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Effect of Paddy Straw, FYM and Zinc on Yield and Uptake of Nutrients by Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted at Agricultural College Farm, Bapatla, during *kharif,* 2011 with an objective to know the use of organic sources of nutrients viz., paddy straw and FYM alone and in combination with zinc sulphate on uptake of nutrients and yield of rice. The results revealed that integrated application of recommended dose of fertilizer and zinc sulphate @ 50 kg ha^{-1} with organic manures (paddy straw/ FYM) was proved to be highly beneficial in improving uptake of nutrients and yield of rice.

Key words : Farmyard manure, Paddy straw, Rice.

Indiscriminate use of high analysis chemical fertilisers had developed many problems like decline in soil organic matter and diseases resulting in total loss of soil health (Chakraborthi and Singh, 2004), which causes losses of nutrients leading to environmental pollution and unsustainable crop production. In that context substitution of part of the chemical fertilizers with locally available organic sources such as paddy straw and farmyard manure etc. is inevitable. In India rice is mostly grown on low zinc soils resulting in production of edible parts with less zinc content which has strong impact on human health (Singh, 2009). The availability of micronutrients in soils is influenced by organic matter additions through increased chelation capacity. Organic manures through correction of secondary and micronutrients deficiency have its beneficial influence on physical and biological properties of soil. In view of this an experiment was conducted to study the effect of paddy straw, FYM and zinc on uptake of nutrients and yield of rice (*Oryza sativa* L.).

MATERIAL AND METHODS

A field experiment was conducted on sandy clay loam soils of Agricultural College Farm, Bapatla during *kharif,* 2011. The experiment was laid out in a randomized block design with three replications. The soil of the experimental site was non-saline, slightly alkaline in reaction (pH 7.3), with 2.1 g kg^{-1} organic carbon and 135, 28.7, 349 kg ha^{-1} and 0.48, 8.90, 6.28, 1.42 mg kg^{-1} available N, P_2O_5, K_2O and Zn, Fe, Mn, Cu, respectively. Rice variety of BPT-5204 was used for the study. Twenty eight days old seedlings were transplanted using two seedlings $hill^{-1}$ with a spacing of 15 cm × 10 cm. The experiment consisted of ten treatments *viz*., T_1 - RDF (120-40-40 kg ha^{-1} of N, P_2O_5 and K_2O, respectively), T_2 - RDF + $ZnSO_4$ @ 25 kg ha^{-1}, T_3 - RDF + $ZnSO_4$ @ 50 kg ha^{-1}, T_4 - RDF + $ZnSO_4$ @ 75 kg ha^{-1}, T_5 - RDF + PS@ 5 t ha^{-1}, T_6 - RDF + PS@ 5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}, T_7 - RDF + PS@ 5 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}, T_8 - RDF + FYM @ 10 t ha^{-1}, T_9 - RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} and T_{10} - RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}. Nitrogen was applied in three splits in the form of urea. Recommended dose of phoshorus as basal and potassium in two splits were applied in the form of SSP and muriate of potash uniformly to all the treatments as per recommendation. Different doses of zinc @ 25, 50 and 75 kg of $ZnSO_4$ ha^{-1} were applied a week day prior to phosphorus. The paddy straw @ 5 t ha^{-1} was incorporated two months before transplanting and a well decomposed FYM @ 10 t ha^{-1} was applied fifteen days before transplanting in the main field as per the treatments. Soil samples were collected from 0 to 30 cm depth at different places before conducting the experiment. The soil samples collected were thoroughly mixed and kept for shade drying. A representative soil sample of about 1kg was drawn by quartering method into a labelled

Chemical composition of organic sources (on oven dry weight basis).

Nutrient	FYM	Paddy straw	Procedure
Organic carbon (%)	12.26	38.62	Chopra and Kanwar (1976)
Macronutrients (%)			
N	0.32	0.61	Macrokjeldahl method as outlined by Chopra and Kanwar (1976) for FYM and Microkjeldahl method as outlined by Piper (1966) for paddy straw
P	0.28	0.09	Vanadomolybdo phosphoric acid yellow colour method as described by Piper (1966)
K	0.75	1.3	Flame photometer method as described by Muhr *et al.* (1965)
Micronutrients (ppm)			
Fe	1100	52	
Zn	70	20.6	Atomic Absorption Spectrophotometer (AAS) method as
Cu	10.5	2.1	described by Lindsay and Norvell (1978)
Mn	208	13.8	

new polythene lined cloth bags. This processed sample is used for analysing for various physical, physico-chemical, chemical and biological properties like Organic Carbon (Jackson, 1973), Bulk density (Dastane, 1967), Available nitrogen (Subbiah and Asija, 1956), Available phosphorus (Olsen *et al.,* 1954), Available potassium (Muhr *et al.,* 1965). DTPA extractable Micronutrients (Lindsay and Norvel, 1978).

RESULTS AND DISCUSSION

Yield

The highest grain and straw yield (5547 and 7630 kg ha^{-1}, respectively) of rice was obtained with the application of RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} (T_{10}) and the lowest (3847 and 5247 kg ha^{-1}, respectively) was obtained with the application of RDF only (T_1), and application of zinc at all levels (T_2, T_3 and T_4) along with RDF, significantly increased the grain yield over control (T_1) (Table 1). The increase in grain yield with increased levels of zinc application could be possibly due to better supply of Zn, which plays specific role in various metabolic activities and might also be attributed that enhanced synthesis of carbohydrates with higher levels of zinc application and their transport to the site of grain formation. Similar findings were reported by (Zayed *et al*., 2011). The increase in yield in integrated plots might be due to better and continuous availability of nutrients for plants which ultimately increased the grain yield (Farhad *et al*., 2009). The supremacy of FYM might be due to higher nutrient content in FYM which is readily available as compared to paddy straw. Due to well decomposition, the nutrients present in the FYM is readily available to the crop, which might have resulted in increased yield. Similar results were also reported by various researchers like Singh *et al*.(2001) and Sangeetha *et al*.(2010).

Uptake of macro nutrients

The uptake of nitrogen, phosphorus and potassium by rice at panicle initiation and at harvest in grain and straw was significantly influenced due to applied treatments. Significantly highest nitrogen, phosphorus and potassium uptake in biomass of rice, in grain and straw was recorded in treatment which received RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} (T_{10}) and the lowest was observed in T_1 (RDF only). High uptake of nutrients in organic treatments is due to the high biomass production and it could also be due to the addition of extra quantities of phosphorus and potassium along with nitrogen (Table 2). The added organic manure (paddy straw and FYM) might have enhanced the activity of beneficial soil microflora in increasing

Table 1. Effect of paddy straw, FYM and zinc on grain and straw yields of rice.

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 : RDF	3847	5247
T_2 : T_1 + $ZnSO_4$ @ 25 kg ha^{-1}	4010	5332
T_3 : T_1 + $ZnSO_4$ @ 50 kg ha^{-1}	4380	5963
T_4 : T_1 + $ZnSO_4$ @ 75 kg ha^{-1}	4407	5980
T_5 : T_1 + PS@ 5 t ha^{-1}	4427	6023
T_6 : T_1 + $ZnSO_4$ @ 25 kg ha^{-1} + PS@ 5 t ha^{-1}	4457	6150
T_7 : T_1 + $ZnSO_4$ @ 50 kg ha^{-1} + PS@ 5 t ha^{-1}	4940	6798
T_8 : T_1 + FYM @ 10 t ha^{-1}	5010	6870
T_9 : T_1 + $ZnSO_4$ @ 25 kg ha^{-1} + FYM @ 10 t ha^{-1}	5163	6949
T_{10} : T_1 + $ZnSO_4$ @ 50 kg ha^{-1} + FYM @ 10 t ha^{-1}	5547	7630
SEm (±)	171	236
CD (P=0.05)	509	701

Table 2. Effect of paddy straw, FYM and zinc on macronutrient uptake (kg ha^{-1}) by rice.

Treatments	Nitrogen				Phosphorus				Potassium			
	Panicle Initiation	Harvest			Panicle Initiation	Harvest			Panicle Initiation	Harvest		
		Grain	Straw	Total		Grain	Straw	Total		Grain	Straw	Total
T_1 : RDF	48.5	35.5	15.8	51.4	8.05	3.02	1.38	4.4	39.2	7.0	50.9	57.9
T_2 : T_1 + $ZnSO_4$ @ 25 kg ha^{-1}	50.1	37.4	16.5	54.0	8.31	3.21	1.60	4.8	40.9	7.8	52.5	60.2
T_3 : T_1 + $ZnSO_4$ @ 50 kg ha^{-1}	56.6	41.3	19.1	60.4	9.61	3.79	2.39	6.2	46.2	8.6	59.6	68.2
T_4 : T_1 + $ZnSO_4$ @ 75 kg ha^{-1}	59.3	42.0	19.7	61.6	9.97	3.90	2.37	6.3	48.4	9.1	60.3	69.5
T_5 : T_1 + PS@ 5 t ha^{-1}	65.9	43.4	23.6	67.0	11.09	4.80	3.41	8.2	55.7	11.1	68.7	79.7
T_6 : T_2 + PS@ 5 t ha^{-1}	68.8	44.1	24.7	68.8	11.63	4.68	3.59	8.3	57.8	11.7	71.3	83.0
T_7 : T_3 + PS@ 5 t ha^{-1}	75.0	49.3	27.9	77.2	12.95	5.84	4.64	10.5	63.0	13.2	80.3	93.5
T_8 : T_1 + FYM @ 10 t ha^{-1}	81.3	51.0	31.4	82.4	14.52	6.89	6.07	13.0	73.4	15.4	89.3	104.7
T_9 : T_2 + FYM @ 10 t ha^{-1}	82.3	53.0	32.4	85.4	14.70	7.23	6.25	13.5	74.8	16.5	91.5	108.0
T_{10} : T_3 + FYM @ 10 t ha^{-1}	90.3	57.5	36.3	93.8	16.13	8.23	7.25	15.5	82.6	18.3	102.4	120.7
SEm±	2.3	1.7	1.0	2.2	0.47	0.17	0.18	0.3	3.0	0.5	3.3	3.3
CD (P = 0.05)	6.8	4.9	2.8	6.6	1.41	0.52	0.55	0.8	9.0	1.3	9.9	9.7

Table 3. Effect of paddy straw, FYM and zinc on zinc and iron uptake (g ha^{-1}) by rice.

Treatments	Zinc				Iron			
	Panicle Initiation	Harvest			Panicle Initiation	Harvest		
		Grain	Straw	Total		Grain	Straw	Total
T_1 : RDF	54.8	44.8	64.4	109.2	291.3	121.1	265.4	386.4
T_2 : T_1 + $ZnSO_4$ @ 25 kg ha^{-1}	129.8	103.9	154.8	258.6	300.7	131.8	273.5	405.3
T_3 : T_1 + $ZnSO_4$ @ 50 kg ha^{-1}	244.0	181.2	283.1	464.3	344.2	151.3	312.5	463.8
T_4 : T_1 + $ZnSO_4$ @ 75 kg ha^{-1}	342.8	237.4	380.0	617.4	359.7	158.2	320.7	478.9
T_5 : T_1 + PS@ 5 t ha^{-1}	95.1	70.1	102.5	172.7	370.1	160.1	336.1	496.2
T_6 : T_2 + PS@ 5 t ha^{-1}	235.9	174.4	266.4	440.8	388.0	176.5	362.3	538.7
T_7 : T_3 + PS@ 5 t ha^{-1}	412.6	293.8	459.0	752.8	424.0	202.3	412.0	614.3
T_8 : T_1 + FYM @ 10 t ha^{-1}	162.0	100.2	151.3	251.5	436.3	202.9	421.7	624.5
T_9 : T_2 + FYM @ 10 t ha^{-1}	408.2	311.8	464.6	776.5	450.7	219.7	428.5	648.1
T_{10} : T_3 + FYM @ 10 t ha^{-1}	598.8	452.7	691.2	1144.0	500.8	238.2	479.2	717.4
SEm±	13.4	8.4	9.2	14.7	20.5	16.8	18.6	23.9
CD (P = 0.05)	39.8	25	27.3	43.7	60.8	49.8	55.3	70.9

Table 4. Effect of paddy straw, FYM and zinc on manganese and copper uptake (g ha^{-1}) by rice.

Treatments	Maganese				Copper			
	Panicle Initiation	Harvest			Panicle Initiation	Harvest		
		Grain	Straw	Total		Grain	Straw	Total
T_1 : RDF	61.3	25.4	76.6	102.0	61.8	55.0	10.5	65.5
T_2 : T_1 + $ZnSO_4$ @ 25 kg ha^{-1}	69.1	28.5	81.4	109.9	64.4	61.8	11.9	73.7
T_3 : T_1 + $ZnSO_4$ @ 50 kg ha^{-1}	83.2	34.2	96.6	130.8	73.1	71.5	14.5	86.1
T_4 : T_1 + $ZnSO_4$ @ 75 kg ha^{-1}	89.3	37.2	100.9	138.0	78.1	73.2	15.7	88.9
T_5 : T_1 + PS@ 5 t ha^{-1}	104.9	39.9	112.8	152.7	84.5	82.3	19.1	101.4
T_6 : T_2 + PS@ 5 t ha^{-1}	110.3	45.0	118.7	163.7	89.5	86.2	21.4	107.5
T_7 : T_3 + PS@ 5 t ha^{-1}	129.2	50.9	139.1	190.0	98.7	103.1	25.2	128.3
T_8 : T_1 + FYM @ 10 t ha^{-1}	160.2	64.7	156.6	221.4	115.4	115.8	34.6	150.3
T_9 : T_2 + FYM @ 10 t ha^{-1}	170.7	69.4	165.1	234.4	120.6	126.5	36.3	162.8
T_{10} : T_3 + FYM @ 10 t ha^{-1}	198.7	80.4	188.5	268.9	134.7	142.5	41.6	184.1
SEm±	21.9	9.9	18.7	18.7	8.2	12.9	6.4	14.1
CD (P = 0.05)	65.0	29.3	55.7	55.6	24.3	38.2	19.1	41.9

the availability and uptake of nutrients by the crop. The increased uptake of N, P and K with increased level of zinc application might be due to higher concentration of zinc in rhizosphere which in turn favoured more utilization of N, P and K nutrients by the crop in producing higher drymatter and nutrient uptake right from the beginning. Further, inclusion of FYM regulates uptake of nutrients by releasing nutrients to soil might be due to increased nutrients content (%) in crop. Similar findings were reported by Chaudhary and Sinha (2007). FYM performed better over paddy straw owing to its low C: N ratio and faster mineralization.

Uptake of Zn, Fe, Mn and Cu

The uptake of micronutrients viz., zinc, iron, manganese and copper by rice (Table 3 & 4) revealed the total uptake of micronutrients was increased at harvest as compared to panicle initiation. The uptakes of zinc, iron, manganese and copper increased with increased level of zinc application either with RDF (T_1 to T_4) or with paddy

straw / FYM + RDF in both the stages of crop growth. The treatment T_{10} (RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}) recorded highest uptakes of zinc, iron, manganese and copper both at panicle initiation and at harvest while the lowest values were observed in T_1(RDF only). The treatments which received organic matter either through FYM or paddy straw (T_5 to T_{10}) recorded higher uptakes of zinc, iron, manganese and copper than the treatments which received RDF and zinc (T_1 to T_4). While, in between paddy straw and FYM, higher uptakes were observed in treatments received FYM @ 10 t ha^{-1}.

Higher uptake of micronutrients by combined addition of inorganics and organics might be due to release of micronutrients on mineralization or production of organic acids during their decomposition, which aids in solubilization of insoluble micronutrient compounds in soil. Application of FYM significantly increased uptake of micronutrients (Fe, Mn, Cu and Zn) by the rice crop. Similar results were reported by Pattar et al. (1999), Chaitanya devi et al. (2003).

CONCLUSION

The results of the field study indicated that under sandy clay loam soils of Bapatla, application of recommended dose of fertilizer (120-40-40 kg ha^{-1} of N, P_2O_5 and K_2O, respectively) was not sufficient to yield the maximum potential of the variety. Application of recommended dose of fertilizer either with any of the organic sources of nutrients such as paddy straw and FYM (e" 25% RDN) and zinc sulphate @ 50 kg ha^{-1} was proved to be beneficial in improving uptake and yield of rice. Application of zinc along with recommended dose of NPK in zinc deficient soils may enhance the productivity of rice and maximum benefit from zinc can only be obtained in the presence of organic sources. It also helped significant increase in zinc content in rice grain, which helps the humans to solve zinc deficiency problems from staple food. The results of the present study showed that FYM was superior over paddy straw in improving performance of rice crop as well as soil properties. However, its incorporation into the soil in fallow period returns most of the nutrients and helps to conserve soil nutrient reserve and complete carbon turnover in the long term. The study suggests that paddy straw can be used as an alternative source to FYM by hastening its decomposition process through chemical and biological decomposers as it is the only organic material available in significant quantities to rice farmers.

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