored in polythene bags labeled for various chemical analysis such and NPK and S content. The uptake of different nutrients was separately carried out in grains and straw samples multiplying nutrient content (%) in grains and straw sample with their corresponding yield data.

$$\text{Nutrient uptake} = \frac{\text{Yield kg ha}^{-1} \times \text{Nutrient content (\%)}}{100}$$

The cost of cultivation (Rs. ha^{-1}) was calculated as per item wise cost incurred in each treatment. Gross return (Rs. ha^{-1}), net return (Rs. ha^{-1}) and benefit-cost ratio were worked out for various treatments at the end of the first crop and also at the end of the crop sequence on the basis of input costs and output prices. Economics of different treatment was worked out as per existing market prices.

Statistical analysis. The statistical significance of the treatment effect was judged with the help of variance ratio test (F test). Critical Difference (C.D.) at 5% level of significance was worked out to determine the difference between treatment means by using the following formula:

$$\text{C.D} = \text{SEm} \pm \times \sqrt{\mathbf{2}} \times t_{0.05} \text{ for error degree of freedom}$$

RESULTS AND DISCUSSION

Nutrient content in grains and straw (%). As evident from the table, the highest N, P and K content in both grains and straw was observed in T_5 (100% RDF + FYM @ 2 t ha^{-1} + PSB) which showed parity with T_4 (100% RDF + FYM @ 2 t ha^{-1}) and both these treatments are significantly superior to the rest of the treatments. Control treatment (T_1) recorded significantly lowest value during both the years of the investigation due to mining of nutrients and continuous cropping without incorporation of nutrient for consecutively two years. However, the S content in grains and straw failed to show any significant variation during both the years of experimentation.
Increase in N content in plants may be the result of positive inter-relationship between nutrients with

enriched compost that had exerted beneficial effects in the release of ammonical and nitrate nitrogen. Similar results have been reported Patra *et al.* (2020) where the addition of nitrogenous fertilizer along with FYM helped in narrowing down of C:N ratio which in return increased mineralization and also speed up the conversion of organically bound N to inorganic forms. The improvement in N content of grain and straw of rice in organic treatment along with inorganic source could possibly be due to slow release of nutrients to the soil along with inorganic source and thus made it available throughout the growing period (Baitilwake *et al.,* 2012; Meetei *et al*., 2019).

The increased phosphorus content in grain and straw could perhaps be due to gradual release of nutrients from organic sources thereby increasing soil nutrients along with inorganic source and made available during the growing season. Similar discovery on higher concentration of P in rice crop was earlier given by Latha *et al.* (2019); Meetei *et al.* (2019). Release of organic acids during decomposition of organic matter and their reaction with inert rock phosphate resulted to give rise to more inorganic phosphorus (Patra *et al*., 2020). Chelation of H^+ or Al^{3+} ions might be another reason for enhancement of phosphorus mobilization (Reyes *et al.,* 2006). Incorporation of PSB in the soil also solubilized phosphorus and is made available to the crop.

Application of either inorganic, organic, bio-fertilizer or their combinations increased the potassium content of rice. This might be due to slow release of nutrients from organic sources thereby increasing potassium in soil along with inorganic source during the growing stage and made it available throughout the growing period (Baitilwake *et al.,* 2012; Meetei *et al*., 2019).

Nutrient uptake by grain and straw (kg ha^{-1}). As evident from the result, the maximum N, P and K uptake by grains and straw was recorded in T_5 (100% RDF + FYM @ 2 t ha^{-1} + PSB) followed by T_4 which is found to be at par with each other and significantly higher than the rest of the treatments. The significantly minimum uptake of nutrients by grains and straw was noted in the control treatment (T_1) during both the years of field trials. However, the value of sulphur uptake by the grains and straw increased with increased levels of fertilizer doses along with FYM and bio-fertilizer but did not show any significant effect on their uptake during two years of study.

N uptake by grains and straw of rice was significantly increased when level of nutrients (NPK) increased up to 100% RDF using fertilizer alone or in combination with organic manures (FYM) and bio-fertilizer. The increase might be due to optimum supply of nutrients either through inorganic fertilizers or with integrated approach which resulted in better growth of roots which extracted higher amount of nutrients from soil resulting in higher uptake of nutrients both in grain and straw of the crop. Similar discovery were also documented by Biswas *et al.* (2020).

The treatments that comprised of more of inorganic P resulted in more P uptake compared to other treatments. The results are in conformity with the works of Kumar *et al*. (2018); Shultana *et al.* (2019). Moreover, incorporation of PSB solubilized the fixed P and made it available to plant and hence enhanced the uptake of P by the plants.

The chemical fertilizer released nutrient faster which leads to higher uptake by the plants meanwhile the availability of potassium and its uptake by the plants increased after the proper decomposition of organic manure. The increased in uptake of potassium as documented by Biswas *et al*. (2020) with integrated approach showed better growth of roots which ultimately extract higher amount of nutrients from the soil thus result in better uptake by the plants.

Economics. Economics of any treatment is the deciding factor in many situations, to judge its applicability in the field condition to recommend farming community to obtain better return with minimum investment in cultivation. Maximum cost of cultivation with a value of Rs. 37486.5 ha^{-1} was recorded in treatment T_5 where 100% RDF + FYM @ 2 t ha^{-1} + PSB was applied closely followed by T_4 treatment (100% RDF + FYM @ 2 t ha^{-1}) in both the years. The result showed that integrated use of inorganic and organic nutrients became costlier as compared to control or lesser rate of fertilizer doses or sole application of fertilizer. The lowest cost of cultivation having a value of Rs. 26800 ha^{-1} was observed in control treatment (T_1) where no nutrient was applied except for the labor charge. Mandal *et al.* (2018) also reported similar findings where cost of cultivation increased with increase in fertilizer quantity. The maximum gross and net was noted in treatment T_5 where the crop received 100% RDF + FYM @ 2 t ha^{-1} + PSB respectively, followed by T_4 with 100% RDF + FYM @ 2 t ha^{-1}. The lowest net return was recorded in control treatment (T_1) during both the years of investigation. Benefit: cost ratio followed an interesting trend. The crops receiving highest dose of fertilizer i.e., 100% RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O) + FYM @ 2 t ha^{-1} + PSB (T_5) paid the highest benefit: cost ratio with the value of 1.23 % in 2019 and 1.27 % followed by T_{12} treatment receiving 109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O (SSNM) which could be due to high cost of fertilizer and organic manure with increase in fertilizer quantity. On the other hand, the lowest return per rupee with the value of 0.75 % and 0.74 % was observed in treatment T_{10} (50% RDF + FYM @ 2 t ha^{-1}). The result was similar with Borkar *et al.* (2008); Mandal *et al*. (2018).

Table 1: Initial soil status of the experiment plot.

Sr. No.	Soil Parameters	Methods	Values	
			2019	2020
1.	Soil pH	Glass electrode pH meter (Richards, 1954)	4.70	4.85
2.	Organic Carbon (%)	Rapid titration method outlined by Walkley and Black (1934) and expressed in percentage as described by Jackson (1973).	1.26	1.40
5.	N (kg ha^{-1})	Alkaline potassium permanganate method as described by Subbiah and Asija (1956)	260.54	276.80
6.	P (kg ha^{-1})	Brays and Kurtz method (1945)	16.93	20.85
7.	K (kg ha^{-1})	Flame photometric method using neutral normal ammonium acetate (pH 7.0) (Jackson, 1973).	133.45	142.64
8.	S (kg ha^{-1})	Turbidimetric method (Chesnin and Yien 1950)	5.20	6.98
14.	Mechanical analysis Sand (%) Silt (%) Clay (%)	International Pipette Method using 1 N NaOH (Piper, 1966)	 51.20 19.00 29.80	 49.90 22.90 27.20
15.	Soil Texture	International Pipette Method using 1 N NaOH (Piper, 1966)	Sandy clay loam	
16.	Nutrient content of FYM	N: 1.32 % P: 0.43 % K: 1.28 %		

Table 2: Influence of integrated nutrient management in direct seeded rice on nitrogen content in grain and straw.

Treatments	N content in grain (%)			N content in straw (%)		
	2019	2020	Pooled	2019	2020	Pooled
T_1: Control	1.11	1.11	1.11	0.58	0.57	0.58
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	1.20	1.21	1.21	0.66	0.66	0.66
T_3: 100% RDF + PSB	1.21	1.22	1.21	0.66	0.67	0.67
T_4: 100% RDF + FYM @ 2 t ha^{-1}	1.25	1.26	1.25	0.69	0.70	0.70
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	1.26	1.27	1.26	0.70	0.71	0.71
T_6: 75% RDF + PSB	1.17	1.17	1.17	0.63	0.63	0.63
T_7: 75% RDF + FYM @ 2 t ha^{-1}	1.18	1.19	1.18	0.64	0.64	0.64
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	1.19	1.19	1.19	0.65	0.65	0.65
T_9: 50% RDF + PSB	1.14	1.14	1.14	0.60	0.60	0.60
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	1.15	1.15	1.15	0.61	0.61	0.61
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	1.16	1.16	1.16	0.62	0.62	0.62
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	1.22	1.23	1.22	0.67	0.68	0.68
Sem±	**0.009**	**0.010**	**0.007**	**0.007**	**0.007**	**0.005**
CD (P=0.05)	**0.026**	**0.028**	**0.019**	**0.020**	**0.019**	**0.013**

Table 3: Influence of integrated nutrient management in direct seeded rice on phosphorus content in grain and straw.

Treatments	P content in grain (%)			P content in straw (%)		
	2019	2020	2019	2020	2019	2020
T_1: Control	0.28	0.27	0.28	0.27	0.28	0.27
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	0.33	0.33	0.33	0.33	0.33	0.33
T_3: 100% RDF + PSB	0.33	0.34	0.33	0.34	0.33	0.34
T_4: 100% RDF + FYM @ 2 t ha^{-1}	0.35	0.36	0.35	0.36	0.35	0.36
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	0.36	0.37	0.36	0.37	0.36	0.37
T_6: 75% RDF + PSB	0.31	0.31	0.31	0.31	0.31	0.31
T_7: 75% RDF + FYM @ 2 t ha^{-1}	0.32	0.31	0.32	0.31	0.32	0.31
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	0.32	0.32	0.32	0.32	0.32	0.32
T_9: 50% RDF + PSB	0.29	0.28	0.29	0.28	0.29	0.28
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	0.30	0.29	0.30	0.29	0.30	0.29
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	0.30	0.30	0.30	0.30	0.30	0.30
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	0.34	0.35	0.34	0.35	0.34	0.35
Sem±	**0.004**	**0.003**	**0.004**	**0.003**	**0.004**	**0.003**
CD (P=0.05)	**0.011**	**0.010**	**0.011**	**0.010**	**0.011**	**0.010**

Table 4: Influence of integrated nutrient management in direct seeded rice on potassium content in grain and straw.

Treatments	K content in grain (%)			K content in straw (%)		
	2019	2020	2019	2020	2019	2020
T_1: Control	0.23	0.22	0.23	0.22	0.23	0.22
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	0.25	0.26	0.25	0.26	0.25	0.26
T_3: 100% RDF + PSB	0.26	0.26	0.26	0.26	0.26	0.26
T_4: 100% RDF + FYM @ 2 t ha^{-1}	0.27	0.27	0.27	0.27	0.27	0.27
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	0.27	0.27	0.27	0.27	0.27	0.27
T_6: 75% RDF + PSB	0.24	0.25	0.24	0.25	0.24	0.25
T_7: 75% RDF + FYM @ 2 t ha^{-1}	0.25	0.25	0.25	0.25	0.25	0.25
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	0.25	0.25	0.25	0.25	0.25	0.25
T_9: 50% RDF + PSB	0.24	0.23	0.24	0.23	0.24	0.23
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	0.24	0.24	0.24	0.24	0.24	0.24
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	0.24	0.24	0.24	0.24	0.24	0.24
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	0.26	0.26	0.26	0.26	0.26	0.26
Sem±	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**
CD (P=0.05)	**0.005**	**0.006**	**0.005**	**0.006**	**0.005**	**0.006**

Table 5: Influence of integrated nutrient management in direct seeded rice on sulphur content in grain and straw.

Treatments	S content in grain (%)			S content in straw (%)		
	2019	2020	2019	2020	2019	2020
T_1: Control	0.16	0.15	0.16	0.15	0.16	0.15
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	0.22	0.22	0.22	0.22	0.22	0.22
T_3: 100% RDF + PSB	0.23	0.23	0.23	0.23	0.23	0.23
T_4: 100% RDF + FYM @ 2 t ha^{-1}	0.25	0.26	0.25	0.26	0.25	0.26
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	0.26	0.26	0.26	0.26	0.26	0.26
T_6: 75% RDF + PSB	0.20	0.19	0.20	0.19	0.20	0.19
T_7: 75% RDF + FYM @ 2 t ha^{-1}	0.21	0.24	0.21	0.24	0.21	0.24
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	0.22	0.21	0.22	0.21	0.22	0.21
T_9: 50% RDF + PSB	0.17	0.16	0.17	0.16	0.17	0.16
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	0.18	0.17	0.18	0.17	0.18	0.17
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	0.19	0.18	0.19	0.18	0.19	0.18
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	0.24	0.24	0.24	0.24	0.24	0.24
Sem±	**0.035**	**0.039**	**0.035**	**0.039**	**0.035**	**0.039**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 6: Influence of integrated nutrient management in direct seeded rice on nitrogen uptake by grain and straw.

Treatments	N uptake by grain (kg ha^{-1})			N uptake by straw (kg ha^{-1})		
	2019	2020	2019	2020	2019	2020
T_1: Control	24.85	24.34	24.85	24.34	24.85	24.34
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	39.24	39.40	39.24	39.40	39.24	39.40
T_3: 100% RDF + PSB	40.94	41.17	40.94	41.17	40.94	41.17
T_4: 100% RDF + FYM @ 2 t ha^{-1}	47.26	48.14	47.26	48.14	47.26	48.14
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	48.94	50.00	48.94	50.00	48.94	50.00
T_6: 75% RDF + PSB	34.38	34.25	34.38	34.25	34.38	34.25
T_7: 75% RDF + FYM @ 2 t ha^{-1}	36.03	36.08	36.03	36.08	36.03	36.08
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	37.52	37.56	37.52	37.56	37.52	37.56
T_9: 50% RDF + PSB	29.58	29.03	29.58	29.03	29.58	29.03
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	31.27	30.93	31.27	30.93	31.27	30.93
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	32.67	32.36	32.67	32.36	32.67	32.36
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	42.50	42.97	42.50	42.97	42.50	42.97
Sem±	**1.08**	**1.14**	**1.08**	**1.14**	**1.08**	**1.14**
CD (P=0.05)	**3.16**	**3.34**	**3.16**	**3.34**	**3.16**	**3.34**

Table 7: Influence of integrated nutrient management in direct seeded rice on phosphorus uptake by grain and straw.

Treatments	P uptake by grain (kg ha^{-1})			P uptake by straw (kg ha^{-1})		
	2019	2020	2019	2020	2019	2020
T_1: Control	6.17	5.97	6.17	5.97	6.17	5.97
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	10.68	10.81	10.68	10.81	10.68	10.81
T_3: 100% RDF + PSB	11.28	11.50	11.28	11.50	11.28	11.50
T_4: 100% RDF + FYM @ 2 t ha^{-1}	13.33	13.84	13.33	13.84	13.33	13.84
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	13.97	14.55	13.97	14.55	13.97	14.55
T_6: 75% RDF + PSB	9.08	8.94	9.08	8.94	9.08	8.94
T_7: 75% RDF + FYM @ 2 t ha^{-1}	9.64	9.59	9.64	9.59	9.64	9.59
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	10.10	10.14	10.10	10.14	10.10	10.14
T_9: 50% RDF + PSB	7.51	7.25	7.51	7.25	7.51	7.25
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	8.03	7.84	8.03	7.84	8.03	7.84
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	8.52	8.32	8.52	8.32	8.52	8.32
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	11.85	12.23	11.85	12.23	11.85	12.23
Sem±	**0.39**	**0.41**	**0.39**	**0.41**	**0.39**	**0.41**
CD (P=0.05)	**1.15**	**1.21**	**1.15**	**1.21**	**1.15**	**1.21**

Table 8: Influence of integrated nutrient management in direct seeded rice on potasssium uptake by grain and straw.

Treatments	K uptake by grain (kg ha^{-1})			K uptake by straw (kg ha^{-1})		
	2019	2020	2019	2020	2019	2020
T_1: Control	5.11	4.93	5.11	4.93	5.11	4.93
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	8.28	8.37	8.28	8.37	8.28	8.37
T_3: 100% RDF + PSB	8.69	8.81	8.69	8.81	8.69	8.81
T_4: 100% RDF + FYM @ 2 t ha^{-1}	10.09	10.38	10.09	10.38	10.09	10.38
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	10.50	10.79	10.50	10.79	10.50	10.79
T_6: 75% RDF + PSB	7.16	7.15	7.16	7.15	7.16	7.15
T_7: 75% RDF + FYM @ 2 t ha^{-1}	7.55	7.58	7.55	7.58	7.55	7.58
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	7.90	7.93	7.90	7.93	7.90	7.93
T_9: 50% RDF + PSB	6.11	5.94	6.11	5.94	6.11	5.94
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	6.45	6.38	6.45	6.38	6.45	6.38
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	6.80	6.73	6.80	6.73	6.80	6.73
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	9.08	9.22	9.08	9.22	9.08	9.22
Sem±	**0.27**	**0.28**	**0.27**	**0.28**	**0.27**	**0.28**
CD (P=0.05)	**0.79**	**0.83**	**0.79**	**0.83**	**0.79**	**0.83**

Table 9: Influence of integrated nutrient management in direct seeded rice on sulphur uptake by grain and straw.

Treatments	S uptake by grain (kg ha^{-1})			S uptake by straw (kg ha^{-1})		
	2019	2020	2019	2020	2019	2020
T_1: Control	3.55	3.24	3.55	3.24	3.55	3.24
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	7.40	7.24	7.40	7.24	7.40	7.24
T_3: 100% RDF + PSB	7.93	7.79	7.93	7.79	7.93	7.79
T_4: 100% RDF + FYM @ 2 t ha^{-1}	9.58	9.69	9.58	9.69	9.58	9.69
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	10.10	10.32	10.10	10.32	10.10	10.32
T_6: 75% RDF + PSB	5.71	5.69	5.71	5.69	5.71	5.69
T_7: 75% RDF + FYM @ 2 t ha^{-1}	6.38	7.15	6.38	7.15	6.38	7.15
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	6.69	6.75	6.69	6.75	6.69	6.75
T_9: 50% RDF + PSB	4.44	4.04	4.44	4.04	4.44	4.04
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	4.81	4.71	4.81	4.71	4.81	4.71
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	5.30	4.97	5.30	4.97	5.30	4.97
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	8.44	8.42	8.44	8.42	8.44	8.42
Sem±	**2.25**	**2.18**	**2.25**	**2.18**	**2.25**	**2.18**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 10: Influence of integrated nutrient management in direct seeded rice on economics of treatments.

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross Return (Rs. ha^{-1})		Net Return (Rs. ha^{-1})		B:C Ratio	
		2019	2020	2019	2020	2019	2020
T_1: Control	26800.00	48815.00	48006.67	22015.00	21206.67	0.82	0.79
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	34406.50	70439.33	70624.00	36032.83	36217.50	1.05	1.05
T_3: 100% RDF + PSB	34486.50	72800.00	73137.00	38313.50	38650.50	1.11	1.12
T_4: 100% RDF + FYM @ 2 t ha^{-1}	37406.50	81484.00	82598.67	44077.50	45192.17	1.18	1.21
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	37486.50	83682.33	84947.67	46195.83	47461.17	1.23	1.27
T_6: 75% RDF + PSB	32584.75	63552.00	63219.67	30967.25	30634.92	0.95	0.94
T_7: 75% RDF + FYM @ 2 t ha^{-1}	35504.75	65971.00	65949.00	30466.25	30444.25	0.86	0.86
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	35584.75	68014.00	68025.67	32429.25	32440.92	0.91	0.91
T_9: 50% RDF + PSB	30683.25	56457.33	55501.33	25774.08	24818.08	0.84	0.81
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	33603.25	58958.67	58330.33	25355.42	24727.08	0.75	0.74
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	33683.25	61100.00	60514.33	27416.75	26831.08	0.81	0.80
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	33899.30	74972.33	75611.67	41073.03	41712.37	1.21	1.23

CONCLUSIONS

The outcome of the study disclosed that T_5 (100% RDF + FYM @ 2 t ha^{-1} + PSB) recorded higher nutrient content and uptake as well as higher profitability during both the years of investigation. Therefore, it can be concluded that integrated nutrient management has emerged as a solution to degraded soil fertility and sustainable crop production.

FUTURE SCOPE

It is suggested that the experiment may be repeated at different sites at least one or two years with more specific treatment combination to get clear-cut recommendation for farmers.

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