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Effect of different integrated nutrient management practices on soil fertility, rice productivity and profitability in Thamirabarani tract of Tamil Nadu

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Abstract

A field experiment was conducted in the Thamirabarani tract of Tamilnadu during pishanam season of 2018-2019 to study the effect of different INM practices on soil fertility, rice productivity and profitability in a sandy clay loam soil, Thamirabarani tract of Tamilnadu. The experiment was laid out in a randomized block design with 9 treatments and 3 replications. The results revealed that among the different INM practices STCR-IPNS along with application of biofertilizers on 15th& 30th days after transplanting recorded the highest productivity and profitability, followed by STCR-IPNS with basal application alone treatment. The same treatment recorded the highest yield (7.70 t ha⁻¹) as well as nutrient uptake besides profitability (Rs.386 ha⁻¹ day⁻¹) over the other treatments. The yield attributes were also improved by the same treatment. The STCR-IPNS treatment with biofertilizers (basal, 15th& 30thDAT) improved the soil available nitrogen, phosphorous, potassium and organic carbon after the harvest. The same treatment recorded the highest net return of Rs.42,436 ha⁻¹. Among the INM treatments 75 % RDF + GLM @ 6.25 t ha⁻¹ + biofertilizers- (basal 15th& 30th DAT) recorded the lowest net return of Rs.32,356 ha⁻¹.

Keywords: INM, economics, nutrient uptake, rice, yield

Introduction

Rice (*Oryza sativa*) L is one of the predominant cereal crop, cultivated all over the world, and also an important staple food crop for most of the countries. India is the second largest rice producing country in the world after China. In India the total rice cultivation is 43.19 million hectares with an annual production of 166.5 million metric tonnes with the average productivity of 3.93 t ha⁻¹.

The cultivation of high yielding rice varieties depleted the inherent soil fertility. The rice production and productivity is influenced by proper nutrient management. Integrated Nutrient Management is very important for sustainable rice production. Many of our problems related to declining productivity of rice are due to improper and inefficient use of nutrients. Improper nutrient management has resulted in nutrient imbalances in the soil, with certain nutrients in excess while others are deficient. (Yadav and Meena, 2014). Through economic and efficient integrated plant nutrition system based management practice, farmer can achieve enhanced agricultural productivity and safe guard the environment. Soil test based fertilizer recommendations result in efficient fertilizer use and maintenance of soil fertility. Several approaches have been used for fertilizer recommendation based on soil test and INM practices, so as to attain maximum yield per unit of fertilizer use by the targeted yield approaches (Ramamoorthy *et al.*, 1967) which had received wide acceptability and popularity in India. The INM practice provides micronutrients, improves soil physical, chemical properties and the use efficiency of nutrients (Baishya *et al.*, 2015) [2]. It also improves the soil fertility and sustain the crop productivity.

The present situation of the escalating price of inorganic fertilizers, low availability and high cost involved in the organics application, improper utilization of bio-fertilizers, it is imperative to identify suitable integrated nutrient management with bio-consortium to reduce the input cost and increasing the use efficiency of nutrients, sustaining soil properties and yield of rice in the Thamirabarani tract of Tamil Nadu.

Materials and Methods

A field experiment was conducted during pishanam season of the year 2018-2019 at Agricultural College and Research Institute, Killikulam in the Thamirabarani tract of

Tamil Nadu using paddy (ASD-16) as test crop. The field was located at southern agro-climatic zone of Tamil Nadu at 8°46' N Latitude and 77° 42' E Longitude at an elevation of 40 m above MSL. The annual rainfall received was 626.6 mm in 37 rainy days. The maximum temperature received was 34.2°C and minimum was 22.5°C during the year 2018. The soil of the experimental field was having the texture of sandy clay loam, and the soil pH was 7.4. The available N,P and K status of the soil was low with respect to KMnO₄-N (247 kg ha⁻¹), medium with respect to Olsen-P (22.5 kg ha⁻¹) and medium with respect to NH₄OAC-K (187 kg ha⁻¹), and low in organic carbon content (4.0 g kg⁻¹). The experiment was conducted in randomized block design with 9 treatments and 3 replications. The treatments consisted of different INM practices viz., T₁- Absolute control; T₂-RDF(120:40:40 kg ha⁻¹ of N:P₂O₅:K₂O) + GLM @ 6.25 t ha⁻¹ + biofertilizers at basal (Azophos +VAM + K Solubilizer); T₃-STCR-IPNS (targeted yield of 7.5 t ha⁻¹) (159:60:43 N:P₂O₅:K₂O kg ha⁻¹) + GLM @ 6.25 t ha⁻¹; T₄ - T₂ +biofertilizers 15th& 30th DAT; T₅- T₃ + biofertilizers 15th& 30th DAT; T₆ -75 % RDF + GLM @ 6.25 t ha⁻¹ + biofertilizers (Azophos+ VAM + K Solubilizer +Si Solubilizer) -basal 15th& 30th DAT; T₇ -75 % STCR-RDF (120:45:32 kg ha⁻¹ N:P₂O₅:K₂O) + GLM @ 6.25 t ha⁻¹ + biofertilizers (Azophos+ VAM + K Solubilizer + Si Solubilizer-basal 15th& 30th DAT; T₈ - T₆ + Polymer coated seeds; T₉ - T₇+ Polymer coated seeds, The percent N,P and K content of Glyricidia sp. was 2.5% N,0.6% P and 2.5% K respectively, the GLM was applied 15 days before transplanting. The crop was harvested at maturity, sun dried and yield was recorded. The yield attributes viz., plant height, no.of active tillers hill⁻¹, no. of productive tillers hill⁻¹ were recorded at different crop growth stages. The economics for the various treatments were worked out based on the cost of input and income obtained from grain and straw. The available N,P & K content of the soil was estimated at different stages of the crop growth and at harvest adopting standard procedures (Jackson,1973). The N, P & K uptake was calculated using the dry matter yield. Crop profitability was worked out by using the formula, Crop profitability (Rs.ha⁻¹ day⁻¹ = Net return (Rs. ha⁻¹) ÷ number. of days field occupied.

Results and Discussion

Effect of different INM practices on growth and yield of rice

The different INM practices significantly influenced the growth and yield of rice (Table.1). Among the INM practices the soil test based STCR-IPNS treatment for the targeted yield of 7.5 t ha⁻¹ along with biofertilizers application at basal 15th& 30th DAT (T5) recorded the highest plant height (104 cm), number.of tillers hill⁻¹ (19.8), productive tillers hill⁻¹ (18.2), grain yield (7.7 t ha⁻¹) and straw yield (10.9 t ha⁻¹of rice).This was followed by the STCR-IPNS treatment for the targeted yield of 7.5 t ha⁻¹ with biofertilizer application at basal alone (T3). The lowest growth and yield parameters of rice among the INM practices was recorded by treatment of RDF (120:40:40) + GLM @ 6.25 t ha⁻¹ along with biofertilizer-basal application (T2). This is in line with the findings of the Basavaraja *et al.* (2017) [3]. The favourable effect of INM practices through STCR-IPNS-targeted yield approach was also reported by Vijayakumar *et al.* (2017) [7]. The soil test based STCR-IPNS for the targeted yield of 7.5 t ha⁻¹ along with biofertilizer application as basal at 15th & 30th

DAT improved the nutrient availability at critical growth stages compared to other INM practices. The favourable effect of different INM practices on the growth and yield of rice was also reported by Baishya *et al.*, (2015) [2].

Nutrient uptake

The positive effect of different integrated nutrient management on the N, P and K uptake by rice was observed (Table.2).The highest uptake of N, P and K was recorded in STCR-IPNS combined with biofertilizer application at basal 15th& 30th DAT (T5).This was closely followed by the treatment of STCR-IPNS with biofertilizer application at basal alone for the targeted yield of 7.5 t ha⁻¹(T3). This might be due to the higher yield achieved by the timely availability of nutrients and also the better soil environment. The highest uptake of nutrients observed by the soil test based STCR-IPNS recommendation was due to the improvement and maintenance of soil fertility, which was also reported by Vijayakumar *et al.*, (2017) [7]. The highest dry matter yield and nutrient content is yet another reason (Baishya *et al.*, 2015) [2]. The STCR-IPNS with biofertilizer application as basal 15th& 30th DAT favour better soil environment for better root proliferation and uptake of nutrients which is in corroborate with the findings of Vijayakumar *et al.*, (2017) [7].

Soil fertility

The soil organic carbon, available phosphorous and potassium after the harvest of rice crop was significantly influenced by the different INM practices (Table.3). The treatment of STCR-IPNS with biofertilizer application as basal 15th& 30th DAT recorded the highest soil organic carbon (5.2 g kg⁻¹) available P (28.5 kg ha⁻¹) and available K (241 kg ha⁻¹).The application of soil test based inorganic fertilizer and GLM addition helps in improving the soil organic carbon status, besides the conversion of organic form to inorganic forms. In addition the application of biofertilizer with silicate solubilizing bacteria was found to enhance the availability of phosphorous and potassium. The effect of INM practices with organic manures and biofertilizer on the enhancement of available P& K was reported by Aasif *et al.*, (2018) [1]. The soil available N at harvest was not significantly influenced by the various INM treatments due to the mineralization process and it was prone to various losses under submergence (Bharose *et al.* (2017) [6].

Economics

The results on the effect of different INM practices showed that the highest gross return (Rs. 87,900 ha⁻¹) and net return (Rs. 42436 ha⁻¹) were recorded in STCR-IPNS with biofertilizers application at basal, 15th& 30th DAT (T5). This was closely followed by the STCR-IPNS treatments with basal application of biofertilizers (T3). The highest benefit: cost ratio (1.92) was recorded in 75% STCR RDF + GLM @ 6.25 t ha⁻¹ + biofertilizer (Azophos+ VAM + K Solubilizer + Si Solubilizer) as basal 15th& 30th DAT and polymer seed coating (T9), followed by the 100% STCR-IPNS+ GLM @ 6.25 t ha⁻¹ + biofertilizers as basal 15th& 30th DAT (1.90).The highest crop profitability of Rs. 385.78 ha⁻¹ day⁻¹ was recorded with STCR-IPNS + GLM @ 6.25 t ha⁻¹ + biofertilizer as basal 15th& 30th DAT. The highest economic return in the above treatment is due to the highest grain and straw yield achieved compared to other treatments.

Table 1: Effect of different INM practices on growth and yield of rice

Trt. No	Treatments	Plant height (cm)	No. of active tillers hill ⁻¹	No. of Productive tillers hill ⁻¹	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)
T1	Absolute Control	89.0	12.4	9.93	4.60	5.92
T2	RDF + GLM @ 6.25 t ha ⁻¹ + Biofertilizer – basal alone	99.8	19.3	15.6	6.70	8.50
T3	STCR-IPNS +GLM @ 6.25t ha ⁻¹ +biofertilizers – basal alone	101	19.5	17.3	7.50	10.4
T4	T ₂ + Biofertilizers also on 15 th & 30 th DAT	99.8	19.4	16.1	6.90	9.04
T5	T ₃ + Biofertilizers also on 15 th & 30 th DAT	104	19.8	18.2	7.70	10.9
T6	75% RDF+GLM @ 6.25t ha ⁻¹ +biofertilizers-basal, 15 th & 30 th DAT	98.0	19.0	14.3	6.50	8.39
T7	75% STCR RDF+GLM @ 6.25t ha ⁻¹ + biofertilizers-basal, 15 th & 30 th DAT	99.8	19.4	16.3	7.20	9.58
T8	T ₆ + Polymer coated seeds	99.5	19.2	15.0	6.60	8.58
T9	T ₇ + Polymer coated seeds	100	19.5	16.5	7.40	10.0
	SE±	4.173	0.56	0.507	0.321	0.424
	CD (0.05%)	8.8	1.2	1.1	0.68	0.90

Table 2: Effect of different INM practices on nitrogen, phosphorous and potassium uptake (kg ha⁻¹) by rice grain and straw

Trt. No	Treatments	Nitrogen		Phosphorous		Potassium	
		Grain	straw	Grain	straw	Grain	straw
T1	Absolute Control	37.7	19.5	9.2	3.55	30.3	39.6
T2	RDF + GLM @ 6.25 t ha ⁻¹ + Biofertilizer – basal alone	76.4	44.2	18.7	10.2	60.3	83.3
T3	STCR-IPNS +GLM @ 6.25t ha ⁻¹ +biofertilizers – basal alone	88.5	61.3	25.5	14.5	78.0	110.2
T4	T ₂ + Biofertilizers also on 15 th & 30 th DAT	80.0	51.5	21.4	12.6	71.0	94.0
T5	T ₃ + Biofertilizers also on 15 th & 30 th DAT	92.4	66.5	26.9	16.3	82.4	123.1
T6	75% RDF+GLM @ 6.25t ha ⁻¹ +biofertilizers-basal (15 th & 30 th DAT)	72.8	41.9	16.9	10.0	55.9	79.7
T7	75% STCR RDF+GLM @ 6.25t ha ⁻¹ + biofertilizers-basal (15 th & 30 th DAT)	82.8	51.7	20.9	12.4	66.2	95.8
T8	T ₆ +Polymer coated seeds	74.6	44.6	17.8	11.1	58.0	84.0
T9	T ₇ +Polymer coated seeds	85.1	56.0	20.7	13.0	69.5	100
		3.128	2.274	0.616	0.498	2.986	3.412
	CD (0.05%)	6.6	4.8	1.3	1.1	6.30	7.20

Table 3: Effect of different INM practices on organic carbon, available N, P₂O₅, and K₂O in post-harvest soil

Trt. No	Treatments	Organic carbon (g kg ⁻¹)	Available N (kg ha ⁻¹)	Available P (kg ha ⁻¹)	Available K (kg ha ⁻¹)
T1	Absolute Control	4.5	240	23.7	182
T2	RDF + GLM @ 6.25 t ha ⁻¹ + Biofertilizer – basal alone	4.8	258	24.6	220
T3	STCR-IPNS +GLM @ 6.25t ha ⁻¹ +biofertilizers – basal alone	5.1	264	25.6	234
T4	T ₂ + Biofertilizers also on 15 th & 30 th DAT	5.1	266	26.4	230
T5	T ₃ + Biofertilizers also on 15 th & 30 th DAT	5.2	270	28.0	241
T6	75% RDF+GLM @ 6.25t ha ⁻¹ + biofertilizers-basal 15 th & 30 th DAT	4.9	262	25.0	216
T7	75% STCR RDF+ GLM @ 6.25t ha ⁻¹ + biofertilizers-basal 15 th & 30 th DAT	4.8	260	26.8	224
T8	T ₆ + Polymer coated seeds	5.0	262	25.8	218
T9	T ₇ + Polymer coated seeds	5.1	264	26.4	222
	SE±	0.0960	10.80	1.026	9.479
	CD (0.05%)	0.02	NS	2.20	20.0

Table 4: Effect of different INM practices on economics of rice

Trt. No	Treatment	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	B:C Ratio	Crop profitability (Rs. ha ⁻¹ day ⁻¹)
T1	Absolute Control	42900	16,600	1.46	151.0
T2	RDF + GLM @ 6.25 t ha ⁻¹ + Biofertilizer – basal alone	75500	33038	1.77	300.3
T3	STCR-IPNS +GLM @ 6.25t ha ⁻¹ +biofertilizers – basal alone	85400	40517	1.88	364.7
T4	T ₂ + Biofertilizers also on 15 th & 30 th DAT	78000	35358	1.80	321.4
T5	T ₃ + Biofertilizers also on 15 th & 30 th DAT	87900	42436	1.90	386.0
T6	75% RDF+GLM @ 6.25t ha ⁻¹ +biofertilizers-basal, 15 th & 30 th DAT	73300	32356	1.79	323.5
T7	75% STCR RDF+GLM @ 6.25t ha ⁻¹ +(biofertilizers-basal, 15 th & 30 th DAT	81500	37995	1.87	345.4
T8	T ₆ + Polymer coated seeds	74500	33496	1.81	304.5
T9	T ₇ + Polymer coated seeds	84000	40435	1.92	367.6

Conclusion

The studies on the effect of different INM practices on sustaining rice productivity, profitability and soil fertility revealed that the application of STCR-IPNS + GLM @ 6.25 t ha⁻¹ + biofertilizer as basal, 15th& 30th DAT was found to be

the most effective. However the use of polymer coated seeds and application of 75% STCR-IPNS+ GLM @ 6.25 t ha⁻¹ + biofertilizer as basal, 15th& 30th DAT may be the best option for getting highest benefit-cost ratio.

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