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Sustainable Nutrient Management Practices to Increase the Productivity of Transplanted Lowland Rice

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Field experiment was conducted at wetland farm of Tamil Nadu Agricultural University, Coimbatore during *samba* season of 2014 to study the effect of organic and inorganic sources of nutrients on transplanted lowland rice. The experiment was laid out in a randomized block design with three replications and nine treatments. Rice variety CO(R) 48 was used. Dhaincha (Green manure), vermicompost, farmyard manure were incorporated before transplanting of rice as per treatment schedule. The observations on nutrient uptake and yield were recorded. Higher nutrient uptake, soil available nitrogen, phosphorus, potassium and organic carbon were recorded with application of 100 % NPK through inorganic fertilizers + 6.25 t dhaincha (Green manure) followed by application of 100 % N through dhaincha (Green manure) + balance P and K through inorganic fertilizers. The results revealed that higher grain yield (6248 kg ha^{-1}) was obtained with application of 100 % NPK through inorganic fertilizers + 6.25 t dhaincha (Green manure) followed by Application of 100 % N through dhaincha (Green manure) + balance P and K through inorganic fertilizers.

Key words: Rice, Organic manure, Soil nutrient status, Yield.

Rice (*Oryza sativa* L.) is an important food crop, which feeds more than half of the world's population. The slogan "Rice is life" is most appropriate to India as this crop plays a vital role in the national food security. Rice is a means of livelihood for millions of rural households. Eventhough the area under rice cultivation is large, the productivity is low due to various interaction factors. The imbalance in usage of fertilizers is one of the main factors responsible for the low productivity; also the continuous use of inorganic fertilizers resulted in declining of soil fertility (Abrol and Katyal, 1990).

To achieve higher and sustainable rice yields, use of organic manures is a must. It is, however, difficult to meet the crop nutrient requirements with bulk of organic manure alone. There is a need for integrated application of different sources of nutrients for sustaining the desired crop productivity and total crop production (Datta and Singh, 2010). Use of organic manure, green manuring, crop residues along with inorganic fertilizers not only reduce the demand for inorganic fertilizers, but also increases the efficiency of applied nutrients due to their favourable effect on physical, chemical and biological properties of soil (Prasad *et al*., 1992). An integrated approach involving organic manures and chemical fertilizers will go a long way in building up of the soil fertility on a permanent basis and the system will supply most of the nutrients in a judicious way and the nutrient uptake by the crop will be enhanced.

Material and Methods

A field experiment was conducted during *samba* season (2014) at wetland farm of TNAU, Coimbatore. The soil of the experimental field was clay loam with the pH, EC and organic carbon (%) of 7.85, 0.42 and 0.58, respectively. The study was conducted with nine treatments *viz*., T_1-100 % N through dhaincha (GM) + balance P and K through inorganic fertilizers, T_2 -50 % N through dhaincha (GM) + balance N, P and K through inorganic fertilizers, T_3-100 % N through vermicompost + balance P and K through inorganic fertilizers, T_4 -50 % N through vermicompost + balance N, P and K through inorganic fertilizers, T_5-100 % NPK (150 : 50 : 50 kg ha^{-1}) through inorganic fertilizers, T_6 -100 % NPK through inorganic fertilizers + 12.5 t farmyard manure, T_7 -100 % NPK through inorganic fertilizers + 6.25 t dhaincha (GM), T_8-100 % NPK through inorganic fertilizers + 5 t vermicompost and T_9-Control. The experiment was laid out in a RBD with three replications. The test crop was used as medium duration of rice variety CO(R) 48. The observations were recorded on the uptake of NPK and productivity of transplanted rice under lowland condition.

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Result and Discussion

Post harvest soil available nutrient status

Soil available nitrogen

The maximum soil available N (255 kg ha^{-1}) was observed with application 100 % NPK through inorganic fertilizers + 6.25t dhaincha (GM) which was comparable with 100 % NPK through inorganic fertilizers + 5t vermicompost and 100 % NPK through inorganic fertilizers + 12.5t FYM. Among the other treatments, higher soil available N (233 kg ha^{-1}) was attained with 100 % N through dhaincha (GM)

+ balance P and K through inorganic fertilizers (Table 1). This might be due to lower amount of residual nutrient in inorganic fertilizer applied field. Inorganic fertilizers cause immediate release of nutrients, which will be utilized by the crop or might have lost the environment through leaching or identification process. Higher N availability in the organic manures such as vermicompost, FYM might be due to higher N content and continuous and slow release of nutrients from organic manure and increased biomass and accumulated soil organic matter. Similar findings were also reported by Amanullah *et al*. (2006b).

Table 1. Effect of sustainable nutrient management practices on soil available nutrients (kg ha^{-1}) and organic carbon (%) at post harvest of transplanted lowland rice

Treatments	N	P	K	Organic C
T_1 - 100 % N through dhaincha + balance P and K through inorganic fertilizers	233	16.1	406	0.64
T_2 - 50 % N through dhaincha + balance N, P and K through inorganic fertilizers	211	14.1	381	0.62
T_3 - 100 % N through vermicompost + balance P and K through inorganic fertilizers	212	14.4	381	0.63
T_4 - 50 % N through vermicompost + balance N, P and K through inorganic fertilizers	211	13.9	380	0.61
T_5 - 100 % NPK through inorganic fertilizers (150: 50:50 kg ha-1)	210	13.5	380	0.60
T_6 - 100 % NPK through inorganic fertilizers + 12.5 t ha-1 FYM	254	17.8	431	0.65
T_7 - 100 % NPK through inorganic fertilizers + 6.25 t ha-1dhaincha	255	18.5	432	0.66
T_8 - 100 % NPK through inorganic fertilizers + 5 t ha-1 vermicompost	254	18.2	431	0.66
T_9 - Control	189	11.7	345	0.59
SEd	9	0.7	11	0.03
CD (P=0.05)	19	1.4	24	NS

Soil available phosphorus

The soil available P status was also improved by the addition of organic and inorganic sources of nutrient management practices (Table 1). Higher soil available P (18.5 kg ha^{-1}) was attained with 100 % NPK through inorganic fertilizers + 6.25t dhaincha (GM) which was comparable with 100 % NPK through inorganic fertilizers + 5t vermicompost (18.2) and 100 % NPK through inorganic fertilizers + 12.5t FYM (17.8). Among the other treatments, 100 % N through dhaincha (GM) + balance P and K through inorganic fertilizers recorded the maximum soil available P (16.1 kg ha^{-1}) compared to control. This might be due to the fact that during the mineralization of enriched organics, a number of organic acids, especially the hydroxyl ions (product of microbial metabolism) are produced, which might have released P through chelation or by removal of metal ions from the insoluble metal phosphates as observed by Mohandas and Appavu (2000). The influence of organic manure in increasing the label P through complexing of cations like Ca^{2+} and Mg^{2+} responsible for P fixation has been reported by Balaguravaiah *et al.* (2005). Pazhanivelan *et al.* (2006) reported that rock phosphate enriched manures maintained higher levels of P in soil solution for a longer period than the inorganic fertilizer. Higher soil available P could be attributed to decomposition of organic manures in the production of organic acids which in turn stabilize native insoluble P and led to available for longer period. Further, the higher quantity of crop residues might also have contributed P to the soil.

Table 2. Effect of sustainable nutrient management practices on grain and straw yield of transplanted lowland rice

Treatments	Grain yield(kg ha^{-1})	Straw yield(kg ha^{-1})
T_1 - 100 % N through dhaincha + balance P and K through inorganic fertilizers	5778	7411
T_2 - 50 % N through dhaincha + balance N, P and K through inorganic fertilizers	5234	6835
T_3 - 100 % N through vermicompost + balance P and K through inorganic fertilizers	5340	6881
T_4 - 50 % N through vermicompost + balance N, P and K through inorganic fertilizers	5111	6772
T_5 - 100 % NPK through inorganic fertilizers (150: 50:50 kg ha^{-1})	5009	6541
T_6 - 100 % NPK through inorganic fertilizers + 12.5 t ha^{-1} FYM	6210	7947
T_7 - 100 % NPK through inorganic fertilizers + 6.25 t ha^{-1}dhaincha	6248	8040
T_8 - 100 % NPK through inorganic fertilizers + 5 t ha^{-1} vermicompost	6220	7996
T_9 - Control	3050	4258
SEd	199	242
CD (P=0.05)	416	507

Soil available potassium

The impact of organic and inorganic sources of nutrient management practices on residual soil K was significant (Table 1). Application of 100 % NPK through inorganic fertilizers + 6.25t dhaincha (GM) registered higher soil available K (432 kg ha-1) and was comparable with 100 % NPK through inorganic fertilizers + 5t vermicompost and 100 % NPK through inorganic fertilizers + 12.5 t FYM. Among the other treatments, significantly higher soil available K (406 kg ha^{-1}) was attained with 100 % N through dhaincha (GM) + balance P and K through inorganic fertilizers. The enhanced K availability irrespective of the season coupled with higher K uptake due to organic manure incorporation could be attributed to higher DMP and K absorption, evidencing the priming effect of K contribution by organic manure (Shobarani *et al.*, 2010). Among the organic manures, Sesbania aculeata played a vital role in improving the uptake of NPK. This might be due to the fact that quick release of N from the added green manure with increased availability of P through the mechanism of reduction, chelation and favourable changes in soil pH and K through the priming effect and besides the direct contribution of K by green manure (Geethalakshmi, 1996). Higher K uptake in rice might be due to the increase in available K, which might have contributed to mineralization of organic manures or solubilization of nutrients from native sources during decomposition as reported by Walia and Kler (2005).

Soil organic carbon

Organic carbon was not much influenced by organic and inorganic sources of nutrient management practices as the variation was not significant between treatments (Table 1). The organic carbon content ranged from 0.59 to 0.66 % in different treatments.

Grain yield

The beneficial effect in respect of grain yield (6248 kg ha^{-1}) was more prominent with application of 100 % NPK through inorganic fertilizers + 6.25t dhaincha (GM) and it was comparable with 100 per cent NPK through inorganic fertilizers + 5t vermicompost and 100 % NPK through inorganic fertilizers + 12.5t FYM, which was followed by 100 % N through dhaincha (GM) + balance P and K through inorganic fertilizers (5778 kg ha^{-1}) compared to other treatments (Table. 2). This might be due to the fact that steady and adequate supply of nutrients by the enhanced biochemical activity of micro-organisms coupled with large photosynthesizing surface that would have helped in the production of more tillers and dry matter with enhanced supply of assimilate to sink resulting in more number of spikelets, higher filling percentage and higher yield. Similar findings were reported by Ramesh (2002).

All along, it is known that because of early mineralization of inorganic nutrients, there might be spontaneous response of rice within season and it is believed earlier that 30 to 50 % of the nutrients applied from organic source were available to rice crop within the season, leaving the remaining for subsequent crops in the cropping system. This falls in line with the findings of Mohandas *et al.* (2008). The lowest grain yield (3050 kg ha^{-1}) was recorded with control. This was quite natural that the soil available nutrients might not have been sufficient to meet the crop demand, since there were no additional application of nutrients by any means.

Straw yield

Higher straw yield was obtained with application of 100 % NPK through inorganic fertilizers + 6.25t dhaincha (GM) (8040 kg ha^{-1}), which was found to be on par with 100 % NPK through inorganic fertilizers + 5t vermicompost and 100 % NPK through inorganic fertilizers + 12.5t FYM followed by 100 % N through dhaincha (GM) + balance P and K through inorganic fertilizers (7411 kg ha^{-1}). This might be due to the fact that adequate biomass production and better nutrient uptake which might have resulted in higher straw yield in these treatments. This is in accordance with the results obtained by Yadav and Lourduraj (2006). The role of fertilizer N in improving the N availability which was responsible for higher DMP production inturn increasing the straw yield has been reported by Bridgit *et al.,*(1996). The straw yield increase in rice due to the combined use of organics and chemical fertilizers have been reported earlier from India (Sudhakar, 2000).

Conclusion

From the experimental results, it can be concluded that application of 100 % NPK through inorganic fertilizers + 6.25t dhaincha (GM) followed by 100 % N through dhaincha and balance P and K through inorganic fertilizers are desirable integrated nutrient management practices for realizing higher grain yield and economic returns in transplanted lowland rice**.**

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