RESPONSE OF LOWLAND RICE TO EFFECTIVE USE OF ORGANIC AND INORGANIC AMMENDMENTS ON GROWTH AND YIELD

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ABSTRACT: A field experiment was carried out during kharif season 2018 at Vallalarpuram, Sankarapalayam, Anthiyur, Erode, Tamil Nadu to study the response of lowland rice to effective use of organic and inorganic ammendments on growth and yield. Application of organic and inorganic sources of nutrient in combination remarkably increased growth and yield of rice than alone. 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium (T_7) recorded significantly higher growth and yield in comparison to other treatments and this was followed by 75% N + 25% N through poultry manure + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium (T_9). 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium was increased plant height, Dry matter production, leaf area index, crop growth rate, number of productive tiller/ m^2, number of filled grains/panicle, test weight, grain yield and straw yield. The lower growth and yield was recorded in control.

Key words: Rice, Vermicompost, Pressmud, Poultry manure, Microbial consortium, Zinc.

I. INTRODUCTION

Due to different agro-climatic conditions in the India, a large number of crops are grown. Rice (*Oryza sativa*) stands first among all food grain crops of the world and is staple food for more than half of world's population. Almost 90% of the total rice is produced and consumed in Asia. Rice plays an important role in Indian agriculture and is staple food for more than 60% of the population. According to 2016-2017 statistics, rice is grown in 114 countries across the global in an area of 161 million hectares with an annual production of around 600 million tonnes with an average productivity of 4.44 tonnes ha^{-1}. In India, rice is cultivated in an area of 43.39 million hectares with a production of 104.32 million tonnes and an average productivity of 2.4 tonnes ha^{-1} (Directorate of Economics and Statistics, 2016). In Tamilnadu, rice is cultivated in an area of 18.30 lakh hectares with a production of 79.49 lakh tonnes and an average productivity of 4.4 tonnes ha^{-1} (Department of Economics and Statistics, 2016). In Erode district, rice is cultivated in a total area of 34,339 hectares with a production of 1,46,570 metric tonnes and the productivity is 4.26 t/ha (Deputy Director of Statistics, 2016).

Rice requires high quantity of nutrients to harness their potential yield. Sustainable production could be achieved only when factors leading to continued maintenance of soil health are taken care of. Hence, the complimentary role of organics as supplements to chemical fertilizers is important for keeping the soil health in order to harness the potential yield in rice (Lency, 2001). To explore the potentiality of integrated use of organic and inorganic nutrient sources, the urgent need is to test easily available alternative sources of energy such as vermicompost, pressmud and poultry manure for increasing rice production and soil health as well.

Vermicompost has been recognized as an ecofriendly technology for converting organic wastes into high value organic manure rich in nitrates, available form of phosphorus, calcium, vitamins, natural phyto regulators and micro flora in balanced form which helps in reestablishment of the natural fertility of soil (K. Chiranjeevi *et al*, 2018).

Pressmud is one of the important by product obtained from sugar factory and rich in organic matter, Ca, P, some organic nitrogen and trace elements. It has been used as a soil conditioner, soil ameliorant and source of nutrients for crop growth. This might be due to improvement in nutrient supply with more organics, which improves soil physico-chemical and biological properties by providing essential food to microbes (Debiprasad Dash *et al*., 2010).

Poultry manure is the feces of chickens used as an organic fertilizer, especially for soil which are low in nitrogen. Of all animal manures, it has the highest amount of nitrogen, phosphorus and potassium. The fertility status of the soil to benefit from poultry manure application since the manure is to improve soil organic matter and micronutrient status and micronutrient qualities of the soil (Soremi *et al.*, 2017). The objective of this study to find out the effect of inorganic and organic amendments on agronomic performance of rice.

II. MATERIALS AND METHODS

A field experiment was conducted during kharif season 2018 at Vallalarpuram, Sankarapalayam, Anthiyur, Erode, Tamil Nadu to study the response of lowland rice to effective use of organic and inorganic ammendments. The farm lies in the western zone (11°61' N, 77°58' E) at +251 m above the mean sea-level. The soil was red loam having pH (7.6), electrical conductivity (0.34 dS/m), organic carbon (0.39%), available N (222.50 kg/ha), P (17.25 kg/ha), K (272.50 kg/ha). The N, P, K and Zn were applied through urea, diammonium phosphate (DAP), muriate of potash (MOP) and zinc sulphate respectively. Half dose of N and full dose of P2O5, K2O and Zn were applied as basal. Remaining N was applied in 2 equal splits at 30 and 60 days after transplanting (DAT) rice. The soil samples were analysed for pH (Jackson, 1973) and EC also as per method of Jackson (1973). For analysis of organic carbon, Wet digestion method of Walkley and Black (1934), available N was estimated by Alkaline KMnO4 method (Subbiah and Asija 1956), P by Olsen's method (Olsen et al., 1954) and K by Flame Photometer method (Stanford and English, 1949).

Nine treatments were laid out in randomized block design with three replications consisting of three organic sources of nutrients (vermicompost, pressmud and poultry manure) along with fertilizers, microbial consortium (*Pseudomonas, Azospirillum* and *Cyanobacteria*) and one micronutrient (zinc). vermicompost (3.3 t ha^{-1} on dry weight basis), pressmud (3.8 t ha^{-1} on dry weight basis), poultry manure (3.6 t ha^{-1} on dry weight basis) were incorporated during last plough as per the treatments. Microbial consortium was applied at the rate of 800 g ha^{-1}. The Slurry can be prepared by mixing microbial consortium at 800 g/ha in 40 litres of water and rice seedlings are dipped in the suspension for 15-30 minutes before transplanting. Zinc was applied in the form of zinc sulphate ($ZnSO_4.H_2O$). Treatments of the experiment were T_1 - Absolute control, T_2 - Recommended dose of fertilizers, T_3 - Farmers practices (87:45:30), T_4 - 25% N +75% N through vermicompost + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha), T_5 - 25% N +75% N through pressmud +100 P and K through inorganic manures + $ZnSO_4$ (25Kg/ha), T_6 - 25% N +75% N through Poultry manure + 100 P and K through inorganic manures + $ZnSO_4$ (25Kg/ha), T_7 - 25% N +75% N through vermicompost + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha) + microbial consortium, T_8 - 25% N +75% N through pressmud + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha) + microbial consortium, T_9 - 25% N +75% N through poultry manure + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha) + microbial consortium. Rice variety ADT-45 was used, nursery for transplanting was raised at the seed rate 60 kg ha^{-1}, transplanted on 21st day, at a spacing of 12.5 cm x 10 cm, manually.

Leaf area index (LAI) was proposed by Palanisamy and Gomez (1974), using formula,

$$LAI = \frac{L \times W \times K \times \text{Number of leaves hill}^{-1}}{\text{Spacing (cm}^2\text{)}}$$

Crop Growth Rate (CGR) was formulated by,

$$CGR = \frac{W_2 - W_1}{(t_2 - t_1)\, S}$$

Absolute Growth Rate (AGR) was formulated by,

$$AGR = \frac{W_2 - W_1}{(t_2 - t_1)}$$

Harvest Index (HI) was suggested by Donold and Humblin (1976), using formula,

$$\text{Harvest Index} = \frac{\text{Economic Yield}}{\text{Biological Yield}} \times 100$$

III. RESULTS AND DISCUSSION

Plant height and Dry matter production of rice

Plant height and dry matter production (DMP) of rice increased significantly (Table 1), the maximum was in T_7 - 25% N +75% N through vermicompost + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha) + microbial consortium, with a plant height (cm) of 55.45,

Table: 1. Effect of organic and inorganic manure on growth and yield on Plant height and Dry matter production of rice

S.No.	Treatments	Plant height (cm)			DMP (Kg/ha)		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
1.	**T_1 - Absolute control**	40.10	67.19	78.17	3283	4679	6285
2.	**T_2 - Recommended dose of fertilizer**	45.68	82.58	86.72	3619	5791	8047
3.	**T_3 - Farmers practice**	44.02	81.92	84.98	3457	5592	7754

4.	**T_4 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/a) + 100% P and K through inorganic fertilizer**	50.58	84.56	91.94	4110	6389	8927
5.	**T_5 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer**	47.33	83.25	88.47	3785	5993	8341
6.	**T_6 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25Kg/ha) +100% P and K through inorganic fertilizer**	48.95	83.90	90.20	3947	6191	8633
7.	**T_7 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium**	55.45	86.49	97.12	4589	6976	9785
8.	**T_8 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium**	52.23	85.23	93.69	4275	6588	9219
9.	**T_9 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25 Kg/ha)+ 100% P and K through inorganic fertilizer + microbial consortium**	53.81	85.83	95.38	4424	6775	9492
	SEd	0.81	0.32	0.86	74.29	91.26	134.65
	CD (p=0.05)	1.62	0.64	1.72	158.9	195.29	288.16

86.49 and 97.12 on 30, 60 and 90 DAT, and with a DMP (Kg/ha) of 4589, 6976 and 9785 on 30, 60 and 90 DAT. (Table- 1) Integrated application of vermicompost which contains high amount of macro and micro nutrients enhanced the nutritional status of soil when applied to the soil in combination with inorganic fertilizers primarily NO_3, PO_4, Ca, K, Mg, S and other essential nutrients in the forms that are readily taken up by the plants which led to higher number of tillers and leaf area index of rice thereby providing an opportunity for the plants to increase the photosynthetic rate which in turn resulted in higher accumulation of dry matter. The findings are in close conformity with those of Amit Kumar *et al.* (2017) and Priyanka Anand, (2010).

LAI, CGR and AGR of rice

Application of vermicompost in conjunction with fertilizer T_7 - 25% N +75% N through vermicompost + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha) + microbial consortium recorded the highest Leaf Area Index (LAI), Crop Growth Rate (CGR) and Absolute Growth Rate (AGR). With a LAI of 2.56, 5.30 and 5.67 at 30, 60 and 90 DAT, and with a CGR (g m^{-2} day^{-1}) of 5.89 and 6.34 at 30-60 and 60-90 DAT interval and AGR (mg $plant^{-1}$ day^{1}) of 24.10 and 49.6 at 30-60 and 60-90 DAT interval (Table- 2). Vermicompost in combination inorganic fertilizers with may be due to its greater availability and active participation in carbon assimilation, photosynthesis, starch formation, translocation of protein and sugar and thereby it increase the leaf area index, crop growth rate and absolute growth rate. This line is with the findings of Sunil kumar *et al.* (2017), Ebrahim Azarpour *et al.* (2014) and Mohinder singh (2016).

Table: 2. Effect of organic and inorganic manure on growth and yield on Leaf Area Index, Crop Growth Rate and Absolute Growth rate of rice

S.No.	Treatments	LAI (cm)			CGR (g m^{-2} day^{-1})		AGR (mg $plant^{-1}$ day^{-1})	
		30 DAT	60 DAT	90 DAT	30-60 DAT	60-90 DAT	30-60 DAT	60-90 DAT
1.	**T_1 - Absolute control**	1.53	3.16	4.22	2.00	3.97	24.1	49.6
2.	**T_2 - Recommended dose of fertilizer**	2.17	3.94	4.61	2.90	5.89	37.4	74.0
3.	**T_3 - Farmers practice**	1.94	3.70	4.43	2.32	5.84	30.7	73.3
4.	**T_4 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/a) + 100% P and K through inorganic fertilizer**	2.47	4.63	5.16	4.45	6.21	56.3	77.4
5.	**T_5 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) +100% P and K through inorganic fertilizer**	2.25	4.18	4.80	3.41	6.05	42.6	75.1
6.	**T_6 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25Kg/ha) +100% P and K through inorganic fertilizer**	2.36	4.40	4.98	3.92	6.10	49.0	76.3
7.	**T_7 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium**	2.56	5.30	5.67	5.89	6.34	72.3	79.3
8.	**T_8 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) +100% P and K through inorganic fertilizer + microbial consortium**	2.39	4.87	5.35	5.03	6.26	63.3	78.2
9.	**T_9 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25 Kg/ha)+ 100% P and K through inorganic fertilizer + microbial consortium**	2.45	5.06	5.49	5.38	6.29	66.0	78.5

	SEd	0.04	0.10	0.07	0.25	0.02	6.1	0.7
	CD (p=0.05)	0.10	0.22	0.16	0.50	0.04	12.2	1.4

Number of productive tillers m^{-2}, number of filled grain $panicle^{-1}$ and test weight of rice

The interaction effect of vermicompost and inorganic fertilizer T_7 - 25% N +75% N through vermicompost + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha) + microbial consortium had significant impact on the number of productive tillers per m^2, test weight, and the number of filled grains per panicle. The highest productive tiller number of 355.2 m^{-2}, the highest filled grain number of 125.3 and with the highest test weight of 18.50 g (Table- 3). The combined application of inorganic fertilizers and vermicompost could have helped

in balanced availability of nutrients at all the growth stages of rice. Further, this might have improved in higher uptake of nutrients which ultimately led to better translocation of photosynthesis from source to sink resulting in maximum number of productive tillers, test weight, higher number of filled grains $panicle^{-1}$. These findings are in conformity with the earlier reports of Balasubramanian and Wahab, (2012) and Md. Kashedul *et al.*, (2015) in rice.

Table: 3. Effect of organic and inorganic manure on growth and yield on Number of productive tillers m^{-2}, number of filled grain $panicle^{-1}$ and test weight (g) of rice

S.No.	Treatments	No. of productive tillers m^{-2}	No. of filled grain $panicle^{-1}$	test weight (g)
1.	**T_1 - Absolute control**	235.0	105.7	17.46
2.	**T_2 - Recommended dose of fertilizer**	307.2	114.9	17.74
3.	**T_3 - Farmers practice**	297.6	113.2	17.61
4.	**T_4 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/a) + 100% P and K through inorganic fertilizer**	331.8	120.8	18.12
5.	**T_5 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer**	315.8	117.1	17.87
6.	**T_6 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25Kg/ha) +100% P and K through inorganic fertilizer**	324.0	119.0	18.00
7.	**T_7 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium**	355.2	125.3	18.50
8.	**T_8 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium**	339.8	122.6	18.25
9.	**T_9 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25 Kg/ha)+ 100% P and K through inorganic fertilizer + microbial consortium**	347.4	123.7	18.38
	SEd	3.45	0.65	0.12
	CD (p=0.05)	7.4	1.4	NS

NS- Non Significance

Grain, Straw yield and Harvest Index of rice

Application of 25% N +75% N through vermicompost + 100% P and K through inorganic manures + $ZnSO_4$ (25Kg/ha) + microbial consortium (T_7) recorded the highest grain, straw yield and Harvest Index (HI %). The highest grain yield of 6180 kg ha^{-1}, straw yield of 9257 Kg ha^{-1} and HI% of 40.00% (Table- 4). This might be due to the slow and steady release of nutrients by vermicompost that provided nutrients such as available N, soluble K, exchangeable Ca, Mg and P that could be readily taken by the plants in balanced manner and subsequent conversion of assimilates into yield attributes in larger fraction which ultimately resulted in higher grain straw yield and Harvest Index. Similar findings of balanced supply of nutrients by integrating organics with inorganics for better growth, yield attributes and yield of rice were consonant with the results of the study of (E. Taheri Ramhimabadi *et al.*, 2017).

Table: 4. Effect of organic and inorganic manure on growth and yield on Grain yield (Kg/ha), Straw yield (Kg/ha) and Harvest Index (%) on rice

S.No.	Treatments	Grain yield (Kg/ha)	Straw yield (Kg/ha)	Harvest Index (%)
1.	**T_1 - Absolute control**	2807	6015	31.81

2.	**T_2 - Recommended dose of fertilizer**	4790	7894	37.76
3.	**T_3 - Farmers practice**	4550	7663	37.25
4.	**T_4 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/a) + 100% P and K through inorganic fertilizer**	5520	8581	39.14
5.	**T_5 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer**	5040	8125	38.28
6.	**T_6 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25Kg/ha) +100% P and K through inorganic fertilizer**	5280	8353	38.72
7.	**T_7 - 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium**	6180	9257	40.00
8.	**T_8 - 75% N + 25% N through pressmud + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + microbial consortium**	5770	8812	39.56
9.	**T_9 - 75% N + 25% N through poultry manure + $ZnSO_4$ (25 Kg/ha)+ 100% P and K through inorganic fertilizer + microbial consortium**	5930	9027	39.64
	SEd	102.8	105.77	0.15
	CD (p=0.05)	220.0	226.36	NS

NS- Non Significance

IV. CONCLUSION

Based on the results of the experiments it can be concluded that application of 75% N + 25% N through vermicompost + $ZnSO_4$ (25 Kg/ha) + 100% P and K through inorganic fertilizer + Microbial consortium was highly impressive and appears to be more promising as an efficient integrated nutrient management system for not only enhancing crop yields in rice but also maintaining soil fertility and eco system, a felt need of present day agriculture. Though vermicompost has a high potential to sustain rice production, further research is required to find out the long–term effects of the application of vermicomposts derived from plant and animal residue. Hence, this nutrient management practice can be recommended for adoption by the farmers in the Western zone of Tamilnadu.

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