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Research Paper

Importance of Industrial Waste in Maximizing the Yield of Rice and Its Effect of Soil Fertility in Coastal Region

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Abstract: *A field experiment was conducted in the coastal region of Ramanathapuram district in Tamil Nadu to maximize the rice yield through integrated nutrient management and its effects on soil properties. There were four sources of amendments, viz., Gypsum as per the gypsum requirement, 2.3 t ha-1), Biocompost (5 t ha-1), Vermicompost (5 t ha-1) and Composted coir pith 10 t ha-1 used with a test crop of rice (var. ADT 45) during Rabi season of 2007-08 with 12 treatment combinations. The results revealed that the addition of recommended dose of fertilizer plus azophos at 2 kg ha-1 plus gypsum plus biocompost at 5 t ha-1 significantly increased the straw and grain yield of rice (7146.14 kg ha-1 and 4306.54 kg ha-1, respectively). Recommended dose of fertilizer plus azophos at 2 kg ha-1 plus gypsum 2.3 t ha-1 plus biocompost at 5 t ha-1 recorded the highest N, P, K uptake by grain and straw. The increased availability of nutrients in post harvest soil were observed in organics applied plots and the highest values of available macro nutrients, viz., N (146.76 kg ha-1), P (17.13 kg ha-1) and K (152.81 kg ha-1) and micro nutrients, viz, Fe (6.23ppm) and Zn (0.37ppm) was observed in the treatments received under biocompost at 5 t ha-1 and vermicompost 5 t ha-1. Similarly more microbial population, viz., bacteria (31.81x106/g of soil), fungi (10.11 x103/g of soil) and actinomycetes (6.48 x103/g of soil) was observed in soil were the treatment received the RDF plus azophos at 2 kg ha-1 plus gypsum 2.3 t ha-1 plus biocompost at 5 t ha-1.*

Keywords: Biocompost, Composted coir pith, Gypsum, Rice, Soil available nutrients Vermicompsot.

Introduction

Rice is a stable food of India, providing 43 per cent of calorie requirement for more than 70 per cent of the Indian population. To meet the demands of increasing population and to maintain self-sufficiency, the present production level of 102 million tones needs to be increased upto 125 million tons by the year 2020[12]. As per the present production growth rate of rice, the estimated production target of coastal regions has been projected at 34 million tonnes to meet the current requirement compared with present level of 20 million tonnes i.e., an increase in the productivity level from 2.13 tonnes ha-1 at present to 3.62 tonnes ha-1. In coastal region farmers are mostly cultivated rice as mono crop grown in the rainy season and leaving the land fallow till the onset of next season.

Out of 42.0 M ha of total rice, 55 per cent of rice predominantly cultivated in coastal areas in India [4].Under such condition soil and water quality, shallow water table and lack of good quality of water are the major constraints affecting the crop production in coastal areas. Hence sustainable production of rice could be achieved only by maintaining a balance between demand and supply of nutrients by integration of inorganic and organic sources of nutrients like vermicompost, biocompost, composted coir pith etc. [10]. At the same time India has a vast scope for reutilization of renewable agricultural industrial wastes like pressmud, coir pith and industrial by-product like gypsum. By the way of addition and to utilize the above waste as raw materials for crop production with suitable technologies is need of the hour.

Preliminary survey indicated that the soil in Ramanathapuram district along seashore has been affected by salinisation due to the use of ground water having high salinity. The soils of this region offer many unique problems like salinisation, water logging and clay pan formation. Apart from that, the soils of this region are mostly coarse textured soil with low water and nutrient retention capacity, high pH and EC, low base saturation and organic matter content. Because major portion of applied N is lost through ammonia volatilization and bulk of P is in the form of Ca-P. Zinc is also declined due to reduction into Zn-S and other micronutrients like iron, manganese and copper are also precipitated as OH and CO_3 which may show their deficiency. Hence, present study was under taken to examining the effect of integrated nutrient management on yield of rice and soil fertility in Ramanathapuram district of Tamil Nadu.

Material and Methods

To study the effect of compost from industrial wastes in maximizing the yield of rice and its effect on soil fertility in coastal soil an experiment was conducted at Ramanatharpuram district in Tamil Nadu with a test crop of rice (var. ADT 45) during Rabi season of 2007-08 with 17 treatment combination. There were three sources of compost from industrial wastes used viz. biocompost, vermicompost and composted coir pith and one industrial by product, namely, gypsum were used. The experimental soil contains 113 kgha-1 of N, 5.9 kgha-1 of P, and 118 kgha-1 of K, 2.31 ppm of Zn and 3.42 ppm of Fe. The soil had pH of 9.2 and EC of 2.9 dS/m.

The treatments consisted no fertilizer (Control), recommended dose of fertilizer (RDF), Gypsum as per Gypsum requirement (2.3 t ha-1) biocompost (5 t ha-1), vermicompost (5 t ha-1) and composted coir pith (10 t ha-1) alone and its combination. The treatment details are as fallows T1. Control, T2.Recommended dose of fertilizer (RDF), T3. RDF+Gypsum, T4.RDF+Biocompost, T5.RDF + Composted coir pith, T6.RDF+Vermicompost, T7.RDF+Gypsum+Biocompost,T8.RDF+Gypsum+Composted coir pith, T9.RDF+Gypsum+Vermicompost-,T10.RDF+Biocompost+Composted coir pith, T11.RDF+Biocompost+,T12.

RDF+Biocompost+Composted coir pith +Verm-icompost. Azophos is a combined inoculams of both azospirillum and phosphobacteria in equal proportion and @ 2 kgha-1 was applied to all the treatments having compost and gypsum. In RDF treatment 120 kg ha-1 of N, 40 kg ha-1 of P_2O_5 and 40 kg ha-1 of K_2O were applied. The initial and post harvest soil samples were collected and analysed for various physico-chemical properties. Grain and straw yield were recorded for each plot and expressed in kg ha-1. The data collected on various parameters of the experiments were analysed based on the procedure given by Gomez and Gomez (1984) [2].

Results and Discussion

pH and EC: The results indicated that considerable reduction in soil pH from 9.2 to 7.45 and EC from 2.9 to 1.7 dSm-1 was observed in the treatment that received of RDF plus azophos @ 2 kg ha-1 plus gypsum @ 2.3 t ha-1 plus biocompost @ 5 t ha-1 (Table 1)**.** This could be due to the organic acid as well as the partial pressure of CO_2 release during decomposition of the organic manures. The beneficial effect of gypsum in lowering pH and EC of the soil is due to downward movement of Na owing to its replenishment by calcium as a result of solubilization of gypsum and the gypsum replacing Na with the Ca at the exchange site [13].

Soil available macronutrients: The data presented in table 1 indicated that the application of organics significantly influenced the soil available macro nutrients such as N, P and K. Among the composts tried the treatment that received of RDF plus azophos @ 2 kg ha-1 plus gypsum @ 2.3 t ha-1 plus biocompost @ 5 t ha-1 recorded the higher N (129.23 kg ha-1), P (10.93 kg ha-1) and K (133.59 kg ha-1). This is ascribed to the nature of biocompost as it is well decomposed and humified organic manure directly adds mineralized nitrogen and humic substance to the soil. This humus reduces the loss of nitrogen from leaching and volatilization. This might be the possibility of higher available nitrogen status in biocompost treated plot. Higher availability of P ascribed due to the organic acids, produced during decomposition of organic manure reduced the activity of polyvalent cations such as Fe, Al and Ca through chelation and reduced the P fixation and there by enhanced the available P in the soil are supported by the findings of Turkhede *et al.* (1998) [14]. Probable reasons for higher availability of potassium was that biocompost itself adds appreciable quantity of K to the soil and also due to rapid decomposition and mineralization which release higher amount of NH_4^+ ion. The increased K availability with increase in NH_4^+ ion was evident because of mutual release between K and NH_4^+ ion in inter lattices position of clay minerals. This could be tangible due to that similarity in ionic radii and both were lattice fixable ions from clay lattices into the soil solution leading to the increased K availability. This is confirmed by the findings of Senthil Kumar (1998) [8].

Gypsum application sustained the available nutrients status of soil perhaps due to reclamatory effect of gypsum. This is might be due to higher nutrient release with incubation time under improved physico-chemical environment of the soil. Akbari *et al.* (2003)[1] also observed the availability of all nutrients in soil remarkably improved by the application of gypsum. This might be due to application of gypsum creates more favourable environment in soil and maintain elements in more available form.

Micronutrients and biological properties: The availability of micronutrients were higher due to the application of RDF plus azophos @ 2 kg ha-1 plus gypsum @ 2.3 t ha-1 along with biocompost @ 5 t ha-1 (Table 1) which hastened the process of mineralization of organically bound micronutrients presence in biocompost, but also to the formation of organic chelates of higher stability with organic legends, which have lower susceptibility to adsorption, fixation and/or precipitation in the soil. Increased availability of cationic micronutrients, such as, Zn (0.329 ppm) and Fe (5.34 ppm) in soils due to application of biocompost and gypsum may be attributed to firstly, lowering of pH and consequent increase in solubility of cationic micronutrients, secondly liberation of micronutrients during decomposition of amendments and thirdly, chelating action of organic anion keeping micronutrients soluble and available are supported by the findings of Singh *et al*. (2004) [11].

The microbial population was favourably influenced by the different amendments. Among the different sources application of RDF plus azophos @ 2 kg ha-1 plus gypsum @ 2.3 t ha-1 along with biocompost @ 5 t ha-1 proved its superiority by highest microbial population of bacteria (39.16 x106/g of soil), fungi (16.65 x103/g of soil) and actinomycetes (8.79 x103/g of soil). The build up of organic carbon in the soil due to organics would be ascribed to the supply of needed energy and nutrient by the inorganic fertilizer for the decomposition of complex organic manure and converting these to mineralized organic colloid which in turn added to the organic manure reserves and rapid multiplication of microbial population[5].

Yield and Nutrient uptake in Rice:

Grain and straw yield: The data on grain (4306.54 kg ha-1) and straw yields (7146.14 kg ha-1) of rice were higher in the treatment received RDF plus azophos @ 2 kg ha-1 plus gypsum @ 2.3 t ha-1along with biocompost @ 5 t ha-1 (Table 2). This might be due to biocompost, which is a decomposed humified organic manures with narrow C: N ratio. This directly added more of mineralized form of major nutrients to the soil and reduced the loss of nutrient through leaching and volatilization and had further increased the plant growth hormones and vitamins that resulted in significantly higher grain yield in rice. Application of organic manure would have increased the yield due to positive effect of organic manures on the plant physiology by developing elaborate root system, provided growth regulator substances and modifying soil physiological behaviours lead to higher grain yield are supported by the findings of Parasuraman *et al.* (2003) [6] and Selvi Reeta Thakkar (1996) [7].

The higher yield with gypsum as observed in this experiment was due to improvement in physico-chemical environment in the root zone and lowering the pH and ESP by gypsum application favoured for uptake of plant nutrient which might have increased in yield of rice. The supply of nutrients through gypsum provides conducive physical environments leading to better aeration, root activity and nutrient absorption and the consequent complementary effect would have resulted in higher straw yield. Concrete evidence on the role of gypsum on yield of rice had been provided by Sultan Singh *et al.* (2005) [13]. Parasuraman *et al.* (2003) [6] reported that the application of organic manure would have increased the yield due to positive effect of organic manures on the plant physiology by developing elaborate root system, provided growth regulator substance and modifying soil physiological behaviours lead to higher straw yield.

Nutrient uptake: Restricted nitrogen availability under high salinity and sodicity condition is one of the serious limitations for growth, yield and nutrient uptake of rice. The higher N uptake (61.62 kg ha-1 and 66.82 kg ha-1 respectively), P uptake (14.66 kg ha-1 and 12.77 kg ha-1 respectively) and K uptake (17.94 kg ha-1 and 111.13 kg ha-1, respectively) by grain and straw was observed with treatments received recommended dose of fertilizer plus azophos @ 2 kg ha-1 plus gypsum @ 2.3 t ha-1 along with biocompost @ 5 t ha-1 by rice than other treatments (Table 2). The enhanced N uptake in rice owned to application of gypsum might be due to favourable environment with reduction in pH and EC. In general the nitrogen uptake in the organic manure treated plots clearly perceptible that the treatment received biocompost had significantly higher nutrient uptake. This is because of the mineralized N from the easily degradable manures like biocompost might have synchronized with N absorption. But, in other manure not evidenced such effect on N, increased N was most probably due to the readily available mineralized nitrogen released from biocompost leads to increased N uptake in rice. The higher uptake of P is attributed to the addition of organic manure in soil decreased the transformation of fertilizers P into Ca-P owing to the formation of organic Ca complex and protective action. Thereby P activity has increased, which enhanced the root activity, leads to higher P content and uptake in the treatments that received organic manure than the control. In the positive effect of gypsum, organic amendments significantly increased P uptake. This might be due to increased availability of P in soil due to acid production by application of organic manures in rice [9]. Higher uptake of potassium might be due to the organic manures added appreciable quantity of K to the soil and also the ammoniacal nitrogen and organic acid produced during the decomposition of organic matter dislocate the K from the clay lattices lead to higher K availability, which enhanced the K content and uptake of the crop. The results are in confirmative with the findings of Senthil Kumar (1998) [8].

Research finding of Singaravel and Balasundaram (1999)[9] also indicated the positive effect of gypsum, organic amendments significantly increased N, P and K uptake. This might be due to the content of N, P and K in amendments besides dual benefits of gypsum coupled with organic manures. Increased K uptake by the application of gypsum and biocompost might be due to their solubilizing effect besides the decomposition of native K minerals. Similar findings were noticed by. As far as the interaction was concerned, the treatment that received recommended dose of fertilizer plus azophos @ 2 kg ha-1 plus gypsum @

2.3 t ha-1 along with biocompost @ 5 t ha-1 were comparable for higher NPK uptake. This is most probably due to improvement in soil ecosystem, enhancement of nutrients regime and balanced nutrients distribution in the soil encouraged the root resulting in absorption of more of water and nutrients to larger area and depth enhanced the uptake was also observed in the findings of Kumar *et al.* (1996) [3].

Conclusion

Thus, from the present investigation it can be opined that the application of biocompost from sugar industry wastes 5 t/ha along with gypsum and biofertilizer (Azophos 2 kg ha-1) was found to be a promising organic sources in improving soil fertility and productivity of rice in salt affected coastal soils and also to get sustained yield of rice.

Table1
Effect of Integrated Nutrient Management on soil fertility in coastal region

Treatment	pH	EC (dS/m)	Nitrogen	Phosphorus	Potassium	Zn	Fe	Bacteria (x106/g)	Fungi (x103/g)	Actinomycetes (x103/g)
			kg/ha			ppm				
T1	8.91	1.81	76.67	3.77	113.90	0.19	1.59	26.01	5.82	6.96
T2	8.43	1.72	107.99	5.47	120.50	0.20	1.95	26.36	8.57	7.18
T3	7.79	1.31	113.35	7.38	124.16	0.26	3.28	19.10	9.09	7.46
T4	8.08	1.47	129.23	8.37	132.28	0.29	4.49	32.92	11.21	8.38
T5	8.43	1.57	124.10	6.87	126.50	0.26	3.38	20.70	10.01	7.88
T6	8.24	1.51	111.72	7.12	133.83	0.27	4.79	32.12	10.52	8.31
T7	7.45	1.17	128.98	10.93	133.59	0.33	5.34	39.16	16.65	8.79
T8	7.68	1.21	118.45	7.25	127.74	0.30	4.94	33.22	11.36	8.46
T9	7.78	1.28	113.74	6.65	129.20	0.30	4.47	20.16	9.31	7.80
T10	7.66	1.26	125.61	7.68	132.21	0.30	4.27	37.57	11.54	8.61
T11	7.51	1.23	127.21	9.95	133.32	0.31	4.69	38.40	11.66	8.77
T12	8.30	1.34	114.27	7.61	127.23	0.21	2.76	35.25	11.49	8.54
SEd	0.47	0.08	7.0411	0.630	7.580	0.026	0.19	1.66	0.41	0.32
CD (p=0.05)	0.94	NS	NS	1.240	NS	0.052	NS	NS	0.81	NS

Table 2
Effect of Integrated Nutrient Management on yield (kg/ha) and nutrient uptake (kg/ha) by rice in coastal region

Treatment	Grain	Straw	Nutrient uptake by grain (kg/ha)			Nutrient uptake by Straw (kg/ha)		
	kg/ha		Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
T1	2925.51	5928.60	18.73	6.15	7.48	25.20	5.34	42.46
T2	3237.95	6297.93	31.75	8.91	10.73	38.11	9.13	69.29
T3	3453.93	6394.30	37.32	10.55	12.12	41.89	11.83	76.44
T4	3657.79	6563.42	43.35	11.72	11.75	49.56	13.79	88.62
T5	3519.48	6315.60	37.88	10.40	12.40	40.11	10.74	72.96
T6	3554.35	6222.95	41.42	11.39	12.38	45.13	12.77	82.70
T7	4306.54	7146.14	61.62	14.66	17.94	66.82	20.37	111.13
T8	3848.18	6742.55	49.07	12.51	15.06	57.65	13.49	95.08
T9	4139.97	6425.79	46.38	13.06	14.93	44.02	11.57	81.95
T10	4085.04	5985.46	56.60	13.50	15.59	54.17	14.37	88.90
T11	4143.56	7157.70	57.40	14.10	15.59	66.21	17.90	108.83
T12	3655.40	6635.91	46.07	11.52	13.74	56.07	14.60	92.59
SEd	439.58	776.14	5.489	1.41	1.80	2.11	0.37	2.38
CD (p=0.05)	877.66	1549.63	10.96	2.81	3.59	4.16	0.73	4.79

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