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Effect of integrated nutrient management on grain yield and quality of traditional rice *(Oryza sativa L.)* varieties

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Abstract

Field experiment was carried out at the Experimental farm, Annamalai University, Annamalai Nagar to study the effect of integrated nutrient management on grain yield and quality of traditional rice *(Oryza sativa L.)* varieties during August 2017 to January 2018 (samba season). The experiment was laid out in split plot design with three main treatments (traditional rice varieties) *viz.*, Mapillai samba, Illupai poo samba and Seeraga samba and six sub treatments includes control, recommended dose of nitrogen, graded dose of nitrogen along with different sources of organic manures *viz.*, EM (effective microorganisms) compost, FYM, green manure, pressmud. The treatments were replicated thrice. Among the main plot treatments (traditional rice varieties), Mapillai samba significantly recorded higher values of of thousand grain weight of 25.39 g, grain yield of 2574 kg ha^{-1} and harvest index of 39.85 and quality character *viz.*, hulling percentage of 74.06, milling percentage of 67.32 and head rice recovery percentage of 53.32. In respect of sub plot treatments (Integrated nutrient management), plots received with 75% RDN along with EM compost @ 5 t ha^{-1} significantly recorded maximum values of thousand grain weight of 18.93 g, grain yield of 2967 kg ha^{-1} and harvest index of 40.56 and higher values of hulling percentage of 74.97, milling percentage of 67.39 and head rice recovery percentage of 53.98. The least values were recorded under control.

Keywords: traditional rice variety, INM, EM compost, grain yield, harvest index, hulling and milling percentage and head rice recovery percentage

Introduction

Rice (Oryza sativa L.) is the major source of calories for 40 percent of the world population. Similarly, rice is the staple food crop for more than two third of population of India. The slogan “RICE IS LIFE” is most appropriate for India as this crop plays vital role in our national food security and a mean of live hood for millions of rural households. In India, rice is cultivated on 44 million hectare and contributing 104.32 million tonnes grain production with productivity of 2.37 t ha^{-1}. (Anonymous, 2016) [1]. The traditional rice varieties can withstand flood, heavy winds and drought situations. The traditional rice varieties have a high level of genetic heterogeneity compared to modern cultivars (Chimmili, 2012) [2]. Thus the traditional rice has many significant role on the human health not only in terms of food but also as a medicine (Hedge *et al*., 2013). Literature on the influence of nitrogen on the growth and yield of modern rice across ecosystems abound. However, similar information’s on the traditional varieties are scanty. After the attainment of self-sufficiency in food grains, there has been increasing demand for quality rice, particularly of traditional varieties. Nitrogen management in rice field is different from other crops because of the incessant sub-mergence or intermittent drying and wetting the environment of root zone is converted from aerobic to anaerobic conditions. During these processes loss of nitrogen takes place through leaching and de-nitrification. Increased use of inorganic fertilizers in crop production has deteriorates effect on soil health, causes health hazard and insecurity of quality food, energy crisis, higher fertilizer cost, sustainability in agri-production system and ecological stability are the important issues which renewed the interest of farmers and research workers in non-chemical sources of plant nutrients like, farmyard manure, green manure, composts etc. The use of organic manures for improving and maintaining the soil health has been in practice since long time but its practicability is limited due to poor availability and higher cost of nutrients supplied through organic sources. But in balanced manner use of nutrients through organic sources like farmyard manure, vermicompost, green manure and pressmud are prerequisites to sustain soil fertility, to produce maximum crop yield with optimum input level (Ramesh and vaiyapuri, 2008) [14]. Jusoh *et al.* (2013) [10] found that compost with EM has higher N, P K, and Fe content as compared to compost without EM after laboratory analysis, and concluded that the application of EM in compost increases the macro and micronutrient content of the soil. Grain quality of rice is very complicated, but an important properties in many areas for rice production in the world, mainly defined by four constituents: namely, milling, cooking, appearance and nutritional quality (Li *et al.*, 2003). In rice production, milling quality and head rice recovery percentage is an important factor for determining the farmer income. Judicious and proper use of fertilizers can evidently increase the yield and improve the quality of rice (Yoshida *et al.*, 1981) [18]. In view of the above facts, field experiment on “effects of integrated nutrient management on grain yield and quality of the traditional rice varieties under tail end area of Cauvery deltaic zone of Tamil Nadu.

Materials and Methods

Field experiment was conducted at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar, Tamil Nadu during August 2017 - January 2018 (samba season) to study the effects of integrated nutrient management on grain yield and quality of the traditional rice varieties. The experimental soil is low in available nitrogen (217.50 kg ha^{-1}), medium in available phosphorus (20.67 kg ha^{-1}) and high in available potassium (280.73 kg ha^{-1}). The experiment was laid out in split plot design with three main treatments (traditional rice varieties) *viz.*, Mapillai samba, Illupai poo samba and Seeraga samba and six sub treatments namely., control (S_1), Recommended dose of nitrogen (RDN) (S_2), 75 % RDN + FYM @ 12.5 t ha^{-1} (S_3), 75% RDN + EM 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. The treatments were replicated thrice. The following organic manures were used in this study *viz.,* FYM, pressmud and EM compost and green manure. EM (effective microorganisms) compost prepared with following procedure, FYM was inoculated with activated effective microorganisms (AEM) solution @ 5 lit / tonne of FYM and heaped. Daily sprinkle water and maintain 60 per cent moisture in the compost. After 45 days the compost was ready to apply in main field. As per treatment schedule all the organic manures were applied as basal one week before transplanting. Thirty days old paddy seedlings were transplanted @ two seedlings $hill^{-1}$ for all three rice varieties with a spacing of 20 × 15 cm was adopted. A fertilizer schedule of 100 kg N, 50 kg P_2O_5 and 50 kg K_2O ha^{-1} was applied. N and K is applied as per the treatment schedule in four equal splits *viz.*, basal, tillering, panicle initiation and heading stages of rice. The entire dose of P_2O_5 was applied basally before transplanting. Need based plant protection measures were taken up based on the economic threshold level of pest and diseases. All other improved recommended package of practices were followed to rice as per the Crop Production Guide. Harvesting was done in each plot separately from the net plot area leaving the border rows. Grains were separated, cleaned and grain yield was recorded plot wise at 14 per cent moisture content. The data on various characters studied during the course of investigation were statistically analyzed as suggested by Gomez and Gomez (1984) [8].

Harvest Index (HI)

The harvest index (HI) of rice was calculated by using the formula suggested by Varma (1973) [19].

$$HI = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where biological yield = Grain yield + Straw yield.

Quality analysis

Hulling percentage

Hulling percentage is the ratio between weight of total brown rice and weight of total rough rice expressed in percentage (Ganga Devi *et al.* 2012) [4]. Rice samples were cleaned and then 3 g of grain sample was shelled with the Satake Sheller. The samples were hulled and weights of de-hulled grains were recorded. The formula is as follows:

$$\text{Hulling percentage} = \frac{\text{Weight of the dehusked kernel (g)}}{\text{Weight of husked grain (g)}} \text{ X100}$$

Milling percentage

Mulling percentage is the ratio between weight of total milled rice and weight of total rough rice expressed in percentage (Ganga Devi *et al*. 2012) [4]. The hulled samples were milled and weight of milled grains was recorded. The formula is as follows:

$$\text{Milling percentage} = \frac{\text{Weight of milled grain(g)}}{\text{Weight of husked grain (g)}} \text{ X100}$$

Head Rice Recovery Percentage (HRR %)

The head rice yield was determined by separating whole grains and 3/4th grains manually and percentage was expressed as:

$$HRR\% \; \frac{\text{Wt. of whole milled rice(g)}}{\text{Wt of rough rice (G)}} X\ 100$$

Result and Discussion

Effect of INM practices on grain yield

Among the varieties, Mapillai samba (M_1) recorded significantly maximum values of thousand grain weight of 25.39 g, grain yield of 2574 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 Mapillai samba rice. In addition, the aforesaid positive parameters are also governed by genetic makeup of rice cultivar. Especially thousand grain weight was higher under Mapillai samba (M_1), It was almost double the value (25.39 g) when compare to other two rice varieties *viz.*, Seeraga samba (M_3) and Illupai poo samba (M_2). This is in conformity with the findings of Ghimire *et al.* (2016) [6]. Variations in yields of cultivars were also reported (Gautam, Kumar, Shivay, & Mishra, 2008). The least grain yield of 2076 kg ha^{-1} and harvest index of 38.12 was recorded under M_2 (Illupai poo samba). However, least thousand grain weight of 13.36 was recorded under Seeraga samba (M_3). Among the INM treatments, EM compost @ 5 t ha^{-1} + 75% RDN (S_4) applied plots registered significantly maximum values of thousand grain weight of 18.93 g, grain yield of 2967 kg ha^{-1} and harvest index of 40.56. The aforesaid increased yield attributes and simultaneous enhanced yield due to inorganic fertilizer along with EM compost might be due to higher nutrient uptake and increased photosynthetic efficiency as evident from increased LAI values. Besides, the constant release of N from organic manure, particularly from EM compost supplemented with NPK fertilizers might have satisfied the demand at every phenophase of rice crop as opined by Singhal *et al.* (2017) [16]. It was followed by S_5 (75% RDN + pressmud @ 10 t ha^{-1}). The least values of thousand grain weight of 18.43, grain yield of 1048 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 found significant for grain yield and non-significant for thousand grain weight and harvest index. 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}. The increased grain yield might be due to continued supply of nutrients in balanced quantity throughout the growth stages that enabled the plant to assimilate sufficient photosynthetic products and thus increased dry matter accumulation and better nutrient supply for chlorophyll synthesis and healthy root growth for translocation of photosynthates which in turn enhances the grain yield. Similar results on rice yields were reported due to integrated application of chemical fertilizer and organic manures (Yaduvanshi, 2003).

Effect of INM practices on quality characters of rice

Among the main plot treatments, Mapillai samba (M_1) recorded significantly maximum values of hulling percentage of 74.06, milling percentage of 67.32 and head rice recovery percentage of 53.32. The next in order of ranking was Illupai poo samba (M_2). This might be due to better ideotype of the plant showing its supremacy in quality characters of rice. In addition, the aforesaid positive parameters are also governed by genetic makeup of rice cultivar. Besides, Variation in quality parameters depends on the grain type, variety, cultural practices and temperature during grain filling to maturity stage and drying condition (Thiyagarajan, & Manonmani, 2006). Head rice recovery is a genetic trait but environmental factors and post-harvest handling play vital role and persuade the grain breakage during milling (Fan, Siebenmorgen, & Yang, 2000) [3]. Similar findings on quality parameters were reported (Ghosh, Mandal, Mandal, Lodh, &, 2004). The least values of hulling percentage of 70.35, milling percentage of 62.27 and head rice recovery percentage of 50.65 was recorded under Seeraga samba (M_3).

Among the INM practices, plots received with 75% RDN alongwith EM compost @ 5 t ha^{-1} (S_4) registered significantly maximum values of hulling percentage of 74.97, milling percentage of 67.39 and head rice recovery percentage of 53.98. Higher availability of nutrients that directly influenced LAI, increased photosynthetic activity assimilate portioning from source to sink might be attributed to better uniform filling of grains, amenability for shelling, good grain size and less number of chalky grains, which in turn registered higher values of hulling and milling percentage and head rice recovery percentage. Similar results were reported by Kyi Moe *et al*. (2017). Besides, organic source (EM compost) and inorganic sources of nitrogen increases in the protein content of rice and a decrease in chaffy grains, further the protein bodies functioned as a binder occupying the space between unpacked starch granules, which resulted in increased resistance of rice grain to breakage during milling, which in turn registered higher values of hulling and milling percentage and head rice recovery percentage. (Sakda jongkaewwattana *et al.,* 1993) [15]. The next in order of ranking was S_5 (75% RDN + pressmud @ 10 t ha^{-1}). The least values of hulling percentage of 67.49, milling percentage of 60.67 and head rice recovery percentage of 48.60 was recorded under S_1 (No fertilizer and no organic manure). The interaction effect between varieties and fertility levels was found non-significant for hulling, milling and head rice recovery.

Conclusion

From the results of field trail, it could be concluded that Mappilai samba rice variety grown with application of 75% RDN along with Effective Microorganisms compost @ 5 t ha^{-1} to exploit the potential yield and rice quality under Cauvery deltaic zone of Tamil Nadu.

Table 1: Effect of INM practices on thousand grain weight, grain yield and harvest index in traditional rice varieties

Treatments	Thousand grain weight (g)				Grain yield (kg ha^{-1})				Harvest index			
	M_1	M_2	M_3	MEAN	M_1	M_2	M_3	MEAN	M_1	M_2	M_3	MEAN
S_1	25.09	17.03	13.18	18.43	1176	0922	1047	1048	37.32	36.11	36.75	36.73
S_2	25.18	17.10	13.24	18.50	2198	1749	1965	1971	38.94	37.46	38.03	38.14
S_3	25.29	17.18	13.30	18.59	2804	2215	2487	2502	40.18	37.86	39.00	39.02
S_4	25.73	17.50	13.57	18.93	3247	2698	2955	2967	41.36	39.78	40.53	40.56
S_5	25.56	17.38	13.47	18.80	3052	2484	2746	2761	40.77	38.93	39.77	39.82
S_6	25.48	17.31	13.42	18.74	2967	2389	2652	2669	40.53	38.55	39.44	39.51
MEAN	25.39	17.25	13.36		2574	2076	2309		39.85	38.12	38.92	
	Main	Sub	M at S	S at M	Main	Sub	M at S	S at M	Main	Sub	M at S	S at M
$S.E_d$	1.59	1.86	3.06	2.83	096	067	191	137	0.24	0.32	0.49	0.59
CD(p=0.05)	3.24	NS	NS	NS	195	136	382	278	0.51	0.63	1.02	1.21

Treatment details

Table 2

M_1 – Mapillai samba		M_2 – Illupai poo samba		M_3 – Seeraga samba	
S_1 – Control	S_2- Recommended dose of nitrogen	S_3 - 75% RDN + FYM @12.5 t ha^{-1}	S_4 - 75% RDN +EM compost @ 5 t ha^{-1}	S_5 - 75% RDN + pressmud @ 10 t ha^{-1}	S_6 - 75% RDN + green manure @ 6.25 t ha^{-1}

Table 3: Effect of INM practices on quality character of traditional rice varieties

Treatments	Hulling percentage				Milling percentage				Head Rice Recovery (%)			
	M_1	M_2	M_3	MEAN	M_1	M_2	M_3	MEAN	M_1	M_2	M_3	MEAN
S_1	69.28	67.39	65.81	67.49	62.98	60.78	58.26	60.67	49.88	48.52	47.38	48.60
S_2	71.63	69.68	68.05	69.79	65.12	62.84	60.24	62.73	51.57	50.17	49.00	50.25
S_3	74.34	72.31	70.62	72.42	67.58	65.21	62.51	65.10	53.52	52.06	50.85	52.14
S_4	76.96	74.86	73.11	74.97	69.96	67.51	64.71	67.39	55.41	53.90	52.64	53.97

S_5	76.25	74.17	72.44	74.29	69.32	66.89	64.12	66.78	54.90	53.40	52.16	53.49
S_6	75.88	73.81	72.08	73.92	68.98	66.57	63.81	66.45	54.63	53.14	51.90	53.22
MEAN	74.06	72.04	70.35		67.32	64.97	62.27		53.32	51.87	50.65	
	Main	Sub	M at S	S at M	Main	Sub	M at S	S at M	Main	Sub	M at S	S at M
$S.E_d$	0.87	0.29	3.39	1.26	0.97	0.24	2.78	1.89	0.64	0.19	2.64	1.72
CD(p=0.05)	1.73	0.59	NS	NS	1.98	0.51	NS	NS	1.32	0.46	NS	NS

Table 4

M_1 – Mapillai samba		**M_2 – Illupai poo samba**		**M_3 – Seeraga samba**	
S_1 – Control	S_2- Recommended dose of nitrogen	S_3 - 75% RDN + FYM @12.5 t ha^{-1}	S_4 - 75% RDN +EM compost @ 5 t ha^{-1}	S_5 - 75% RDN + pressmud @ 10 t ha^{-1}	S_6 - 75% RDN + green manure @ 6.25 t ha^{-1}

References

1. Anonymous. Annual Report, Directorate of Economics & Statistics, Directorate of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India, Krishi Bhawan, New Delhi110001, 2016.
2. Chimmili SR. Genetic analysis for nutritive traits using medicinal land races of rice (*Oryza sativa* L.), M.Sc. (Ag.) Thesis, TNAU, Coimbatore, 2012.
3. Fan J, Siebenmorgen TJ, Yang W. A study of head rice yield reduction of long-and medium-grain varieties in relation to various harvest and drying conditions. Transactions of the ASAE. American Society of Agricultural Engineers,2000:43:1709-1714. https://doi.org/10.13031/2013.3072.
4. Ganga Devi M, Tirumala Reddy S, Sumati V, Pratima T, John K. Nitrogen management to improve the nutrient uptake, yield and quality parameters of scented rice under aerobic culture. Int. J. of Applied Biol. and Pharma. Tech,2012:3(1):340-344.
5. Gautam AK, Kumar D, Shivay YS, Mishra BN. Influence of nitrogen levels and plant spacing on growth, productivity and quality of two inbred varieties and a hybrid of aromatic rice. Archives of Agronomy and Soil Science,2008:54:515-532. https://doi.org/10.1080/03650340802283470.
6. Ghimire S, Sherchan DP, Andersen P, Pokhrel C, Ghimire S, Khanal D. Effect of Variety and Practice of Cultivation on Yield of Spring Maize in Terai of Nepal. Agrotech,2016:5(2):1-6.
7. Ghosh M, Mandal BK, Mandal BB, Lodh SB, AK. The effect of planting date and nitrogen management on yield and quality of aromatic rice (Oryza sativa). The Journal of Agricultural Science,2014:142:183-191. https://doi.org/10.1017/S002185960400423X
8. Gomez K, Gomez A. Statistical procedures of agricultural research. John Wiley and Sons. Inc., New York, USA, 1984.
9. Hegde S, N Yenagi, Itagi S, Babala HB, Prashanthi SK. Evaluation of red rice varieties fornutritional and cooking quality cultivated underorganic and conventional farming system. Karnataka J. of Agrl. Sci,2013:26(2):288-294.
10. Jusoh ML, Manaf LA, Latiff PA. Composting of rice straw with effective microorganisms (EM) and its influence on compost quality. Iranian J. Envi. Health Sci. Eng,2013:10(17):1-9.
11. Kyi Moe, Kumudra Win, Kyaw Kyaw Win, Takeo Yamakawa. Combined Effect of Organic Manures and Inorganic Fertilizers on the Growth and Yield of Hybrid Rice (Palethwe-1). American J. of Plant Sci,2017:8:1022-1042.
12. Li Z, Wan J, Xiao J, Yano M. Mapping of quantitative trait loci controlling physico-chemical properties of rice grain. *Breeding Sci*,2003:53:209-215.
13. Pellaiyar P, Mohandass R. On the completion of cooking in rice. Indian J. Nutrition and Diet,1981:18:121-122.
14. Ramesh S, Vaiyapuri V. Yield potential and economic efficiency of rice (*Oryza Sativa*) as in influenced by organic nutrition under Cauvery deltaic region of tamil nadu. Plant Archives,2008:8:621-622.
15. Sakda jongkaewwattana, Shu geng, Marlin Brandon and James E hill. Effect of N and harvest grain moisture on head rice yield. Agronomy Journal 85, 1993, 1143-1146.
16. Singhal DK, Janardan Yadav, Shiv Singh Meena, Divyesh Chandra Kala. Effect of rice husk biochar, carpet waste, FYM and plant growth promoting rhizobium on the growth and yield of rice. J. of Applied and Natural Sci,2017:(9):2043-2046.
17. Yaduvanshi NPS. Substitution of inorganic fertilizers by organic manures and the effect on soil fertility in a rice-wheat rotation on reclaimed sodic soil in India. The Journal of Agricultural Science,2003:140:161-168. https://doi.org/10.1017/S0021859603002934
18. Yoshida S. Fundamentals of rice crops science. International Rice Research Institute, Los Banos, 1981.
19. Varma SC. Agronomy of new plant types. Tate publications. Varanasi, 1973, 128.
20. Nasr ME, Zinhoum RA, Lotfy K. Efficacy of cold plasma against three of stored grain insects. Int J Entomol Res. 2020;5:113-7.