

Productivity, economic efficiency and agronomic efficiency of traditional rice varieties as influenced by EM compost and fertilizer nitrogen under Cauvery delta zone of Tamil Nadu, India

*S. Ramesh¹, S. Keerthana³, P. Sudhakar¹, S. Manimaran¹ and K. Arivukkarasu²

^{1,2}Department of Agronomy, Annamalai University, Annamalai Nagar 608 002, India

³Adhiyamaan College of Agriculture and Research, Hosur, India

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ABSTRACT

Field experiment was carried out at the Experimental farm, Annamalai University, Annamalai Nagar to study the productivity, economic efficiency and agronomic efficiency of traditional rice varieties as influenced by EM compost and fertilizer nitrogen under Cauvery delta zone of Tamil Nadu (2018). The experiment conducted in split-plot design and treatments were replicated thrice, the three traditional rice varieties were assigned as main plot treatments *viz.*, Mapillai samba, Illupai poo samba and Seeraga samba, and integrated nutrient management were assigned as sub plot treatments, it includes control, graded dose of nitrogen alone and its combination with FYM, EM (effective microorganisms) compost, pressmud, green manure. From the results of field study, among the rice varieties, Mapillai samba significantly recorded higher grain yield of 2574 kg ha⁻¹, straw yield of 3831 kg ha⁻¹ and harvest index of 39.85 and nitrogen use efficiency of 36.58 (NUE) agronomic efficiency of 21.68 (AE) and apparent N recovery (%) of 56.93 (ANR). The aforesaid parameters were least under Illupai poo samba rice variety. In respect of INM treatments, plots received with 75% RDN along with EM compost @ 5 t ha⁻¹ significantly recorded maximum grain yield of 2967 kg ha⁻¹, straw yield of 4341 kg ha⁻¹ and harvest index of 40.56. Also the same treatment recorded higher values of nitrogen use efficiency of 39.56 (NUE), agronomic efficiency of 25.58 (AE) and apparent N recovery (%) of 66.44 (ANR). The lowest grain yield, straw yield and harvest index of rice were registered under control. But lowest values of nitrogen use efficiency (NUE), agronomic efficiency (AE) and apparent N recovery (%) (ANR) were recorded under 100% recommended dose of nitrogen (RDN). In respect of economics, among the treatment combination seeraga samba rice variety received with 75% RDN + EM compost @ 5 t ha⁻¹ registered higher gross return, net return and return per rupee invested.

Key words: Traditional rice varieties, Grain and straw yields, Harvest index, Nitrogen use efficiency (NUE) agronomic efficiency and apparent N recovery (%) (ANR) and Economic efficiency

Introduction

Rice (*Oryza sativa* L.) is an important and extensively cultivated food crop which feeds more than fifty percent of the world's population. In Asia alone,

more than 2 billion people obtain 60 to 70 per cent of their energy intake from rice and its derivatives. In India, it is grown in an area of 44 million hectares with production of 105 million tonnes and the productivity of 2.4 t ha⁻¹. In Tamil Nadu, rice is grown

(¹Associate Prof., ² Assistant Prof., ³Assistant Prof.)

in an area of 1.93 million hectare with the production of 7.63 million tones and the productivity is 3.9 t ha^{-1} (Annual report on Agriculture 2016-2017). Introduction of high yielding varieties and hybrids leads to reducing the area of cultivation of traditional rice varieties. It has many significant role on the human health not only in terms of food but also as a medicine. Even though poor response of nitrogen by traditional rice cultivar the optimum dose of nitrogen to traditional rice varieties is still not clear. Therefore, urgent need for optimize the dose nitrogenous fertilizer for traditional rice cultivation. Apply plenty of chemical fertilizers in the crop cultivation has led to environmental pollution and deterioration of soil health. To achieve higher and sustainable rice yields, use of bulky organic manures or compost is a must (Gill *et al.*, 2008). It is, however, difficult to meet the crop nutrient requirements with organic manure alone and there is a need for combined application of different sources of nutrients for sustaining the expected crop productivity. Integrated application of organic manures like FYM, green manure, vermicompost and pressmud and inorganic fertilizers is the prerequisites to sustain soil health and to provide higher crop yield (Ramesh and Vaipuri, 2008). EM compost leads to the constant release of nutrients during the throughout the crop growing period and check the nutrient losses due to increased absorption of nutrients (Jaffer basha *et al.*, 2016). Even though research work on organic manure with inorganic fertilizer on rice crop was in plenty, EM compost and other organic manures *viz.*, FYM, green manure and pressmud in traditional rice is almost meager. Therefore, the present experiment was conducted to evaluate the influence of organic and fertilizer nitrogen on grain yield, agronomic and economic efficiency of traditional rice varieties under Cauvery delta zone of Tamil Nadu.

Materials and Methods

Field experiment was conducted at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar, Tamil Nadu (2018) to study the Productivity, Profitability and agronomic efficiency of traditional rice varieties as influenced by different sources of nitrogen under Cauvery delta zone of Tamil Nadu. The experimental soil is low in available nitrogen ($217.50 \text{ kg ha}^{-1}$), medium in available phosphorus (20.67 kg ha^{-1}) and high in available potassium ($280.73 \text{ kg ha}^{-1}$). The experiment

conducted in a split-plot design and treatments were replicated thrice, the three traditional rice varieties were assigned as main plot treatments *viz.*, Mapillai samba, Illupai poo samba and Seeraga samba, and integrated nutrient management were assigned as sub plot treatments, it include control (S_1), Recommended dose of nitrogen (RDN) (S_2), 75 % RDN + FYM @ 12.5 t ha^{-1} (S_3), 75% RDN + EM (effective microorganisms) compost @ 5 t ha^{-1} (S_4), 75% RDN + pressmud @ 10 t ha^{-1} (S_5), 75% RDN + green manure @ 6.25 t ha^{-1} (S_6) and uniform dose of phosphorus and potassium as per fertilizer schedule was given to all the treatments except control. EM compost prepared at the experimental farm with recommended procedure, the activated effective microorganisms (AEM) solution @ 5 lit inoculated to per tonne of FYM. Daily sprinkle water and maintain sixty per cent moisture in the compost. After forty-five days the EM compost was ready to apply in experimental plots. As per treatment schedule all the organic manures were applied as basal seven days before transplanting. Thirty days old rice seedlings were transplanted @ two seedlings hill⁻¹ with a spacing of $20 \times 15 \text{ cm}$ for all three rice varieties. A fertilizer schedule of 100 kg N , $50 \text{ kg P}_2\text{O}_5$ and $50 \text{ kg K}_2\text{O ha}^{-1}$ was applied. Observation on grain yield and straw yield were recorded.

Agronomic Efficiency (AE)

In this approach, agronomic efficiency was calculated in terms of seed yield obtain from fertilized plot and unfertilized plot to kg^{-1} of nitrogen applied. It was computed using the formula as given below:

$$AE = \frac{\text{Grain yield in fertilizer Plot} - \text{Grain yield in unfertilizer Plot} (\text{kg ha}^{-1})}{\text{Amount of nitrogen applied} (\text{kg ha}^{-1})}$$

Apparent N Recovery (ANR)

Apparent N recovery efficiency is defined as the quantity of nitrogen absorbed per unit of nitrogen applied. It was computed as per the formula suggested by Pillai and Varmadevan (1978) and expressed in percentage.

$$ANR = \frac{\text{Uptake of N in fertilizer Plot} - \text{Uptake of N in unfertilizer Plot} (\text{kg ha}^{-1})}{\text{Amount of nitrogen applied} (\text{kg ha}^{-1})} \times 100$$

Statistical analysis

The data on various characters studied during the course of investigation were statistically analyzed as

suggested by Gomez and Gomez (1984).

Results and Discussion

Grain and straw yields

In respect of grain and straw yields, Mapillai samba (M_1) recorded significantly maximum grain yield of 2574 kg ha⁻¹, straw yield of 3831 kg ha⁻¹ and harvest index of 39.85. This might be due to higher photosynthetic machineries; photosynthetic pigments and photosynthetic rate which could have contributed for greater assimilate supply from source to sink which would have helped in higher yield attributes which in turn registered higher yield of rice. In addition, the aforesaid positive parameters are also governed by genetic makeup of rice cultivar (Ghimire *et al.*, 2016). The lowest grain yield of 2076 kg ha⁻¹ and straw yield of 3329 kg ha⁻¹ and harvest index of 38.12 were recorded under Illupai poo samba (M_2). In respect of INM practices, plots received with 75% RDN + EM compost @ 5 t ha⁻¹ (S_4) registered significantly maximum grain yield of 2967 kg ha⁻¹, straw yield of 4341 kg ha⁻¹ and harvest index of 40.56. Higher grain yield might be due to higher nutrient uptake and increased photosynthetic efficiency as evident from increased LAI values, which leads higher grain yield from plots received with inorganic fertilizer along with EM compost. Besides, the constant release of N from organic ma-

nure, particularly from EM compost supplemented with NPK fertilizers might have satisfied the demand at every phenophase of rice crop as opined by Sharma *et al.* (2014). It was followed by 75% RDN + pressmud @ 10 t ha⁻¹ (S_5). The least grain yield of 1048 kg ha⁻¹, straw yield of 1803 kg ha⁻¹ and harvest index of 36.73 was recorded under S_1 (No fertilizer and no organic manure). The interaction effect between main and sub plots were significant. The treatment combination of M_1S_4 (Mapillai samba along with 75% RDN + EM compost @ 5 t ha⁻¹) registered the maximum grain yield of 3247 kg ha⁻¹ and straw yield of 4604 kg ha⁻¹ and harvest index of 41.36.

Nitrogen use efficiency, agronomic efficiency and apparent N Recovery (%)

In respect of the different rice varieties, M_1 (Mapillai samba) recorded the maximum nitrogen use efficiency of 36.58, agronomic efficiency of 21.69 and apparent nitrogen recovery percentage of 56.93. This might be attributed to better growth and establishment of Mapillai samba rice variety, which in turn higher DMP and grain yield resulting in higher NUE and ANR (Sampath *et al.*, 2017). This treatment was followed by Seeraga samba (M_3). The least nitrogen use efficiency of 29.59, agronomic efficiency of 17.92 and apparent nitrogen recovery of 52.06 was recorded under Illupai poo samba (M_2).

Table 1. Effect of INM practices on productivity and nitrogen use efficiency in traditional rice varieties

Treatments	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index	Nitrogen use efficiency*	Agronomic efficiency *	Apparent nitrogen recovery (%)*
MAIN PLOTS						
M_1 – Mapillai samba	2574	3831	39.85	36.58	21.69	56.93
M_2 – Illupai poo samba	2076	3329	38.12	29.59	17.92	52.06
M_3 – Seeraga samba	2309	3577	38.92	32.84	19.57	54.17
S.Ed.	096	104	0.24	-	-	-
C.D(P=0.05)	195	212	0.51	-	-	-
SUB PLOTS						
S_1 – Control	1048	1803	36.73	-	-	-
S_2 - Recommended dose of nitrogen	1971	3189	38.14	33.36	9.22	29.76
S_3 - 75% RDN + FYM @12.5 t ha ⁻¹	2502	3900	39.02	39.56	19.38	54.66
S_4 - 75% RDN +EM compost @ 5 t ha ⁻¹	2967	4341	40.56	36.81	25.58	66.44
S_5 - 75% RDN + pressmud @ 10 t ha ⁻¹	2761	4163	39.82	35.59	22.83	61.68
S_6 - 75% RDN + green manure @ 6.25 t ha ⁻¹	2669	4077	39.51	19.71	21.61	59.40
S.Ed.	067	073	0.32	-	-	-
C.D(P=0.05)	136	149	0.63	-	-	-

*Statistically Not Analyzed

Table 2. Economics of traditional rice varieties cultivation

Treatments	Cost of Cultivation (Rs. ha ⁻¹)	Gross return (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	B:C ratio
M1S1	30726.00	36291.00	5565.00	1.18
M1S2	35776.00	67761.00	31985.00	1.89
M1S3	40456.00	86207.00	45751.00	2.13
M1S4	39255.00	99712.00	60457.00	2.54
M1S5	39755.00	93777.00	54022.00	2.36
M1S6	40656.00	91187.00	50531.00	2.24
M2S1	29676.00	31262.00	1586.00	1.05
M2S2	34726.00	59233.00	24507.00	1.71
M2S3	39406.00	74918.00	35512.00	1.90
M2S4	38205.00	91089.00	52884.00	2.38
M2S5	38705.00	83923.00	45218.00	2.17
M2S6	38705.00	80744.00	42039.00	2.09
M3S1	30526.00	35485.00	4959.00	1.16
M3S2	35576.00	68476.00	32900.00	1.92
M3S3	40256.00	86503.00	46247.00	2.15
M3S4	39055.00	102638.00	63583.00	2.63
M3S5	39555.00	95444.00	55889.00	2.41
M3S6	40456.00	92204.00	51748.00	2.28

M₁ – Mapillai samba M₂ – Illupai poo samba M₃ – Seeraga samba

S₁ – Control, S₂ - Recommended dose of nitrogen, S₃ - 75% RDN + FYM @12.5 t ha⁻¹, S₄ - 75% RDN +EM compost @ 5 t ha⁻¹, S₅ - 75% RDN + pressmud @ 10 t ha⁻¹, S₆ - 75% RDN + green manure @ 6.25 t ha⁻¹

With regard to nutrient management practices, 75% RDN + EM compost @ 5 t ha⁻¹ (S₄) registered significantly maximum nitrogen use efficiency of 39.56, agronomic efficiency of 25.58 and apparent nitrogen recovery percentage of 66.44. This might be due to combined application of organic manures and along with chemical fertilizer checks nitrogen losses, conservation of soil N by forming organic minerals complex thus ensure continuous N availability to rice. Which would have helped in higher grain yield, uptake of N, which in turn higher NUE, agronomic efficiency and ANR (Shobitsingh *et al.*, 2017). It was followed by 75% RDN + pressmud @ 10 t ha⁻¹ (S₅). The least values of nitrogen use efficiency of 19.71, agronomic efficiency of 09.22 and apparent nitrogen recovery of 29.76 recorded under 100 RDN (S₂). The interaction effect was not significant.

Economics

Higher gross return of Rs. 1,02,638 ha⁻¹, net return of Rs. 63,583 ha⁻¹ and return per rupee invested Rs. 2.63 were obtained under Seeraga samba rice variety received with 75% RDN along with EM compost @ 5 t ha⁻¹. Increased profitability under Seeraga samba traditional rice variety raised with 75% RDN + EM compost @ 5 t ha⁻¹ could be attributed to lower cost

of cultivation, higher gross returns and better premium price of Seeraga samba rice variety. The lowest gross return of Rs. 31,262 ha⁻¹, net return of Rs. 1586. ha⁻¹ and return per rupee invested of Rs.1.05 were recorded under Illupai poo samba rice variety raised without fertilizer and organic manure.

Conclusion

From the results of the field trail, it can be concluded that cultivation of Mapillai samba traditional rice variety along with 75% RDN + EM compost @ 5 t ha⁻¹ recorded higher grain and straw yields, nitrogen use efficiency, agronomic efficiency and apparent nitrogen recover percentage. However gross return, net return and return per rupee invested were obtained under seeraga samba rice variety applied with 75% RDN + EM compost @ 5 t ha⁻¹.

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