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STUDIES ON RELATIVE EFFICACY OF ORGANICS AND THEIR INTEGRATION WITH FERTILIZER N ON RICE YIELD AND NUTRITION

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Abstract

Field experiments were conducted in two years in clay loam soil to study the influence of organic sources and mineral N on yield and nutrients uptake of rice tested on N equivalence. The treatments consisted of different organics *viz.*, composted coir pith (CCP), green manures (GM), sugarcane trash compost (STC), vermicompost (VC), poultry manure (PM) and FYM applied at 100% RDN and combination of above organics @ 50% N and urea @50% N besides 100% RDN as urea and control. The results revealed that addition of organics or mineral N or both significantly improved rice yield and nutrients uptake over control. Among the organics alone, the grain yield ranged from 4271, 4752 kg ha^{-1} (CCP) to 4603, 5078 kg ha^{-1} (VC). Rice yield improved remarkably with organics and fertilizer N were applied as 50% + 50%. The grain yield ranged from 4674, 5070 kg ha^{-1} CCP (50%) + urea N (50%) to 4943, 5332 kg ha^{-1} VC (50% N) + urea N (50% N) and straw yield ranged from 6276, 6728 kg ha^{-1} (CCP) to 6782, 6746 kg ha^{-1} (VC). With respect to integrated treatments, the straw yield ranged from 6698, 6765 CCP (50% N) + 50% urea N) to 7314, 7725 VC (50%N)+ 50% urea N. Application of vermicompost (50%N) + urea (50% N) (T_{11}) recorded highest nutrients uptake *viz.*, nitrogen (98.4, 100.8 kg ha^{-1}), phosphorus (24.5, 29.4 kg ha^{-1}) and potassium (72.7, 80 kg ha^{-1}) in *Kharif* 2007 and 2008 respectively. Among the organics alone, application of vermicompost (100% N) recorded highest nutrients uptake *viz.*, nitrogen (68.2, 69.1 kg ha^{-1}), phosphorus (13.92, 15.88 kg ha^{-1}) and potassium (52, 55.7 kg ha^{-1}) in both years. The lowest nutrients uptake was recorded in CCP (100% N) among organics alone and CCP (50% N) + mineral N (50% N) among integrated treatments in clay loam soil.

Keywords: mineral nitrogen, organics, nutrients uptake, grain, straw yield, rice

Introduction

Rice is an important crop of the world which is staple food for half of the population and that provides their calorie requirement. The crop is grown in around 158.8 million hectare (FAO, 2016) annually in different parts of the world under diverse climatic conditions with a wide range of growing environments. India is the second largest producer of rice after China with total production of 104 million tons in the year 2015-16 out of 45 Mha areas. It is estimated that the population pressure is likely to be increased up to 138.89 crores by the end of 2025; to meet the requirement of growing population estimated 130 MT of rice will be required. Nitrogen (N) is the most limiting nutrient of rice (Amanullah, 2016). Continuous use of chemical fertilizers without organic manures will lead to gradual decline of organic matter content and change of native N status in the soils which results in lower productivity in the rice cropping system (Pei *et al.,* 2015). There is a growing awareness among the farmers to cultivate crops under organic farming system because of escalating cost of chemical fertilizers, decrease of soil fertility in respect of organic matter, secondary and micro nutrients, environmental and health concerns due to pesticides usage and expected premium prices for the organically produced crops (Ramesh *et al.,* 2005). These evidences suggest that the use of organic manu re like farm yard manure, vermicompost and poultry manure could be a key factor for achieving and maintaining high level of production and quality of rice under different cropping system. (Yadav *et al.,* 2013) However the sole use of organic manures is not popular as it cannot fulfill the nutrient requirements of most crops especially rice. The integrated use of chemical fertilizers and organic fertilizers has proved more effective than their sole use

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(Hidayatullah *et al.,* 2013). In this view present study was undertaken to investigate the impact of different organics and mineral nitrogen on rice yield and nutrients uptake with different combinations in clay loam soil.

Materials and Methods

Field experiments were conducted in *Kharif* season for two years as rice is the test crop (var.ADT 43) at farmer's field in kuttalam. The soil was clay loam in texture with neutral in reaction (pH 6.2) with electrical conductivity 0.36 d Sm^{-1}). The organic carbon content was(6.19 g kg^{-1}) and the available nitrogen content was low(227.0 kg ha^{-1}), available phosphorus(14.8 kg ha^{-1}) and available potassium(316.2 kg ha^{-1}) were medium and high in status respectively. There were 14 treatments with randomized block design in three replications. The treatments include T_1 – Absolute control(no nitrogen, P, K), T_2 - Composted coir pith (CCP - 100% N), T_3 - Green Manure (GM - 100% N), T_4 - Sugarcane trash compost (STC - 100% N), T_5 - Vermicompost (VC - 100% N), T_6 - Poultry manure (PM - 100% N), T_7 - Farm yard manure (FYM - 100% N), T_8 - CCP (50% N) + Urea (50% N), T_9 - GM (50% N) + Urea (50% N), T_{10} - STC (50% N) + Urea (50% N), T_{11} - VC (50% N) + Urea (50% N), T_{12} - PM (50% N) + Urea (50% N), T_{13} - FYM (50% N) + urea (50% N), T_{14} - RDF (120 : 38 : 38 N, P_2O_5, K_2O kg ha^{-1}). In kharif, all the treatments received recommended dose of 38 kg ha^{-1} and potassium 38 kg ha^{-1} except control. In *Kharif* rice, the treatment T_8 to T_{13} received 60 kg N ha^{-1} through various organics (50% N) and 60 kg N ha^{-1} through urea (50% N). All the package of practices recommended for growing rice were followed to ensure good crop growth and better yields. Representative soil samples from surface were collected from the field before laying out the experiment. Treatment wise soil and plant sample were collected at tillering, panicle initiation and harvest stages. The samples were dried under shade, pounded, to pass through a 2mm sieve and then were preserved in polythene bags for analysis of different characteristics. Grain and straw yield were recorded at harvest. Nutrients uptake (nitrogen, phosphorus and potassium) was estimated by multiplying the nutrient content with respective grain and straw yields. The data was subjected to statistical scrutiny to arrive at meaningful explanation for the effect of treatments on rice crop.

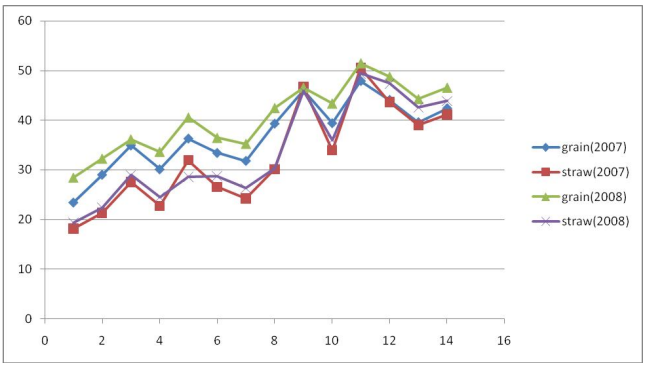
Results and Discussion

Rice yield

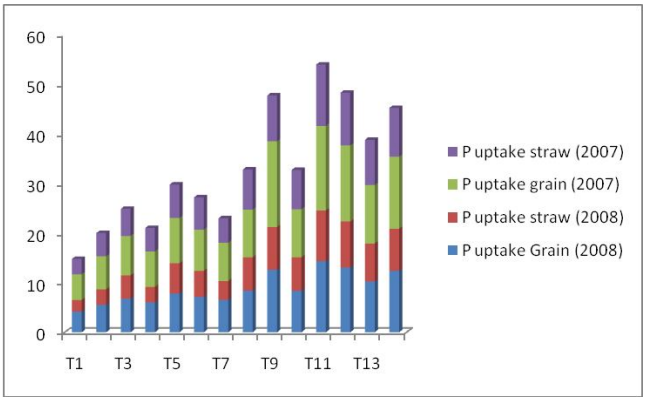
Grain and straw yield of rice in both years was significantly increased due to addition of various yield organics alone or urea at 100% RDN or combined addition at equal rate of N over control Table 1. The treatment received vermicompost (50% N) + urea (50% N) recorded highest grain yield (4943, 5332 kg ha^{-1}) and straw yield (7314, 7725 kg ha^{-1}) in both years followed by poultry manure (50% N) + urea N (50% N) over control. The best treatment caused 26.9% increase in grain yield over control, 3.8% over 100% RDN urea and 7.3% over 100% N through vermicompost. On an average addition of various organics caused 13.4% increase over control whereas recommended dose of N through urea

Table 1: Effect of organics and mineral nitrogen on rice yield (kg ha^{-1}) in clay loam soil

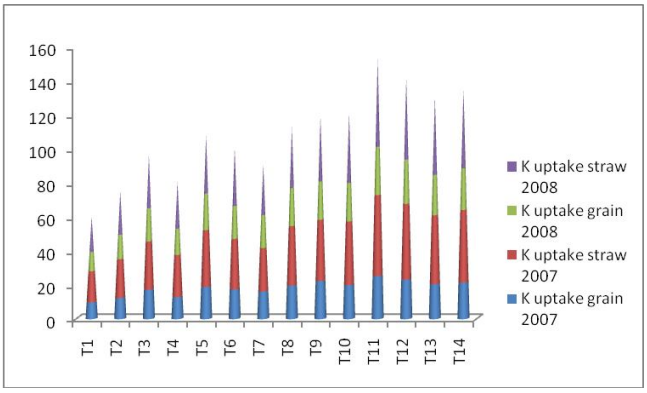
Treatments	*Kharif* 2007				*Kharif* 2008			
	Grain yield	Percent increase over control	Straw yield	Percent increase over control	Grain yield	Percent increase over control	Straw yield	Percent increase over control
T_1 - Absolute control	3896	–	5846	–	4300	–	6235	–
T_2 - (CCP-100% N)	4271	9.6	6276	7.3	4752	10.5	6728	7.9
T_3 - (GM-100% N)	4527	16.2	6716	14.8	4962	15.4	7108	14.0
T_4 - (CST-100% N)	4296	10.2	6315	8.1	4777	11.1	6746	8.2
T_5 - (VC-100% N)	4603	18.1	6782	16.0	5078	18.1	6746	8.2
T_6 - (PM-100% N)	4451	14.2	6620	13.2	4881	13.5	7239	16.1
T_7 - (FYM-100% N)	4363	11.9	6366	8.9	4825	12.2	7040	12.9
T_8 - CCP (50% N) + Urea (50% N)	4674	19.9	6698	14.6	5070	17.9	6765	8.5
T_9 - GM (50% N) + Urea (50% N)	4857	24.7	7177	22.7	5088	18.3	7108	14.0
T_{10} - CST (50% N) + Urea (50% N)	4634	18.9	6786	16.1	5113	18.9	7201	15.5
T_{11} - VC (50% N) + Urea (50% N)	4943	26.9	7314	25.1	5332	22.9	7725	23.8
T_{12} - PM (50% N) + Urea (50% N)	4841	24.2	7151	22.3	5285	24.0	7607	22.0
T_{13} - FYM (50% N) + Urea (50% N)	4654	19.5	6962	19.1	5135	22.9	7600	212.8
T_{14} - RDF (120:38:38 N, P_2O_5 K_2O kg ha^{-1})	4762	22.2	7092	21.3	5210	21.2	7575	21.5
LSD (p=05)	76.2	–	89.7		91.5	–	104.5	–



Fig, 1a: Effect of organics and mineral N on nitrogen uptake in rice in clay loam soil



Fig, 1b: Effect of organics and mineral N on phosphorus uptake in rice in clay loam soil



Fig, 1c: Effect of organics and mineral N on potassium uptake in rice in clay loam soil

caused 22.2% increase over control. On integration of organics and urea the grain yield increase ranged from 16.9% to 26.9% over control. The percent increase in straw yield ranged from 7.3 to 25.1% and 7.9 to 23.8% over control in both years. The best treatment caused (2.41, 2.27%) and (17.84, 10.69%) increase over 100% RDN and (56.8, 32.2 %) over 100% N through vermicompost. The favorable growth in terms of higher LAI and DMP with higher nutrient uptake along with increased yield attributes *viz.*, productive tillers m^2, panicle length and number of filled grains $panicle^{-1}$ which resulted in producing higher grain yield. The increase in grain yield might be due to improved yield attributes morphological and biological characters and better translocation of photosynthates from source to sink (Ashish Kumar and Anil Kumar, 2017). Increase in growth attributes due to increased uptake of nitrogen, photosynthesis and translocation of photosynthates towards reproductive parts which might have increased number of panicles / m^2, panicle length, number of filled grains $panicle^{-1}$, test weight and finally grain and straw yield of rice / hill (Imade *et al.,* 2017).

Nutrients uptake

Data with respect to nutrients uptake by rice indicates that significant improvement in nutrients uptake were noticed under treatments consisting of vermicompost (50% N) + urea N (50% N) over 100% RDN or organics alone (Fig. 1a, 1b, 1c). Among the organics alone, maximum N uptake (36.3, 40.5 kg ha^{-1}), (31.9, 28.6 kg ha^{-1}), P uptake (7.82, 9.14 kg ha^{-1}), (6.10, 6.74 kg ha^{-1}) and K uptake (18.87, 21.3 kg ha^{-1}), (33.2, 34.4 kg ha^{-1}) were noticed under vermicompost (100% N) in grain and straw respectively of rice over control in both years. Among the integrated treatments, maximum N uptake (47.9, 51.4 kg ha^{-1}), (50.5, 49.4 kg ha^{-1}), P uptake (14.33, 17.06 kg ha^{-1}), (10.23, 12.36 kg ha^{-1}) and K uptake (25.20, 28.3 kg ha^{-1}), (47.5, 51.7 kg ha^{-1}) were noticed under vermicompost (50% N) + urea N (50% N) while least were recorded in CCP (50% N) + urea N (50% N) in grain and straw respectively of rice over control. The higher nutrients uptake with organic manure application might be attributed to solubilization of native nutrients, chelation of complex intermediate molecules produced during decomposition of added organic manures, their mobilization and accumulation of different nutrients in different plant parts (Yadav *et al.,* 2013). This significant response in uptake of N, P and K might be due to the enhanced nutrient availability to the crops by the application of organic manure in combination with inorganic fertilizer (Krishnaprabu and Myrtle Grace, 2017). A combined use of organic manures and inorganic fertilizers checks nitrogen losses conserves soil N by forming organic mineral complexes and thus ensures continuous N availability to rice plants and greater N uptake (Sharma and Mittra 1988). The highest phosphorus uptake may be due to formation of weak acids during decomposition of organic manure which helps to convert the complex forms of phosphorus into soluble form. Availability of phosphorus increases its content in plants and total biological yield which ultimately increases the phosphorus uptake. The availability of potassium was increased which increased the potassium uptake might be due to application of potassium fertilizer and organic

manures (Ashish Kumar and Anil Kumar, 2017). Higher dry matter production and significant differences in rice grain yield due to the higher application of N might have contributed to the higher K uptake. Another possible reason could be the higher proliferation of roots in N applied treatments which could have resulted in higher uptake of nutrients (Budhar, 1994).

Conclusion

Thus it can be concluded that the application of 50% N through vermicompost and 50% N through urea N is better preposition to improve the yield and nutrients uptake in rice over organics alone or urea alone.

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