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Effect of organic and inorganic nutrition on soil and productivity of rice under rice-rice system

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ABSTRACT

The effect of long term fertilization with organic and inorganic sources of nutrition on the grain yield, NPK uptake and availability under rice-rice system in alluvial soils was studied at Maruteru, Andhra Pradesh. Experimental results revealed that significantly higher grain yield of 5. 55 t ha^{-1} and 5.59 t ha^{-1} during wet and dry seasons, respectively was obtained with 100% recommended dose of NPK + Zn + S along with FYM at 5 t ha^{-1}. N uptake of 76.35 kg ha^{-1} in wet season and 80.04 kg ha^{-1} in dry season, P uptake of 24.69 kg/ha in wet and 20-69 kg ha^{-1} in dry and K uptake of 20.28 kg ha-1 in wet seasonand 13.98 kg ha^{-1} in dry season were found significantly superior to all other treatments.

Key words: *rice-rice system, alluvial soil, yield, nutrient uptake, available NPK,*

Continuous use of high level of chemical fertilizers had led to soil degradation problems, which are proving detrimental to rice production. A declining trend in the productivity of rice even when grown under adequate application of N, P and K was reported by Nambiar and Abrol (1989). Soil fertility and productivity in Godavari delta are likely to be affected very seriously due to intensive rice monoculture with imbalanced fertilization under excessive use of irrigation water. Earlier results of long term fertility management at Maruteru indicated a significant improvement in grain and straw yields due to combined application of organic and inorganic treatments (Anonymous, 2005). Therefore, the present investigation was undertaken to explore the effect of organic and inorganic nutrition on soil fertility and prodcutivity.

MATERIALS AND METHODS

A field experiment on long term soil fertility management in rice-rice system was being assessed over the years (initiated during 1989) on Godavari alluvials (Vertic chromusterts) at Maruteru. The data of three wet seasons and three dry seasons (2006-2009) were pooled and analysed. The soil was clay-loam in texture and with pH of 6.3, EC (0.79 dS m^{-1}), organic carbon (0.72%), available N (249 kg ha^{-1}), Olsen's P_2O_5 (26.9 kg ha^{-1}) and ammonium-acetate extractable K_2O (270 kg ha^{-1}). The experiment was laid in randomized block design consisting of 14 treatments viz. Control, 100% N; 100% NP, 100% NPK + Zn +S, 100% NPK (-) Zn, 100% NPK (-) S, 100% N + 50% P + 50%K, 50% NPK, 50% NPK + 50% (GM) green manure – N, 50% NPK + 50% FYM – N; 50% NPK + 25% GM -N + 25% FYM – N; FYM at 10 t ha^{-1}; 100% PK and 100% NPK + Zn +S + FYM at 5 t ha^{-1} replicated thrice. Rice variety MTU - 1061 (150 days duration) was transplanted at a spacing 20 cm x 15 cm during wet season (WS) and 15cm x 10 cm spacing during dry season (DS) with 30 days old seedling. Organic manure as per treatment was applied to the respective plots 2 weeks before planting. Recommended doses of fertilizers (60-40-40 kg N, P_2O_5, K_2O ha^{-1}) and (120-60-40 kg N, P_2O_5, K_2O ha^{-1}) for wet and dry seasons, respectively were applied. Nitrogen was applied with full 'P' and 'K' as basal in three equal splits as basal, at tillering and at panicle initiation stage. Zinc Sulphate at 40 kg ha^{-1} was applied to supply Zinc and Sulphur along with NPK for 100% recommended dose of fertilizers (RDF) treatment. $ZnSo_4$ at 40 kg ha^{-1} was applied during dry season except in treatments. In one treatment Zn was not applied while in treatment No.7 Zinc oxide was used before transplanting rice to supply zinc. In treatments were 100% N+50% P +50% K applied phosphorus was applied through diammonium phosphate (DAP) and the balance of N was supplied

through urea. In all other treatments, P was supplied through SSP and was followed for both the seasons continuously. Before each season, the organic manures were analysed for the nitrogen content to fix the quantity required as per the treatments. Water was maintained at 2 cm depth during vegetative and 5 cm depth during reproductive stage of the crop until ripening. The surface soil samples before and after the harvest of the crop were collected and analysed for the physico-chemical properties.

RESULTS AND DISCUSSIONS

Experimental results indicated that the application of NPK + Zn + S along with FYM at 5 t ha^{-1} recorded significantly higher grain yield of 5. 55 t ha^{-1} and 5.59 t ha^{-1} during wet and dry seasons, respectively over the 100% NPK+Zn+S (Table 1). The efficiency of inorganic fertilizers might have also increased when it was applied along with organic manures and brought a beneficial effect on rice grain yield. Larsen and Clapp (1984) also observed similar effects on grain yield due to combined application of organic and inorganic treatments. The addition of organics and inorganics has favoured more productive tillers per square meter. Sharma and Sharma (1994) also reported that combined application of inorganic fertilizer and FYM increased number of productive tillers mt^{-2}. Beena and Balachandran (2002) reported that application of FYM at 5 t ha^{-1} in addition to recommended dose of fertilizer produced significantly higher grain yield in rice. Similar results were also reported by Jayakrishnakumar *et al.,* (1994) and Pandey *et al*. (2001). A strong positive correlation 0.849* (wet season) and 0.97* (dry season) was observed between grain yield with productive tillers. Substituting N by 50% with either of FYM or green manure or both could not show any significant improvement in yield.

The combined treatment of organic and inorganic sources influenced significantly higher uptake of N in the grain (Table 2). The treatment with 100 per cent NPK + Zn + S and FYM at 5 t ha^{-1} recorded higher N uptake of 76.35 kg ha^{-1} in wet and 80.04 kg ha^{-1} in dry and was better than inorganic sources alone. Yoshida and Padre (1975) also reported that the organic

Table 1. Effect of conjunctive use of organics and inorganics on the grain yield and productive tillers m^2 in rice- rice system

Treatment details	Grain yield (t ha^{-1})		Productive tillers m^2	
	Pooled data 2006-09 seasons			
	Wet	Dry	Wet	Dry
Control	1.96	1.76	165.7	176.7
100% N	3.11	3.26	192.3	237.8
100% NP	3.53	3.55	192.3	287.9
100% NPK + Zn +S	4.76	4.99	205.7	323.1
100% NPK (-) Zn	4.44	4.68	188.0	306.5
100% NPK (-) S	4.43	4.62	196.3	303.3
100% N + 50% P + 50%K	3.88	4.77	203.0	309.8
50% NPK	3.36	3.25	188.7	251.5
50% NPK + 50% GM - N	3.72	3.75	202.3	283.3
50% NPK + 50% FYM - N	3.87	4.00	193.7	275.7
50% NPK + 25% GM -N + 25% FYM - N	3.98	4.11	191.0	287.5
FYM at 10 t ha^{-1}	3.22	2.95	191.3	224.1
100% PK	3.11	1.97	173.7	190.3
100% NPK + Zn +S + FYM at 5 t ha^{-1}	5.55	5.59	232.0	343.4
Mean	3.78	3.80	194.0	271.5
S.EM±	2.21	1.11	8.7	10.5
CD (P=0.05)	4.48	3.23	25.4	30.5

FYM - farm yard manure, GM- green manure

Table 2. Effect of conjunctive use of organic and inorganic nutrients on the uptake of N, P and K in the rice grain

Treatment details	Pooled data 2006-2009seasons					
	N Uptake (kg ha^{-1})		P Uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	Wet	Dry	Wet	Dry	Wet	Dry
Control	18.15	14.31	6.34	3.45	4.30	3.06
100% N	35.12	37.75	10.66	6.95	7.30	5.66
100% NP	43.04	43.13	12.62	9.16	9.11	6.74
100% NPK + Zn +S	62.83	66.35	20.96	15.19	14.91	11.63
100% NPK (-) Zn	55.95	62.76	18.93	13.47	13.15	10.01
100% NPK (-) S	47.01	59.77	18.88	13.75	12.37	10.57
100% N + 50% P + 50%K	48.95	57.92	15.07	11.46	9.92	10.41
50% NPK	36.64	32.52	12.79	7.73	8.47	6.32
50% NPK + 50% GM - N	43.73	41.40	15.41	10.16	10.25	7.83
50% NPK + 50% FYM - N	46.13	46.03	16.33	11.65	11.27	8.63
50% NPK + 25% GM -N +25% FYM - N	46.51	46.72	16.74	11.49	11.25	8.31
FYM at 10 t ha^{-1}	34.61	31.97	12.80	7.66	8.91	6.30
100% PK	28.37	18.01	11.23	5.34	7.30	3.62
100% NPK + Zn +S + FYM at 5 t ha^{-1}	76.35	80.04	24.94	20.69	20.28	13.98
Mean	44.53	45.62	15.26	10.58	10.63	8.08
S.EM±	2.59	2.86	0-90	0.78	1.45	0.48
CD (P=0.05)	7.52	8.31	2.62	2.26	4.22	1.39

FYM - farm yard manure, GM- green manure

manures reduced N losses and conserved soil N by forming organo-mineral complex, maintained supply of N to rice plant and increased the N uptake in grain. It was also mentioned that higher NPK uptake was observed with application of FYM (Jana and Ghosh, 1996). The uptake of phosphorus in the grain was significantly influenced by integrated application of 100% NPK+Zn+S and FYM at 5 t ha^{-1} (Table3). P uptake of 24.69 kg/ha in wet and 20-69 kg ha^{-1} in dry seasons were recorded. Similar results on NPK uptake was reported by Jana and Ghosh, (1996). The uptake of potassium in the grain was significantly influenced by the combined application of 100 % NPK+Zn+ S and FYM at 5 t ha^{-1}. K uptake of 20.28 kg ha-1 (WS) and 13.98 kg ha^{-1} (DS) were found significantly superior to all other treatments. The results are in conformity with the findings of Jana and Ghosh (1996). The pooled analysis of data showed that continuous application of inorganic fertilizer (100% NPK+Zn+S) along with FYM at 5 t ha^{-1} over the period of eight years in long term fertility experiment showed significant increase in the availability of nutrients (N, P and K) during both the wet and dry seasons (Table 3). Among the different organic and inorganic sources, the treatment with 100 per cent NPK+Zn+S along with FYM at 5 t ha^{-1} recorded significantly higher available N status than the other treatments. A build up in the N status of soil of 279 kg ha^{-1} and 358 kg ha^{-1} was observed during wet and dry seasons, respectively compared to the control. The results are in conformity with the findings of Gill and Meelu (1982) who reported that the soil nitrogen was greater when N was supplied through organic and inorganic sources of fertilizers.

It was found that significantly higher available P in soil was recorded in the treatment with 100% NPK+Zn+S and FYM at 5 t ha^{-1}. Higher P status of 51.37 kg ha $^{-1}$during WS and 46.34 kg ha^{-1} during DS was recorded compared to all the other treatments. Khan *et al.* (1984) reported that the build up of available phosphorus in soil was due to release of organic acids during the microbial decomposition of organic manures which help to improve native phosphorus content of soil. Similar findings were also reported Anand and Ghosh (1991).

The available potassium status of soil was significantly influenced by combined application of organic and inorganic nutrients. The treatment with

Table 3. Effect of conjunctive use of organic and inorganic nutrients on the organic carbon, available N, P and K in soils

Treatment details	Pooled data 2006-2009 seasons							
	Organic Carbon(%)		Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Control	0.79	0.89	185.33	232.81	11.73	12.43	238.06	181.33
100% N	0.99	0.95	212.67	261.27	12.41	12.69	250.56	195.98
100% NP	1.06	1.07	205.00	270.59	29.71	26.68	266.11	211.07
100% NPK + Zn +S	1.25	1.18	243.33	314.24	37.42	38.23	306.67	282.63
100% NPK (-) Zn	1.12	1.12	221.33	294.27	33.81	31.30	287.50	241.26
100% NPK (-) S	1.14	1.09	230.33	292.29	34.71	32.26	302.22	250.07
100% N + 50% P + 50% K	1.10	1.15	218.00	274.89	33.65	26.76	284.72	226.05
50% NPK	1.00	1.13	197.00	256.69	26.51	21.29	286.94	232.55
50% NPK + 50% GM - N	1.39	1.31	213.00	295.67	29.51	26.15	315.00	261.42
50% NPK + 50% FYM - N	1.49	1.33	225.00	323.34	36.83	34.38	320.28	272.69
50% NPK + 25% GM -N + 25% FYM - N	1.37	1.33	224.00	308.45	33.82	31.90	310.28	267.32
FYM at 10 t ha^{-1}	1.54	1.44	240.00	308.34	44.28	36.18	332.22	299.30
100% PK	1.05	1.09	196.33	258.45	29.58	28.76	303.61	258.91
100% NPK + Zn +S + FYM at 5 t ha^{-1}	1.40	1.34	279.00	358.43	51.37	46.34	359.44	308.34
Mean	0.79	1.17	220.74	289.27	31.81	28.95	297.40	249.21
S.EM±	0.11	0.03	10.28	13.90	3.02	2.58	10.00	11.64
CD (P=0.05)	0.32	0.09	29.90	40.42	8.77	7.50	29.07	33.84

FYM - farm yard manure, GM- green manure

100% NPK+Zn+S along with FYM @ 5 t ha^{-1} recorded significantly higher available K_2O of 359.44 kg ha^{-1} (WS) and 308.34 kg ha^{-1} (DS). Tandon and Sekhon (1988) related that the build up of potassium in soil was due to beneficial effect of organic manure on reduction of potassium fixation, releasing K due to the interaction of organic matter with clay and silt and direct addition of K to the available pool of soil. Continuous addition of FYM along with NPK fertilizers resulted in higher NPK content of the soil. Udayasooriyan and Paramasivam (1991) also were also of the same opinion. The organic carbon content in the soil was also influenced significantly by the organics and inorganic treatments (Table 3). Higher organic carbon content was maintained with 100% NPK along with FYM at 5 t ha^{-1}. This may be probably due to the addition of FYM in plots, which, on decomposition, might have increased organic matter content of soil. Sahu and Nayak (1971) opined that the balanced use of fertilizers might have improved the organic matter status of rice soil. The results of this study indicated that long term application of inorganic fertilizer (NPK +Zn+S) and organic (FYM at 5 t ha^{-1}) showed a significant increase in grain yield, uptake and availability of nutrients which could sustain higher productivity by maintaining higher level of soil fertility in alluvial soils under rice-rice cropping system.

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