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Research Article

Effect of integration of inorganic and organic sources of fertilizers on the yield and economics of rice cultivation var. CR1009

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Abstract

The complimentary role of organics as supplements to chemical fertilizers is important for keeping the soil healthy in order to harness the potential yield in rice. Therefore, a field experiment was carried out during the cropping year of 2020-2021 to ascertain the impact of inorganic and organic source fertilizers integration on rice production's yield and its economics in Cauvery deltaic region of Tamil Nadu. The experiment was laid out in randomized block design with three replications. The experiment comprised of eight treatments *viz.*, T_1 - RDF + 12.5 t FYM (Farmer's practice), T_2 - Vermicompost @ 5 t/ha + RDF, T_3 - Coirpith compost @ 5 t/ha + RDF, T_4 - Pressmud compost @ 5 t/ha + RDF, T_5 - Poultry manure compost @ 5 t/ha + RDF, T_6 - Goat manure compost @ 5 t/ha + RDF, T_7 - Bone sludge compost @ 5 t/ha + RDF and T_8 - Sewage sludge compost @ 5 t/ha + RDF was applied to see the effect of integration of both organic and inorganic sources of fertilizers on the yield and economics of rice (CR1009) cultivation. The present study's findings showed that the integrative application of vermicompost @ 5t ha^{-1} along with 100 per cent recommended dose of fertilizers (T_2) excelled all treatments and gave significantly increased grain yield of 5792 kg ha^{-1} with a value of 37 per cent over control and benefit-cost ratio of 3.45. The integrated application of Vermicompost @ 5tha^{-1} along with 100 per cent recommended dose of NPK registered the highest values in yield attributes, yield and economic returns in rice.

Keywords: Bone sludge compost, Goat manure compost, Poultry manure compost, Pressmud compost, Vermicompost, grain yield

INTRODUCTION

The uncontrolled disposal of industrial waste threatens human health and the soil's ability to support the entire plant kingdom. Therefore, avenues are being searched to recycle these wastes in such a way that they are useful to the environment, including soil (Monojkumar*et al.* (2019). Industry waste from agriculture and non-agricultural fields is being accepted for recycling in agriculture because it has soil ameliorative properties, acts as a source of plant nutrients, can improve fertilizer use efficiency, and helps the indigenously available resources by acting as a low-cost input in agriculture. Waste originating from the sugar industry, biogas plants, paper and pulp mills, chemical industries and industries involved in food processing is finding its place in today's agriculture. The challenge is to properly incorporate these wastes in a controlled management programme so that the applied wastes do not contribute to the problem of pollution. Krishnaveni*et al.* (2020). Imbalanced, inappropriate and indiscriminate application of chemical fertilizers leads to the heavy withdrawal of nutrients from the soil, resulted in poor soil fertility and deterioration of soil health and land degradation (Bisht and Chauhan, 2020). There has been a gradual deterioration not only in productivity but also in soil recuperative capacity, pollution of water resources and chemical contaminations of food grains (Jhon and Babu, 2021).

Sustainable production can be achieved only when factors leading to continued maintenance of soil health are taken care of. Hence, the complementary role of organics as supplements to chemical fertilizers is important for keeping the soil healthy in order to harness the potential yield of rice (Vignesh and Sudhagar Rao, 2019). Under these circumstances, greater emphasis is now being given to the integration of inorganic and organic, including crop residues, agro-based industrial wastes and byproducts, to improve soil productivity (Mohanasundar and Saravana Perumal, 2021).

Bone sludge is a byproduct of the ossein industry that consists of suspended bone particles in bone washings that are filtered and sun-dried (Sivakumar, 2020). The pressmud compost from sugar industry contains a great efficiency of macro and micronutrients and hence has a great scope for being used as manure for agricultural crops (Diaz, 2016). The organic manures *viz*., vermicompost, poultry manure compost, coirpith compost, goat manure compost, bone sludge compost and sewage sludge compost are excellent organic fertilizers, as they contain a high amount of nitrogen, phosphorus, potassium and other essential nutrients and have been promising in arresting the declining trend of soil health and in increasing productivity through correction of marginal deficiency Adekiya*et al*. (2020) Hence, the present investigation was carried out to develop an efficient integrated nutrient management practice for rice using locally available organic sources and inorganic fertilizers to augment rice productivity in the tail end Cauvery deltaic zone of Tamil Nadu.

MATERIALS AND METHODS

A field experiment was carried out in the M block of the experimental farm at Annamalai University, Department of Agronomy, Faculty of Agriculture, Annamalai Nagar which is located at 11º24' N latitude and 79º44' E longitude at an altitude of + 5.79 m above mean sea level. The soil of the experimental field was classified as *Udicchromustert* (clay soil) according to Food and Agricultural Organization (2021). The initial analysis of the experimental soil revealed that heavy clay with neutral in reaction (pH 7.5), with low soluble salts (EC 0.33 dSm^{-1} low in available N (215.35 kg ha^{-1}), medium in available P_2 O_5 (19.85 kg ha^{-1}) and high in available K_2O (368.90 kg ha^{-1}). The experiment was laid out in randomized block design with three replications. The experiment comprised of eight treatments *viz*., T_1 - RDF + 12.5 t FYM (Farmer's practice), T_2 - Vermicompost @ 5 t/ha + RDF, T_3 - Coirpith compost @ 5 t/ha + RDF, T_4 - Pressmud compost @ 5 t/ha + RDF, T_5 - Poultry manure compost @ 5 t/ha + RDF, T_6 - Goat manure compost @ 5 t/ha + RDF, T_7 - Bone sludge compost @ 5 t/ ha + RDF, T_8 - Sewage sludge compost @ 5 t/ha + RDF. The rice variety CR 1009 was chosen as the test crop for the investigation. Vermicompost, pressmud compost, poultry manure compost, goat manure compost, sewage sludge compost and FYM were obtained from the Department of Agronomy, Faculty of agriculture farm unit, Annamalai University, Annamalai Nagar. Bone sludge compost used in this study was obtained from Pioneer Jellice India Pvt. Ltd., Cuddalore and the Coir pith compost was obtained from Vinod Coir industry, Cuddalore.

The nutrient content of organic manure composts *viz*., Vermicompost N-1.50%,P-0.30%,K-0.60%, press mud compost N- 2.63% ,P-2.54%, K-2.36%, goat manure compost N-2.23%,P-1.24%,K-3.69%, poultry manure compost N-2.20%,P-1.40%,K-1.20%, bone sludge compost N-2.10% P-9.96%,K-0.38%, coirpith compost N-1.24%,P-0.06%,K-1.20%, sewage sludge compost N -1.00%,P-0.102% K-0.60% and FYM N-0.58% P-0.27%,K-0.60% respectively. The recommended package of practice of 150:50:50 kgs ha^{-1} of N, P_2O_5 and K_2O ha^{-1}wasfollowed.The recorded dates were analyzed statistically with analysis of variance using Agres software with a critical difference at 0.05 level of probability which was suggested by (Gomez and Gomez, 1978).

RESULTS AND DISCUSSION

Yield attributes

The yield attributes of rice variety CR1009*viz.,* number of productive tillers m^{-2} and number of filled grains panicle^{-1} were favourably influenced by the incorporation of organic manure composts along with 100% recommended NPK fertilizer dose (Table 1). Maximum productive tiller number of 384 m^{-2} and number of filled grain panicle^{-1} 93.10 were registered under the integrated use of vermicompost @ 5 t ha^{-1} along with 100% reccomended dose of NPK fertilizer (T_2). It was followed by applying pressmud compost @ 5 t ha-1 along with a 100% recommended dose of NPK fertilizer (T_4). Application of FYM @ 12.5 t ha^{-1} with recommended NPK ha^{-1} (T_1) (Traditional farmers' practice) registered the minimum tiller number of 297 m^{-2} with filled grains of 74.99 panicle^{-1}. The higher availability of nutrients from inorganic fertilizers and organic vermicompost (T_2) might have improved the physiological and metabolic function inside the plant body and laid down the foundation for synthesis of more chlorophyll and sustained the leaf through higher level of N concentration throughout the cropping period which ultimately led to the production of more number of tillers. The present findings agree with the earlier report (Kheyri, 2017), which indicated that application of vermicompost was significant on all the agronomic traits and enhanced the growth and development of rice crop with thehighest grain yield of 3863 kg ha^{-1}.

The use of both inorganic fertilizers and organic manures could have helped in balanced nutrient availability at all the growth stages of rice. Further, this might have improved the macro and micronutrient availability resulting in higher absorption of nutrients which ultimately led to better translocation of photosynthesis

Table 1. Effect of integrated inorganic and organic sources on the yield attributes and yield of rice cultivation

Treatments	Number of productive tillers m^{-2}	Number of filled grains $panicle^{-1}$	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 -Control- Application of FYM at 12.5 t/ha^{-1}, Farmer's practice	297	74.99	4221	6279
T_2 - Application of vermicompost @ 5 t ha^{-1}+ Recommended dose of fertilizers	384	93.10	5792	8111
T_3 -Application of coirpith compost @ 5 t ha^{-1}+ Recommended dose of fertilizers	325	80.16	4677	6814
T_4 -Application of pressmud compost @ 5 t ha^{-1}+ Recommended dose of fertilizers	368	90.52	5585	7898
T_5 -Application of poultry manure compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	355	88.01	5281	7533
T_6 -Application of goat manure compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	342	85.49	5052	7276
T_7 -Application of bone sludge compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	328	82.63	4779	6951
T_8 -Application of sewage sludge compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	310	77.52	4469	6576
S. Em ±	4	0.83	61.67	70.67
CD (p=0.05)	12	2.50	185	212

Table 2. Effect of integrated inorganic and organic sources on the economics of rice cultivation

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit cost-ratio
T_1 -Control- Application of FYM @ 12.5 t/ha^{-1}, (Farmer's practice)	30000	69594	39594	2.31
T_2 - Application of vermicompost @ 5 t ha^{-1}+ Recommended dose of fertilizers	27500	94991	67491	3.45
T_3 -Application of coirpith compost @ 5 t ha^{-1}+ Recommended dose of fertilizers	27250	76969	49719	2.82
T_4 -Application of pressmud compost @ 5 t ha^{-1}+ Recommended dose of fertilizers	27500	91673	64173	3.33
T_5 -Application of poultry manure compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	28000	86748	58748	3.10
T_6 -Application of goat manure compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	27000	83056	56056	3.07
T_7 -Application of bone sludge compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	26500	78636	52136	2.96
T_8 -Application of sewage sludge compost@ 5 t ha^{-1}+ Recommended dose of fertilizers	26500	73611	47111	2.77

from source to sink, resulting in a greater number of spikelets and filled grains $panicle^{-1}$. These findings are consistent with previous reports in rice by Bejbaruah*et al.* (2018), who stated that the application of vermicompost releases higher micro and macro nutrients resulting in higher availability of balanced plant nutrients in soil throughout the crop growth period, which resulted in higher yield parameters such as panicle, filled grains per panicle, and total spikelets per panicles and highest grain yield of 3910 t ha^{-1} of rice.

Yield

The integrated use of inorganic and organic nutrient sources substantially impacted rice grain and straw yield (Table 1). Application of 100% recommended dose of NPK fertilizer along with vermicompost @ 5 t ha^{-1} (T_2) significantly registered the highest grain yield of 5792 kg ha^{-1} and straw yield of 8111 kg ha^{-1}. It was followed by applying press mud compost@ 5 t ha^{-1} + Recommended dose of fertilizers recorded with a grain yield of 5585 kg ha^{-1} and straw yield of 7898 kg ha^{-1}.

Application of FYM @ 12.5 t ha^{-1} with recommended NPK ha^{-1} (T_1) (Traditional farmers' practice) registered the minimum grain yield of 4221 kg ha^{-1} and straw yield of 6279 kg ha^{-1}. Grain yield might have increased due to higher yield contributing characteristics under integrated nutrient management which received the essential nutrients at balanced proportions for better growth of rice.

Furthermore, vermicompost relatively added a greater proportion of macro and micro nutrients especially P, Ca and Mg which are involved in enzyme activities and impart biochemical and physicochemical activities of soil. The plants absorbed these nutrients, resulting in more photosynthates assimilation and subsequent conversion of assimilates into yield attributes in larger fractions, which ultimately resulted in higher yields of grain and straw as well as a harvest index. Similar findings of a steady supply of nutrients by integrating vermicompost with inorganics for better growth of rice (CR1009) yield characteristics and yield were in agreement with the results of Kumar *et al.* (2021), who stated that the application of vermicompost obtained higher yields and yield attributes in rice crop

Economics

Integrated use of 100% recommended dose of NPK fertilizers along with vermicompost @ 5 t ha^{-1} (T_2) significantly registered the highest gross return of Rs.94991 ha^{-1}, a net return of Rs.67491 ha^{-1} and benefit-cost ratio of 3.45 (Table 2). The minimum gross return of Rs.69594 ha^{-1}, a net return of Rs.39594 ha^{-1} and a return per rupee invested of 2.31 was noticed under control. Sarkar *et al.* (2021) also confirmative these findings of higher return per rupee invested in rice by combining organic and inorganic manure sources to reduce the purchase cost of higher-priced chemical fertilizers.

Conclusion

The present study concluded that combining 100 % recommended dose of NPK fertilizers with vermicompost @ 5 t ha^{-1} (T_2) produced considerably greater yield characteristics, yield, and a benefit-cost ratio of 3.45 in var. CR1009. Hence, this integrated nutrient management strategy has emphasized boosting production and economics; and preserving the ecosystem.

Conflict of interest

The authors declare that they have no conflict of interest.

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