Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 52-55
Received: 04-07-2018
Accepted: 08-08-2018

S Ramesh
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

Correspondence
S Ramesh
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

Grain yield, nutrient uptake and nitrogen use efficiency as influenced by different sources of vermicompost and fertilizer nitrogen in rice

S Ramesh

Abstract

Field experiments were conducted at Annamalai University, Experimental Farm, Annamalainagar, during Navarai season 2016 (January to April) and Kuruvai season (June to September) to study grain yield, nutrient uptake and nitrogen use efficiency as influenced by different sources of vermicompost and fertilizer nitrogen application in rice cultivation. The experiment comprised of ten treatments which includes control, recommend dose of nitrogen (RDN) alone and in combination with graded dose of nitrogen along with various organic manures namely sewage sludge compost, pressmud, FYM and water hyacinth compost and different sources of vermicompost. These were laid out in randomized block design and replicated thrice. Rice cultivar ADT 43 was used as test variety. The results revealed that crop raised with 50 % N through urea + 50% N through pressmud vermicompost registered higher DMP and grain yield. The same treatment also noticed significant influence on the nutrient uptake. Plots received with 50 % N through urea + 50% N through pressmud registered higher values of Nitrogen use efficiency, Agronomic efficiency (AE), Apparent nitrogen recovery (ANR), physiological efficiency and Internal efficiency. From the above experimental results, it could be concluded that with application 50% N through urea along with 50 % N through pressmud vermicompost resulted in higher rice grain yield and also superior in respect of nutrient uptake and conserve the nitrogen under rice cultivation.

Keywords: rice, grain yield, nutrient uptake, nitrogen use efficiency, agronomic efficiency (AE), apparent nitrogen recovery (ANR), physiological efficiency and internal efficiency

Introduction

As the global population grows, stress on natural resources increases, making it difficult to maintain food security for future. For long time food security requires a balance between increasing crop production, maintaining soil health and environmental sustainability. In India, nutrient management has played an important role in accomplishing the enormous increase in food grain production from 52 million tonness in 1951-52 to 259 million tonnes during 2014-15. However, application of imbalanced and/or excessive nutrients led to declining nutrient-use efficiency making fertilizer consumption uneconomical and producing combat effects on soil microorganism, soil enzymes activities, and atmosphere causing health hazards and climate change. Nutrient use efficiency (NUE) is a critically important concept in the evaluation of crop production systems. It can be greatly impacted by fertilizer management as well as by soil and plant water management. The objective of nutrient use is to increase the overall performance in crop cultivation by providing economically optimum nourishment to the crop while minimizing nutrient losses from the field. The declining response to inputs has been received to be the major issue challenging the sustainability of rice cultivation. In recent years different combination of organic manures are used along with inorganics for sustaining the rice production and vermicompost was one among them which excels most. In order to test the potential of vermicompost on the yield, nutrient uptake and nitrogen economy of the soil of rice, the present investigation was under taken.

Materials and Methods

Field experiments were conducted at Experimental Farm, Annamalai University, Annamalainagar, during Navarai season 2016 (January to April) and Kuruvai season (June to September) to study the grain yield, nutrient uptake and nitrogen use efficiency as influenced by different sources of vermicompost and fertilizer nitrogen in rice cultivation. The experimental soil was deep clay, low in available soil nitrogen (193 kg ha^{-1}), medium in available soil phosphorus (21.3 kg ha^{-1}) and high in available soil potassium (274 kg ha^{-1}). The experiment was laid out in randomized block design and replicated thrice.

The experiment comprised of ten treatments *viz.*, T_1- control (no fertilizer and no organic manure), T_2- recommended dose of nitrogen (RDN), T_3- 50 % N through urea + 50% N through sewage sludge compost, T_4 – 50 % N through urea + 50% N through pressmud, T_5 - 50 % N through urea + 50% N through FYM, T_6 – 50 % N through urea + 50% N through water hyacinth compost, T_7 – 50% N through urea + 50 % N through sewage sludge vermicompost, T_8 – 50 % N through urea + 50% N through pressmud vermicompost, T_9 – 50% N through FYM vermicompost, T_{10} – 50 % N through urea + 50% N through water hyacinth vermicompost. The average annual rainfall of Annamalainagar is 1250 mm, distributed over 51 rainy days. The mean maximum and minimum temperature are 30.8 $^{\circ}$C and 24.7 $^{\circ}$C respectively. Relative humidity ranges from 76 to 94 per cent. A short duration rice variety cv. ADT 43 was chosen for both the season. The collected organic manures were turned over manually for 15 days in order to pre-compost it, so that it becomes palatable to earthworms. The earthworms used for composting was *Eisenia fetida* and vermicompost was prepared under heap method. After three months, matured vermicompost was applied to the experimental plots as per the treatment schedule. The experimental field was puddled to a satisfactory colloidal state. The recommended seed rate of 60 kg ha^{-1} was used for the experiment and twenty eight days old seedlings were transplanted with a spacing of 15 X 10 cm. Fertilizer was applied according to treatment details. The recommended dose of 120: 38:38 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. Efforts were taken to maintain a water level of 2.5 and 5 cm in the early and later stages of crop growth period respectively. Irrigation was withheld 10 days before harvesting.

All necessary management practices were carried out as per standard recommendation for rice crop. Observations on DMP and grain yield were recorded. Plants were also analyzed for N, P and K uptake after harvest. The plant samples after estimation of dry matter were chopped and powdered by using a Willey mill and were analysed for N, P and K contents. The plant samples were analysed for nitrogen content by Microkjeldahl method as suggested by Yoshida *et al*. (1981) [15] and expressed in kg ha^{-1}. Phosphorus content in plant samples was determined colorimetrically using triple acid digestion method suggested by Jackson (1973) [4] and expressed in kg ha^{-1}. Potassium content in the plant sample was estimated by flame photometer using the triacid mixture and expressed in kg ha^{-1} by Jackson (1973) [4]. Effort was also made assessment of N use efficiency by following method.

Indices for assessment of N use efficiency

Agronomic use efficiency (AEN)

Most commonly used index by agronomic researchers. It is expressed as units increase in economic yield per unit N fertilizer applied. The calculation on AEN essentially requires establishment of research plot without N input (termed as controlled plot). It can be calculated by: AEN (kg kg^{-1}) = Gf – Gu/Na, where Gf is the grain output from N fertilized plot (kg), Gu is the grain output from the controlled plot and Na is the quantity of nitrogen applied (kg).

Apparent recovery efficiency (REN)

Apparent N recovery can be described by difference in N uptake (above-ground biomass of crops) between the N fertilized and that of controlled plot relative to the quantity of N applied. It can be calculated by: REN (%) = (Nf – Nu/Na) × 100, where, Nf is the nitrogen uptake by crop (above ground biomass) from fertilized plot (kg), Nu is the nutrient uptake by crop (above ground biomass) from unfertilized plot (kg), and Na is the doses of N fertilizer applied (kg).

Internal utilization efficiency (IEN)

It is a simple measure of NUE based on crop yield and nitrogen uptake. The value of this index is depending upon agro-climatic conditions, crop cultivar, and level of soil-plant management. Nutrient utilization efficiency is the cross product of physiological efficiency and apparent recovery efficiency of N. It can be calculated by: IEN (kg kg^{-1}) = PEN × REN.

Physiological efficiency (PEN)

It is defined as the yield increase in relation to the increase in crop uptake of the N in above - ground biomass of the crop. It can be calculated by: PE (kg kg^{-1}) = BYf – BYu / Nf–Nu, where, BYf is the biological yield from N fertilized plot (kg), BYu is the biological yield from unfertilized plot (kg), Nf is the nitrogen uptake (above ground biomass) in N fertilized plot, and Nu is the nitrogen uptake (above ground biomass) in unfertilized plot (kg).

Statistical analysis

The data on observations and characters studied were statistically analysed by adopting the procedure of Panse and Sukhatme (1978) [7] and for the results that were significant, the critical differences were calculated at 5 per cent probability level to draw statistical conclusion.

Results and Discussion

Effect of deferent sources of nitrogen on DMP and grain yield

In both the season, all the treatments attained significant influence on the DMP and grain yield. Plots received with 50% N through urea + 50 % N through pressmud vermicompost (T_8) significantly registered the higher DMP of 12491 and 12857 kg ha^{-1} and grain yield of 5.81 and 5.98 t ha^{-1} during first crop and second crop, respectively. This might be due to higher availability of both native and applied nutrients in this treatment along with better source and sink relationship in the crop which have contributed to better dry matter accumulation. A similar view of better performance was reported by Dash *et al.* (2010) [2]. Lesser response of rice to other organic manures could be attributed to slow mineralization of organically bound nutrients and low population of beneficial microbes as compared to pressmud vermicompost (Khatik and Dikshit, 2001). Besides, 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) [1]. The superiority of inorganic fertilizer along with vermicompost over inorganic fertilizer alone on rice was earlier reported by Sudhakar and Balamurugan (2012). The treatment (T_1) control registered the lowest grain yield of 2.07 and 2.25 t ha^{-1}during first crop and second crop, respectively.

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, 50% N through urea + 50 % N through pressmud vermicompost (T_8) resulted in the highest nitrogen uptake of 99.84 and 102.68 kg ha^{-1}, phosphorus uptake of 20.49 and 21.84 kg ha^{-1} and potassium uptake of 129.74 and 132.35 kg ha^{-1} during first and second crop, respectively. This might be due to the congenial environment in pressmud vermicompost for soil organisms involved in nitrogen transformation which has increased the available nitrogen status and retention capacity of nutrients and there by total nitrogen uptake by rice plant. Increase in available N due to application of pressmud vermicompost was also reported by Rayar (1984) [8]. The organic acids released from pressmud solubalise fixed phosphorus from Fe and Al complexes in the soil during organic matter decay (Yadvinder Singh *et al.*, 2010) [14]. The application of pressmud vermicompost also decreased the adsorption capacity and increased the soluble P and P desorption in soil and this lends support to the higher uptake of P in pressmud vermicompost treatments (Reddy *et al*., 1980) [9]. Similar trend of higher K uptake was registered in treatment with application of 50 % N through urea + 50% N through pressmud vermicompost. This increased uptake of K due to in pressmud vermicompost might be due to the increased availability of K and also due to its higher K content in the compost (Joshi and Sharma. 2010) [5]. Besides, the increase in nutrient uptake was directly related to the crop yield. It can be explained on the basis that application of fertilizers along with manures improved initial process of plant growth such as cell division, number of root hairs etc. The healthy root system might have helped the plant in better absorption of nutrients from soil. Similar trend was reported by Kumar *et al.,* (2014) [6]. The lowest NPK uptake in control plot by the rice crop is due to the lower yield obtained in this plots.

Effect of vermicompost and fertilizer nitrogen on NUE

Different INM treatments had marked influence on nitrogen use efficiency, agronomic efficiency, apparent nitrogen recovery (%), physiological efficiency and internal efficiency. Among the treatments, 50% N through urea + 50 % N through pressmud vermicompost (T_8) registered the higher nitrogen use efficiency of 40.92 and 42.11. agronomic efficiency of 26.34 and 26.27 apparent nitrogen recovery (%) of 42.03 and 42.55, physiological efficiency of 62.77 and 61.73 internal efficiency of 58.19 and 58.24 during first crop and second crop, respectively (Table 2). This might be due to increased availability of nitrogen in vermicompost in the form of mucous, nitrogenous excretory substances which were not present in other organic sources (Viel *et al*., 1987) [13]. Nitrogen fixing bacteria were also found to be more in this vermicompost which might have reduced the loss of nitrogen from the soil and increased the use efficiency of inorganic fertilizers applied (Ihseen *et al*., 2003) [3]. This treatment also recorded significantly higher values in internal efficiency. This is because of prolonged supply of organic bound nitrogen as a result of mineralization, which reflected on higher IE under inorganic fertilizer applied with organic manure (Verendra Kumar and Ahlawat, 2004) [12]. 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. These finding were also supported by Tayefe *et al.* (2011) [11].

Table 1: Grain yield and nutrient uptake as influenced by different sources of vermicompost and fertilizer nitrogen in rice

	DMP (kg ha^{-1})		Grain yield (t ha^{-1})		Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
Treatments	**First crop**	**Second crop**	**First crop**	**Second crop**	**First crop**	**Second crop**	**First crop**	**Second crop**	**First crop**	**Second crop**
T_1	4450	4837	2.07	2.25	40.16	42.26	7.98	8.73	50.86	53.72
T_2	7503	7826	3.49	3.64	66.53	68.92	11.63	12.79	81.73	84.42
T_3	9374	9804	4.36	4.56	78.57	80.11	16.64	17.14	103.78	107.46
T_4	10191	10578	4.74	4.92	86.17	88.05	17.84	18.89	113.57	116.74
T_5	9503	9911	4.42	4.61	82.41	84.14	17.08	18.05	108.71	112.48
T_6	8772	9116	4.08	4.24	74.42	76.12	15.89	16.23	99.32	103.26
T_7	11588	12018	5.39	5.59	94.21	96.85	19.38	20.67	122.93	126.84
T_8	12491	12857	5.81	5.98	99.84	102.68	20.49	21.84	129.74	132.35
T_9	11868	12190	5.52	5.67	95.97	98.74	19.77	20.95	124.85	128.29
T_{10}	10879	11287	5.06	5.25	90.29	92.43	18.62	19.75	118.74	121.67
SEd	305	325	0.13	0.14	1.74	1.80	0.33	0.47	1.97	1.99
CD(p=0.05)	611	652	0.26	0.28	3.52	3.65	0.68	0.98	3.98	4.02

Treatment details:- T_1- control (no fertilizer and no organic manure), T_2- recommended dose of nitrogen, T_3- 50 % N through urea + 50% N through sewage sludge compost, T_4 – 50 % N through urea + 50% N through Pressmud, T_5 - 50 % N through urea + 50% N through FYM, T_6 – 50 % N through urea + 50% N through water hyacinth compost, T_7 – 50% N through sewage sludge vermicompost, T_8 – 50 % N through urea + 50% N through pressmud vermicompost, T_9 – 50% N through FYM vermicompost, T_{10} – 50 % N through urea + 50% N through water hyacinth vermicompost

Table 2: Nitrogen use efficiency as influenced by different sources of vermicompost and fertilizer nitrogen in rice

	Nitrogen use efficiency		Agronomic efficiency		Apparent nitrogen recovery (%)		Physiological efficiency		Internal efficiency	
Treatments	**First crop**	**Second crop**	**First crop**	**Second crop**	**First crop**	**Second crop**	**First crop**	**Second crop**	**First crop**	**Second crop**
T_1	-	-	-	-	-	-	-	-	-	-
T_2	29.08	30.33	11.83	11.58	21.98	22.22	53.85	52.14	52.46	52.81
T_3	27.90	29.18	14.77	14.90	24.78	24.42	59.62	61.03	55.49	56.92
T_4	27.56	28.60	15.52	15.52	26.75	26.62	58.03	58.31	55.01	55.88
T_5	32.26	33.65	17.15	17.23	30.84	30.57	55.62	56.35	53.63	54.79
T_6	28.14	29.24	13.86	13.72	23.63	23.35	58.67	58.77	54.82	55.70
T_7	38.99	40.43	24.01	24.16	39.10	39.49	61.42	61.18	57.21	57.72
T_8	40.92	42.11	26.34	26.27	42.03	42.55	62.67	61.73	58.19	58.24

T_9	39.36	40.43	24.60	24.39	39.79	40.27	61.82	60.55	57.52	57.42
T_{10}	36.87	38.25	21.82	21.90	36.59	36.62	59.64	59.80	56.04	56.80

Treatment details:- T_1- control (no fertilizer and no organic manure), T_2- recommended dose of nitrogen, T_3- 50 % N through urea + 50% N through sewage sludge compost, T_4 – 50 % N through urea + 50% N through Pressmud, T_5 - 50 % N through urea + 50% N through FYM, T_6 – 50 % N through urea + 50% N through water hyacinth compost, T_7 – 50% N through sewage sludge vermicompost, T_8 – 50 % N through urea + 50% N through pressmud vermicompost, T_9 – 50% N through FYM vermicompost, T_{10} – 50 % N through urea + 50% N through water hyacinth vermicompost

Conclusion

Thus from the present study, it can be concluded that application 50% N through urea + 50 % N through pressmud vermicompost produces higher grain yield, increases nutrient uptake along with conserving nitrogen in rice soils which pave way for sustainability in rice cultivation.

References

1. Das K, Medhi DN, Guha B. Application of crop residues in combination with chemical fertilizers for sustainable productivity in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) system. Indian J. Agron., 2003; 48(1):8-11.
2. Dash D, Patro H, Tiwari RC, Shahid M. Effect of organic and inorganic sources of N on growth attributes, grain and straw yield of rice (*Oryza sativa*). Int J of Pharm & Life Sci. 2010; 2(4):655-660.
3. Ihseen J, Horn MA, Matthies C, Gobner A, Schramn A, Drake HL. N_2O producing microorganisms in gut of earthworm *Aporrectodea caliginosa* are indicative of ingested soil bacteria. Appl. Environ. 2003; 69:1655-1661.
4. Jackson ML. Soil chemical analysis, Prentice Hall of India Pvt. Ltd., New Delhi. IInd Indian Reprint, 1973, 1-498.
5. Joshi N, Sharma S. Physio-chemical Characterization of sulphidation pressmud Composted pressmud and Vermicomposted pressmud. Environment Sci. 2010; 2(3):223-264.
6. Kumar A, Meena RN, Yadav L, Gilotia YK. effect of organic and inorganic sources of nutrient on yield, yield attributes and nutrient uptake of rice Cv. Prh-10. The international quarterly journal of life science 2014; 9(2):595- 597
7. Panse VG, Sukhatme PV. Statistical method for agricultural workers, ICAR, New Delhi, India, 1978, 145.
8. Rayar AA. Physio-chemical properties of semi-arid soils incubated with different sources of organic manures. Madras Agric. J. 1984; 71:43-47.
9. Reddy KR, Khaleel KR, Overcash MR. Nitrogen, phosphorus and carbon transformation in a coastal plain soil treated with animal manures. Agric. Wastes, 1980; 2:225-228.
10. Subehia SK, Sepehya S. Influence of long-term nitrogen substitution through organics on yield, uptake and available nutrients in a rice-wheat system in an acidic soil. Journal of the Indian Society of Soil Science. 2012; 60(3):213-217.
11. Tayefe M, Zade AN. Effect of nitrogenfertilizer on nitrogen uptake. nitrogen use efficiency of rice. Intl. conference on biology, Environment and Chemistry IPCBEE. 2011; 105(2):189-196
12. Verendra Kumar, Ahlawat. Carry over effect of biofertilizers and nitrogen applied to wheat (*Triticum aestivum*) and direct applied N in maize (*Zea mays*) in wheat-maize cropping system. Indian J Agron. 2004; 49(4):233-236.
13. Viel M, Sayag D, Andre L. Optimization of agricultural industrial waste management through in vessel composting. In: Compost, production, quality and use, Eds. M.de Bertoldi, M.P. Ferranti, P.L. Hermite and F.Zucconi, London, UK, Elsevier Applied Science, 1987, 230-237.
14. Yadvinder Sing RK, Bijay Sing JK, Gupta JS, Ladha Bains, Jagmohansing. Evaluation of pressmud cake as a source of nitrogen and phosphorus for rice-wheat cropping system in the Indo-Gangetic plains of India. 2010; 44(5):755-762.
15. Yoshida S. Fundamentals of rice crop science. IRRI, Los Banos, Philippines, 1981.