

Effect of Integrated Nutrient Management on Growth, Yield, Nutrient Content and Economics of Summer Rice (*Oryza sativa* L.)

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ABSTRACT

A field trial was performed during summer season of 2019 at M.S. Swaminathan School of Agriculture, Paralakhemundi, Odisha. The experiment was laid out in randomized block design with eight treatments which are replicated thrice. Treatments are 100% RDN (T_1), 75% RDN+25% N through vermicompost (T_2), 75% RDN+25% N through FYM (T_3), 50% RDN+50% N through vermicompost (T_4), 50% RDN+50% N through FYM (T_5), 50% RDN+25% N through vermicompost+25% N through FYM (T_6), 25% RDN+25% N through vermicompost+50% N through FYM (T_7) and Control (T_8). The rice variety used in the trial was RNR 15048. The integrated nutrient management (INM) expressed significantly better results on growth, yield, nutrient content and economics of summer rice. The treatments with 75% RDN along with 25% vermicompost (T_2) and 75% RDN along with 25% FYM (T_3) recorded enhanced growth, nutrient content and productivity which were at par with 100% RDN and the lowest results are found with control (no fertilizer).

Keywords: Rice, FYM, vermicompost, Recommended dose of nitrogen (RDN), Growth, Productivity, Economics

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important staple food grain crops in both India and the world. It plays a major role in food security. Globally, the largest area under rice cultivation is in India (43.8 M ha) and it is the second largest producer in the world (112.9 million t) with an average productivity of 2.78 t ha⁻¹ (Agriculture Statistics at a Glance, 2018). In South Odisha conditions, rice is grown

mainly during kharif and summer seasons. As rice is the major nutrient draining crop, there will be huge deficit in the soil nutrients in rice based cropping system. To overcome the problem and maintain soil fertility, there is need for integration of nutrients from organic and inorganic sources which can help in obtaining good crop yields as well as the production sustainability (Sahu et al., 2017; Ullah et al., 2019; Shankar et al., 2020).

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The combined use of inorganic fertilizers along with organic sources like FYM and vermicompost can improve the soil health and also helps in proper growth and productivity of rice. Considering the above, the present experiment has been conducted to evaluate the performance of INM on summer rice.

MATERIALS AND METHODS

The experiment was carried out during summer, 2019 at Bagusala Experimental farm of M.S. Swaminathan School of Agriculture, located at (23°39' N latitude and 87° 42' E longitude) of Gajapati district of Odisha. The experiment was laid out in Randomized Block Design with three replication and eight treatments during summer season. The plot size was 5 m x 4 m and the treatment combinations are 100% RDN(T₁), 75% RDN+25% N through vermicompost (T₂), 75% RDN+25% N through FYM (T₃), 50% RDN+50% N through vermicompost (T₄), 50% RDN+50 % N through FYM (T₅), 50% RDN+25% N through vermicompost+25% N through FYM (T₆), 25% RDN+25% N through vermicompost+50% N through FYM (T₇) and control (T₈). The rice variety used in experiment was RNR 15048. The experimental soil was sandy clay loam in texture, acidic in response (pH 6.1), low in organic carbon (0.18%) and medium in available nitrogen (230.0 kg ha⁻¹), phosphorus (11.2 kg ha⁻¹) and potassium (125.0 kg ha⁻¹). The land was first ploughed thoroughly crosswise with tractor drawn plough and final land preparation with rotavator for obtaining good tilth and leveling. The field was flooded with water and the puddling was done under saturated condition. After proper leveling, the field was designed to replications with leaving water channels for irrigation. The fertilizers doses were applied considering 80:40:40 kg ha⁻¹ as recommended dose in summer season respectively. The sources of fertilizers were urea for nitrogen, single super phosphate for phosphorous and muriate of potash for potassium. Half dose of nitrogen and potassium and full dose of phosphorus were applied as basal dose before transplanting. The remaining half of nitrogen and potassium was applied as top dressing at 30 days after transplanting and 60 DAT i.e. at

active tillering stage and flag leaf stage in two splits. The data of plant height, LAI, dry matter accumulation, Number of tillers, crop growth rate, net accumulation rate, nutrient content and expenditure and income were recorded. The data of field observations were collected from five plants in each plot which are randomly selected. The experimental data recorded for various parameters under study were statistically analysed with ANOVA given by to draw the conclusion.

RESULTS

Growth parameter

The observations on plant height and dry matter accumulation recorded at 30, 60 and 90 days after transplanting (DAT) were analysed statistically and presented in the Table 1. The nutrient management treatments played a major role on plant height and dry matter accumulation of summer rice. The maximum height of the plants was recorded at 90 DAT in the treatment receiving 75% RDN+25% N through vermicompost (T₂) and it was closely followed by T₃ (75% RDN + 25% N through FYM), T₁ (100% RDN), T₄ (50% RDN+50% N through vermicompost), T₅ (RDN+50 % N through FYM) and all these treatments were statistically at par in expression of plant height. However, the treatment with 75% RDN+25% N through vermicompost (T₂) was significantly superior to 50% RDN+25% N through vermicompost+25% N through FYM (T₆), 25% RDN+25% N through vermicompost+50% N through FYM (T₇) and control (T₈). As expected the control treatment (T₈) revealed the lowest plant height at 90 DAT. In case of dry matter production, the treatments varied significantly over control. With the gradual progression dry matter production by crop was increased. At 90 DAT, All nutrient management treatments being statistically at par showed significantly more dry matter production than control (T₈). The results are in conformity with the findings of Biswanath et al. (2019) as they noted different proportion of organic manures and chemical fertilizers influenced on plant height and dry matter accumulation of the rice. Similar result was observed in case of number of tillers m⁻² and leaf area index as observations recorded at

30, 60 and 90 DAT (Table 2). The maximum values of number of tillers m^{-2} were found at 90 DAT. The treatment with 75% RDN+25% N through vermicompost (T_2) recorded the maximum number of tillers m^{-2} and it remained statistically at par with other treatments except control (T_8). But the maximum LAI of summer rice was noted at 60 DAT, because of peak growth stage and afterwards crop entered into reproductive phase with gradual senescence of leaves. The maximum LAI was observed with 75% RDN+25% N through vermicompost (T_2) which was statistically at par with T_1 (100% RDN), T_3 (75% RDN+25% N through FYM), T_4 (50% RDN+50% N through vermicompost) and T_5 (RDN+50% N through FYM) and superior to other treatments, namely, 50% RDN+25% N through vermicompost+25% N through FYM (T_6), 25% RDN+25% N through vermicompost+50% N through FYM (T_7) and control (T_8). Similar observations on the effect of different proportion of organic manure and chemical fertilizer mixture on influencing tiller production of rice were also reported by several workers Kumara et al. (2015) and Shankar et al. (2014). Similar results were reported by Yadav and Meena (2014) and Patra et al. (2017).

Yield

The grain yield and straw yield and harvesting index are analysed statically and presented in the Table 3. The grain yield and the straw yield were observed to follow the same trend as noted in growth parameters. The grain yield and the straw yield were found maximum in treatments receiving 75% RDN + 25% N through vermicompost (T_2) and it was closely followed by the treatment with 75% RDN + 25% RDN through FYM (T_3) and 100% RDN (T_1). This was due to high inorganic nitrogen supply to the crop which helped to exhibit growth parameters like dry matter accumulation and number of tillers resulting in the better productivity with the treatments. The lowest grain and straw yields were found in the control (T_8) as there was lack of nutrients as reflected in other growth parameters. The harvest index did not vary significantly among the different nutrient management practices in summer rice. The results corroborate with the

findings of earlier researches (Jeyajothi and Durairaj, 2015 and Shankar et al. 2020).

Nutrient content

The content of nitrogen (N) of grain and straw of summer rice (Table 4) was maximum in the treatments with 75% RDN+25% N through vermicompost (T_2) and it was closely followed by the treatment 75% RDN+25% RDN through FYM (T_3) and 100% RDN (T_1). Moreover, N content of grain of T_2 (75% RDN+25% N through vermicompost) was significantly more than rest of the treatments 50% RDN+50% N through vermicompost (T_4), 50% RDN+50% N through FYM (T_5), 50% RDN+25% N through vermicompost +25% N through FYM (T_6), 25% RDN+25% N through vermicompost +50% N through FYM (T_7) and Control (T_8). But maximum N content in straw was recorded with 75% RDN+25% RDN through FYM (T_3) and it was statistically at par with 75% RDN+25% N through vermicompost (T_2) and 100% RDN (T_1). The N content in straw of the treatment T_3 (75% RDN+25% RDN through FYM) was further significantly superior to 50% RDN+50% N through vermicompost (T_4), 50% RDN+50% N through FYM (T_5), 50% RDN+25% N through vermicompost+25% N through FYM (T_6), 25% RDN+25% N through vermicompost+50% N through FYM (T_7) and Control (T_8). The content of phosphorus (P) in grain and straw of rice was at par with all nutrient management treatments except control and the control treatment (T_8) was significantly inferior to others. The potassium (K) content of grain and straw was also shown the similar trend as noted in case of P content and as expected the control treatment (T_8) showed the least value in terms of K content which was further significantly inferior to other nutrient management treatments. The results are in conformity with the works of Garai et al. (2014), Mondal et al. (2015) and (Samaint, 2015).

Economics

The data on cost of cultivation, gross return, net return and benefit cost ratio were analysed statistically and presented in the Table 5. The cost of cultivation was increased due to increase in the rate of vermicompost and FYM

and maximum cost involved with the use of 25% RDN+25% N through vermicompost + 50% N through FYM (T₇). In control (T₈) and 100% RDN (T₁) were found to incur less cost of cultivation because in control treatment (T₈) there was no fertilizer cost and in 100% RDN(T₁) nutrients are provided by chemical sources which are cheap than organic manures. Similar observations were also noted earlier by Dissanayake et al. (2014). The highest gross return was recorded when crop was supplied nutrients with 75% RDN+25% N through vermicompost (T₂) and it was statistically at par with 75% RDN+25% RDN through FYM (T₃), 100% RDN (T₁), 50% RDN+50% N through vermicompost (T₄), 50% RDN+50% N through FYM (T₅) and 50% RDN+25% N

through vermicompost+25% N through FYM (T₆). The net returns was found highest in 75% RDN+ 25% RDN through FYM (T₃) and it was closely followed by 75% RDN+25% N through vermicompost (T₂) and 100% RDN (T₁). Further, these three treatments were statistically at par with each other. As expected, the control treatment (T₈) resulted in the least gross and net return from summer rice. The benefit cost ratio was found higher in 100% RDN (T₁) and it was followed by 75% RDN+25% RDN through FYM (T₃). Earlier researchers noted variation in economics of summer rice due to nutrient management treatments (Baishya et al., 2015; Mondal et al., 2015).

Table 1: Effect of integrated nutrient management on plant height and dry matter of summer rice

Treatments	Plant height (cm)			Dry matter (g m ⁻²)		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T ₁ -100% RDN	40.8	80.8	94.5	152	708	1297
T ₂ -75% RDN+25% N through vermicompost	45.8	84.3	100.2	154	735	1307
T ₃ - 75% RDN + 25% N through FYM	43.0	80.5	96.2	146	728	1285
T ₄ - 50% RDN + 50% N through vermicompost	41.7	77.5	93.0	133	684	1231
T ₅ - 50% RDN+50 % N through FYM	41.4	75.3	90.6	123	646	1199
T ₆ - 50% RDN + 25%N through vermicompost + 25% N through FYM	40.5	76.0	86.9	123	662	1187
T ₇ - 25% RDN+25% N through vermicompost + 50% N through FYM	40.0	73.8	83.3	114	667	1173
T ₈ -CONTROL	37.0	68.8	79.8	102	489	766.
S Em (+)	2.3	2.8	4.0	7.23	30.2	56.6
C D at 5%	7.0	8.5	12.0	21.9	91.7	171.8
C V (%)	NS	6.3	7.6	9.6	7.9	8.3

Table 2: Effect of integrated nutrient management on number of tillers m⁻² and leaf area index of summer rice

Treatments	Number of Tillers m ⁻²			Leaf area index (LAI)		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T ₁ -100% RDN	148.3	318.0	269.0	1.6	4.1	2.5
T ₂ -75% RDN+25% N through vermicompost	139.7	319.0	273.3	1.9	4.4	2.6
T ₃ - 75% RDN + 25% N through FYM	141.3	316.3	270.3	1.7	4.3	2.3
T ₄ - 50% RDN + 50% N through vermicompost	127.3	303.3	254.7	1.5	3.9	2.0
T ₅ - 50% RDN+50 % N through FYM	115.0	288.0	248.7	1.5	3.7	1.7
T ₆ - 50% RDN + 25%N through vermicompost + 25% N through FYM	117.0	290.7	247.0	1.5	3.5	1.8
T ₇ - 25% RDN+25% N through vermicompost + 50% N through FYM	112.0	294.3	237.7	1.4	3.1	1.6
T ₈ -CONTROL	87.7	234.3	194.0	1.0	2.5	1.3
S Em (±)	5.66	13.35	14.05	0.16	0.25	0.15
C D at 5%	17.2	40.5	42.6	0.5	0.7	0.5
C V (%)	7.9	7.8	9.8	2.3	11.5	13.6

Table 3: Effect of integrated nutrient management on yield (t ha⁻¹) of summer rice

Treatments	Yield (t ha ⁻¹)		
	Grain yield	Straw yield	Harvest index
T ₁ -100% RDN	5.09	7.31	41.1
T ₂ -75% RDN+25% N through vermicompost	5.18	7.29	41.6
T ₃ - 75% RDN + 25% N through FYM	5.13	7.18	41.7
T ₄ - 50% RDN + 50% N through vermicompost	4.93	7.05	41.1
T ₅ - 50% RDN+50 % N through FYM	4.85	7.01	41.0
T ₆ - 50% RDN + 25%N through vermicompost + 25% N through FYM	4.82	6.92	41.1
T ₇ - 25% RDN+25% N through vermicompost + 50% N through FYM	4.35	6.28	41.1
T ₈ -CONTROL	2.68	3.90	40.7
S Em (±)	0.16	0.35	1.64
C D at 5%	0.5	1.1	5.0
C V (%)	5.9	9.2	NS

Table 4: Effect of integrated nutrient management on nutrient content (%) of summer rice

Treatments	N content (%)		P content (%)		K content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
T ₁ -100% RDN	0.80	0.42	0.25	0.16	0.37	1.32
T ₂ -75% RDN+25% N through vermicompost	0.86	0.43	0.26	0.16	0.38	1.34
T ₃ - 75% RDN + 25% N through FYM	0.83	0.44	0.26	0.16	0.38	1.34
T ₄ - 50% RDN + 50% N through vermicompost	0.75	0.41	0.24	0.15	0.37	1.27
T ₅ - 50% RDN+50 % N through FYM	0.69	0.40	0.24	0.15	0.38	1.29
T ₆ - 50% RDN + 25%N through vermicompost + 25% N through FYM	0.71	0.39	0.24	0.15	0.37	1.29
T ₇ - 25% RDN+25% N through vermicompost + 50% N through FYM	0.73	0.41	0.23	0.14	0.36	1.26
T ₈ -Control	0.51	0.36	0.20	0.11	0.32	1.16
S Em (±)	0.02	0.01	0.01	0.01	0.01	0.04
C D at 5%	0.07	0.02	0.03	0.02	0.02	0.14
C V (%)	5.7	3.1	7.3	7.1	3.4	6.1

Table 5: Effect of integrated nutrient management on economics of summer rice

Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C Ratio
T ₁ -100% RDN	32635	75083	42448.3	1.30
T ₂ -75% RDN+25% N through vermicompost	42791	84920	42129.0	0.98
T ₃ - 75% RDN + 25% N through FYM	40244	84167	43922.7	1.09
T ₄ - 50% RDN + 50% N through vermicompost	54747	80983	26236.3	0.48
T ₅ - 50% RDN+50 % N through FYM	48889	79807	30917.7	0.63
T ₆ - 50% RDN + 25%N through vermicompost + 25% N through FYM	53754	79270	25516.0	0.47
T ₇ - 25% RDN+25% N through vermicompost + 50% N through FYM	61461	72513	22152.3	0.26
T ₈ -Control	30294	44103	13809.3	0.46
S Em (±)	-	2392.34	2392.34	0.06
C D at 5%	-	7256.0	7256.0	0.2
C V (%)	-	5.4	13.6	14.0

CONCLUSION

Integrated nutrient management practices showed positive and favourable effect on improving almost all the growth characters, yield, nutrient content and economics of summer rice. The crop receiving 75% RDN+25% N through vermicompost yielded maximum and it was followed by the crop raised with 75% RDN+25% RDN through FYM and 100% RDN through chemical fertilizers which achieve higher productivity and sustainability of summer rice. From the study, it may be concluded that summer rice requires sufficient nutrient to produce satisfactory yield and application of 100% RDN can be provided to obtain it. But considering the soil health and sustainability in rice production, INM should be adopted with either of 75% RDN+25% N through vermicompost or 75% RDN+25% RDN through FYM in south Odisha conditions.

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