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RESEARCH ARTICLE

INFLUENCE OF ORGANIC AND IN ORGANIC SOURCES OF NITROGEN ON GRAIN YIELD, NUTRIENT UPTAKE AND AGRONOMIC EFFICIENCY IN RICE

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ABSTRACT

Field experiments were conducted at Annamalai University, Experimental Farm, Annamalainagar, during 2007 and 2008 to identify and evaluate different organic manures on productivity enhancement, nutrient uptake and agronomic efficiency and apparent nitrogen recovery in low land rice. The experiment comprised of eight treatments which includes control, recommend dose of nitrogen alone and in combination with graded dose of nitrogen along with various organic manures namely green manure, vermicompost and pressmud compost. These were laid out in randomized block design and replicated thrice. Rice cultivar CO 43 was used as test variety. Both the experiment conducted during samba season (August to January). The results revealed that crop raised with vermicompost registered higher grain, straw yield and harvest index. The vermicompost along with 100% RDN treatments had significant influence on the nutrient uptake. However, higher Agronomic efficiency (AE) and Apparent nitrogen recovery (ANR) was registered under vermicompost along with 75% RDN receive plots. From the above experimental results, it could be concluded that with application of vermicompost @ 5.0 tha^{-1} along with 100% RDN not only resulted in higher yields but also superior in respect of nutrient uptake under rice cultivation.

INTRODUCTION

The United Nation General Assembly (UNGA) declared 2004 as International Year of Rice (IYR). The theme of IYR was "Rice is life". This is because rice is the staple food of over half of the world's population and more than 70 per cent of people' s energy is obtained from rice (Godhawale *et al*., 2007). Above 90 per cent of the world's rice is grown and consumed in Asia, where 60 per cent of the people on the earth live. In India, rice being grown over an area of 44 million hectare with a production of 87.80 million tonnes (Directorate of Economics and Statistics, 2005). Rice often surprises us with phenomenal adjustments to its environment perhaps that is the reason why it has become one of the world's prime food crops.To feed the exploding population by 2025 AD, it is obligatory to produce around 140 million tonnes, which can be made only possible by increasing the production by over 2.0 million tonnes per year for the coming years (Subbiah, 2006). In contrast, recent slow down (or) stagnation of yields in low land rice was noticed as a result of eroding of soil fertility and decline in productivity level. The low yield of rice is due to several factors. Among these, poor fertility is the major factor for low yield of rice.

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Nitrogen is the key element for increasing crop production and it is required in larger amount compared with other fertilizers but it is a costly item when it is derived from artificial sources. But adding organic material from easy and available sources can minimize the cost. Effort is needed to formulate an input package with a combination of organic and inorganic fertilizers. But the research work for the use of vermicompost as a source of N is minimum. Therefore, the present study was conducted to evaluate the effect of organic and synthetic nitrogen and their combination on productivity, nutrient uptake, nitrogen use efficiency in rice.

MATERIALS AND METHODS

Field experiments were conducted at Experimental Farm, Annamalai University, Annamalainagar, during 2007 and 2008 to identify a suitable organic manures in combination with graded doses of nitrogen under rice cultivation on grain and straw yields, nutrient uptake and nitrogen use efficiency of rice. Both the experiment conducted during samba season (August to January). The experimental soil was deep clay, low in available soil nitrogen (197 kg ha^{-1}), medium in available soil phosphorus (19.8 kg ha^{-1}) and high in available soil potassium (271 kg ha^{-1}). The experiment was laid out in randomized block design and replicated thrice. The experiment comprised of eight treatments includes, T_1 - Control (No fertilizer and no organic manure) T_2 - 100% RDN

(Recommended dose of nitrogen), T_3 - T_2 + Green manure @ 6.25 t ha^{-1} , T_4 - 75% RDN + Green manure @ 6.25 t ha^{-1}, T_5 - T_2 + Vermicompost @ 5 t ha^{-1}, T_6 - 75% RDN + Vermicompost @ 5 t ha^{-1}, T_7 - T_2 + Pressmud @ 10 t ha^{-1}, T_8 - 75% RDN + Pressmud @ 10 t ha^{-1}. The rice variety CO 43 was chosen for the study. The recommended seed rate of 30 kg ha^{-1} was used for the experiment and 28 days old seedlings were transplanted with a spacing of 20 X 10 cm. Fertilizer was applied according to treatment details. The recommended dose of 150:50:50 kg ha^{-1} of N, P_2O_5 and K_2O was applied. N and K_2O were 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. N, P_2O_5 and K_2O were supplied through urea (46 per cent N), single super phosphate (16 per cent P_2O_5) and muriate of potash (60 per cent K_2O) respectively. All necessary management practices were carried out as per standard recommendation for rice crop. Observations on grain and straw yield were recorded. Plants were also analyzed for N, P and K uptake after harvest. Effort was also made for calculating Agronomic efficiency and apparent nitrogen recover efficiency by following method.

Agronomic efficiency (AE): In this approach agronomic efficiency was calculated in terms of seed yield kg^{-1} of nitrogen applied. It was computed using the formula as given below.

$$AE = \frac{\text{Grain yield in fertilized plot (kg ha}^{-1}\text{)} - \text{Grain yield in unfertilized plot (kg ha}^{-1}\text{)}}{\text{Amount of nitrogen applied (kg ha}^{-1}\text{)}}$$

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 Vamadevan (1978).

$$ANR = \frac{Y_t - Y_o}{N_t} \times 100$$

Yt = Uptake of N in particular treatment (kg ha^{-1})
Yo= Uptake of N unfertilized plot (kg ha^{-1})
Nt =Quantity of N applied for the treatment (kg ha^{-1})

The data on various studies recorded during the investigation were subjected to statistical scrutiny as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

In both the years, there was perceptible difference observed in rice grain yield due to effect of INM treatments.

Table 1. Influence of different sources of organic and in organic nitrogen on grain and straw yields and harvest index in rice

	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Harvest index	
Treatments	Season-I	Season-II	Season-I	Season-II	Season-I	Season-II
T_1	2.07	2.11	2.78	2.85	42.70	42.52
T_2	3.47	3.60	4.41	4.63	44.05	43.76
T_3	4.91	5.14	5.85	6.17	45.64	45.43
T_4	4.62	4.84	5.58	5.90	45.29	45.05
T_5	5.74	6.02	6.66	7.05	46.27	46.06
T_6	5.42	5.70	6.35	6.73	46.06	45.87
T_7	4.41	4.62	5.42	5.73	44.84	44.62
T_8	4.14	4.35	5.13	5.45	44.64	44.40
SED	0.13	0.15	0.11	0.12	0.79	0.84
CD(p=0.05)	0.28	0.29	0.21	23.12	NS	NS

T_1 - Control (No fertilizer and no organic manure) **T_2** - 100% RDN (Recommended dose of nitrogen) **T_3** - T_2 + Green manure @ 6.25 t ha^{-1} , **T_4** - 75% RDN + Green manure @ 6.25 t ha^{-1}, **T_5** - T_2 + Vermicompost @ 5 t ha^{-1}, **T_6** - 75% RDN + Vermicompost @ 5 t ha^{-1}, **T_7** - T_2 + Pressmud @ 10 t ha^{-1}, **T_8** - 75% RDN + Pressmud @ 10 t ha^{-1}

Table 2. Influence of different sources of organic and in organic nitrogen on nutrient uptake, agronomic efficiency and apparent nitrogen recovery % (ANR%) in

	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})		Agronomic Efficiency*		Apparent N recovery*	
Treatments	Season-I	Season-II	Season-I	Season-II	Season-I	Season-II	Season-I	Season-II	Season-I	Season-II
T_1	52.10	53.33	9.65	9.88	98.13	118.23	-	-	-	-
T_2	84.65	88.40	15.68	16.37	107.46	121.16	9.33	9.93	21.70	23.38
T_3	115.60	121.57	21.41	22.51	116.86	124.70	12.37	13.20	27.67	29.73
T_4	109.62	115.46	20.30	21.38	122.83	128.10	13.28	14.22	29.96	32.36
T_5		140.44	24.68	26.01	127.43	131.16	14.39	15.33	31.84	34.16
T_6	126.45	133.53	23.42	24.73	121.73	127.56	15.40	16.51	34.18	36.87
T_7	105.68	111.26	19.57	20.60	130.63	132.93	10.40	11.16	23.81	25.75
T_8	99.65	105.27	18.45	19.49	117.16	124.90	11.04	11.95	25.36	27.70
SED	2.16	2.26	0.38	0.44	0.42	0.47	-	-	-	-
CD(p=0.05)	4.32	4.51	0.76	0.91	0.83	0.98	-	-	-	-

T_1 - Control (No fertilizer and no organic manure) T_2 - 100% RDN (Recommended dose of nitrogen) T_3 - T_2 + Green manure @ 6.25 t ha^{-1} , T_4 - 75% RDN + Green manure @ 6.25 t ha^{-1}, T_5 - T_2 + Vermicompost @ 5 t ha^{-1}, T_6 - 75% RDN + Vermicompost @ 5 t ha^{-1}, T_7 - T_2 + Pressmud @ 10 t ha^{-1}, T_8 - 75% RDN + Pressmud @ 10 t ha^{-1} * Agronomic Efficiency and Apparent N recovery % - Data statistically not analysed

Among the INM treatments, 100% RDN along with vermicompost @ 5 t ha^{-1} (T_5) registered the maximum grain yield of 5.74 and 6.02 t ha^{-1} in season I and season II, respectively (Table 1). The next best in order was 75% RDN + vermicompost @ 5 t ha^{-1} and (T_6), 100% RDN + green manure @ 6.25 t ha^{-1} (T_3). The aforesaid increased yields due to vermicompost might be due to the constant release of N from organic manure, particularly from vermicompost supplemented with NPK fertilizers might have satisfied the demand of the rice crop at every phenophase of rice crop as opined by Das *et al.* (2003). The superiority of inorganic fertilizer along with vermicompost over inorganic fertilizer alone on rice was earlier reported by Jat and Ahlawat (2004). The least grain yield was recorded in no fertilizer plots (T_1). In respect of harvest index, the treatments which receive vermicompost recorded superior values which were followed by green manure applied plots. This might be ascribed to optimum plant vigour caused by vermicompost which favoured the portioning of the photosynthates to reproductive part that increased grain to straw ratio. The least values were recorded in absolute control.

Crop nutrient uptake: Rice crop with different organic manure registered higher nutrient uptake and was significantly superior to recommended dose of nitrogen alone and absolute control. The date on the effect of different organic manures show that, 100% RDN + vermicompost @ 5 t ha^{-1} (T_5) resulted in the highest N, P and K uptake in season I and season II, respectively by the rice crop. Enhanced N, P and K uptake in this treatment could be attributed to increased dehydrogenase activity and higher nutrients supplied by vermicompost along with inorganic fertilizer. This inturn increased their availability in the forming of NH_4–N, NO_3-N, orthophosphates and potassium and their uptake by crop. A similar finding was reported by Arancon *et al.* (2006).

In respect of agronomic efficiency and apparent nitrogen recovery % (ANR) was highest recorded in 75% RDN + vermicompost @ 5 t ha^{-1} (T_6) as agronomic efficiency of 15.40 and 16.51 for season I and season II, respectively and apparent nitrogen recovery (%) of 34.18 and 36.87 for season I and season II, respectively (Table 2). The lowest values was observed in 100% RDN alone (T_2) plots. Increased AE and ANR (%) This could be attributed to application of organic manures along with reduced level of inorganic fertilizer leading to higher AE and ANR. These trends might be due to increased vegetative growth with increasing N supply but not contributing towards grain production (Yoshida, 1981). Also N loss from the soil increases with N doses (Dhayani and Mishra, 1993).

The least values were recorded under T_2 (100% RDN). This might be due to characteristics of mineral inorganic nitrogenous fertilizer, its susceptibility different types of losses and hence lesser nitrogen use efficiency as compared to INM treatments (Sudhakar and kuppuswamy. 2006). Thus from the present study, it can be concluded that application of 5 t/ha vermicompot along with 100% recommended dose of nitrogen produces higher grain and straw yields, increases nutrient uptake along with conserving nitrogen in rice soils which pave way for sustainability in rice cultivation.

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