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Influence of Different Sources of Nutrients on Available Nutrient Status of Soil after Harvest of Rice Crop

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ABSTRACT

A field experiment was conducted for two consecutive years (2011-2012 and 2012-2013) on fine texture soils of Agricultural college farm, Bapatla. The experiment was laid out in a randomized block design in *kharif* season with four treatments and replicated five times. The treatments consisted of M_1 (RDF - Control), M_2 (10t FYM ha^{-1} + RDF), M_3 (1.5t vermicompost ha^{-1} + RDF), M_4 (Green manuring + RDF). Data collected on available nutrient (N, P, K, Ca, Mg, Fe, Mn, Cu and Zn) status of soil after harvest of rice crop was significantly increased with the application of 100%NPK in combination with FYM @ 10t ha^{-1}. However, it was on par with that of green manuring together with 100% NPK during both the years of the study.

Key words : Available nutrients, Organic sources, Rice crop.

Rice (*Oryza sativa* L.) is the most important food grain crops next only to wheat in world and in India. Among several management practices that affect soil quality, fertilizer application is of paramount importance for its role in growth and development of the crop. The integrated use of organic manures and inorganic fertilizers can help to maintain optimum crop yields and long term soil productivity. There is vast scope for increasing nutrient supply through use of organic manures and adoption of proper cropping system, which together can contribute significantly to the required nutrient pool.

MATERIAL AND METHODS

The balanced fertilization through integrated use of manures and fertilizers has been found useful in various crops. In order to investigate the influence of different sources of nutrients on available nutrient status of soil, the present experiment was conducted in the field number 49A and 49B of the Agricultural College Farm, Bapatla, during the years 2011-12 and 2012-13, respectively.

Prior to preparatory cultivation of the experimental site, soil samples from 0 to 15 cm depth were collected at random and a composite soil sample during both the years was analyzed for different physico-chemical and physical properties.

The results of the soil analytical data indicated that the experimental soil is clay and sandy clay during first and second year, respectively in texture, slightly alkaline in reaction, low in organic carbon (0.52 and 0.50% during first and second year, respectively) and available nitrogen (175.6 and 159.8kg ha^{-1} during first and second year, respectively), and high in available phosphorus (95.3 and 93.9 kg P_2O_5 ha^{-1} during first and second year, respectively) and potassium (960.0 and 925.6 kg K_2O ha^{-1} during first and second year, respectively).

The experiment consisted of four treatments *viz*., M_1 (RDF - Control), M_2 (10t FYM ha^{-1} + RDF), M_3 (1.5t vermicompost ha^{-1} + RDF), M_4 (Green manuring + RDF). The experiment was laid out in RBD and replicated five times. The recommended fertilizer dose was applied as 160:40:40 kg N, P_2O_5 and K_2O ha^{-1}. The organics applied in the study was analyzed before start of the experiment and results were given in the table 4 and 5

A popular super fine rice cultivar BPT 5204 (Samba Mashuri) was selected for *kharif* season. FYM and vermicompost were added 7 days before transplanting of rice on dry weight basis. Dhaincha crop was raised with the seed rate of 60kg ha^{-1} in individual plots and it was incorporated 7 days before transplanting of rice as green manure at flowering stage. Nitrogen was applied in the form of urea in three splits, first split at the time of transplanting, second split at 30 DAT and third split at 60 DAT. Phosphorus was applied in the form of SSP as basal dose before transplanting. Potassium was applied in the form of MoP in two splits, first as basal before transplanting and second at 60 DAT.

Plot wise surface (0-15) soil sample were collected immediately after harvest of rice. The soil samples were air dried in shade, ground and screened through 2mm sieve and used for laboratory analysis. Available nitrogen was estimated by alkaline permanganate method by using macro Kjeldahl distillation unit (Subbiah and Asija, 1956). Available phosphorus was extracted with Olsen's reagent (Olsen *et al.*, 1954), and estimated using spectrophotometer as described by Watanabe and Olsen (1965). Available potassium was extracted with neutral normal ammonium acetate and estimated with the flame photometer (Jackson, 1973). Exchangeable Ca and Mg were estimated by using EDTA method in the neutral normal ammonium acetate extract as described by Hesse (1971). Micronutrients (Fe, Mn, Cu, Zn) were extracted with DTPA and estimated with the help of AAS (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

Available nitrogen

Data presented in the table 1 revealed that the treatments those received FYM, vermicompost and green manuring along with the RDF (M_2, M_3 and M_4) significantly increased the available N status of soil over the treatment received only RDF (M_1). These results were in close conformity with the findings of Kumar and Singh (2010). Among the organic treatments, M_2 and M_4 were on par with each other. The results were in consonance with the findings of Malewer and Hasnabade (1995) who reported significant increase in available nitrogen with application of organics and inorganics and sustained the productivity.

The increase of available N in soil due to incorporation of organic material was attributed to the enhanced mineralization under favourable soil conditions. The green manuring might have helped the mineralization of soil N leading to buildup of higher available N (Bajpai *et al.*, 2006; Prasad *et al.*, 2010). Application of inorganic fertilizers alone or in combination with organic manures significantly increased all the forms of nitrogen (Sharma and Verma, 2001; Sihag *et al.*, 2005).

Incorporation of organic manures in rice-maize system increased the nutrient pool and reduced the losses of nutrients. Green manures, which are comparatively more succulent with narrow C: N ratio release nitrogen on decomposition steadily into the soil pool to meet the crop requirement. Significantly lower available N in soil was observed with application of 100% NPK. Urea which contains highest content of N when applied to rice is subjected to leaching, volatilization losses in addition to crop uptake resulted in lower availability after *kharif* rice (Mallareddy and Devenderreddy, 2008).

Available phosphorus

Close examination of the data presented in table 1 and Fig. 1 revealed that the soil available phosphorus during both the years of study was significantly influenced by various organic treatments. The higher available phosphorus (98.51 and 99.53kg P_2O_5 ha^{-1} during 2011 and 2012, respectively) was recorded with the treatment of 10t FYM ha^{-1} along with recommended dose of NPK (M_2), followed by green manuring along with recommended dose of NPK (M_4) (97.57 and 99.51kg P_2O_5 ha^{-1} during 2011 and 2012, respectively). All the organic treatments were on par but significantly superior to M_1 during second year whereas, treatment M_2 and M_4 were superior to the treatment M_3 (vermicompost 1.5t ha^{-1} + RDF) during 2012 *kharif* season.

Increase in available P with FYM, green manuring and vermicompost application might be due to additional application of P and mobilization of P of the soil. This increase in P might also be attributed to the decomposition of organic manures accompanied by release of appreciable quantity of CO_2 (Gaffar *et al.*, 1992) and organic acids.

Available P content of the soil increased with the incorporation of green manuring and organic manures as compared to its initial status of (95.33 and 93.93kg P_2O_5 ha^{-1} in 2011 and 2012 *kharif*, respectively) soil whereas, it was decreased with the application of inorganic sources of nutrients alone (81.87 and 86.22kg P_2O_5 ha^{-1}) than initial available P of soil. These results were in conformity with the findings of Mallareddy and Devenderreddy (2008) who, reported that the buildup of available P in soil was due to release of organic acids during microbial decomposition of green manuring which, might have helped in the solubility of native P.

Table 1. Effect of different sources of nutrients on available nutrient status of soil after harvest of rice.

Treatment	2011-2012			2012-2013		
	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
M_1 - RDF (Control)	183.14	81.87	794.35	179.38	86.22	793.95
M_2 - FYM 10t ha^{-1} + RDF	213.88	98.51	891.63	201.33	99.53	879.22
M_3 - Vermicompost 1.5t ha^{-1} + RDF	199.39	96.27	843.71	198.20	95.58	845.71
M_4 - Green manuring + RDF	211.99	97.57	876.39	199.45	99.51	869.99
Initial	175.60	95.33	960.00	159.80	93.93	925.60
SEm ±	5.24	3.42	19.32	5.207	2.744	16.350
CD (P: 0.05)	16.14	10.53	53.53	16.04	8.45	50.38
CV (%)	5.8	8.2	5.1	6.0	6.4	4.3

Table 2. Effect of different sources of nutrients on exchangeable Ca and Mg (cmol (p+) kg^{-1}) of soil after harvest of rice.

Treatment	2011-2012		2012-2013	
	Ca	Mg	Ca	Mg
M_1 - RDF (Control)	28.60	5.84	27.88	5.80
M_2 - FYM 10t ha^{-1} + RDF	33.24	6.84	31.38	6.84
M_3 - Vermicompost 1.5t ha^{-1} + RDF	32.28	6.76	31.24	6.74
M_4 - Green manuring + RDF	33.40	6.62	31.28	6.72
Initial	29.30	6.20	27.30	6.30
SEm ±	0.77	0.23	0.874	0.242
CD (P: 0.05)	2.37	0.71	2.69	0.74
CV (%)	5.4	7.9	6.4	8.3

Table 3. Effect of different sources of nutrients on micronutrient status (ppm) of soil after harvest of rice.

Treatment	2011-2012				2012-2013			
	Fe	Mn	Cu	Zn	Fe	Mn	Cu	Zn
M_1 - RDF (Control)	36.79	4.59	4.28	3.69	41.99	4.64	4.53	3.93
M_2 - FYM 10t ha^{-1} + RDF	39.97	5.58	5.11	4.25	47.46	5.34	5.54	5.02
M_3 - Vermicompost 1.5t ha^{-1} + RDF	38.99	5.03	5.39	4.07	45.18	5.22	5.44	4.67
M_4 - Green manuring + RDF	38.63	5.49	4.66	4.19	46.23	5.28	5.40	4.73
Initial	26.34	5.42	4.65	3.49	40.89	4.91	3.21	3.69
SEm ±	0.915	0.284	0.204	0.155	1.708	0.239	0.225	0.135
CD (P: 0.05)	2.82	0.87	0.63	0.48	5.26	0.74	0.69	0.41
CV (%)	5.3	12.2	9.4	8.6	8.4	10.4	9.6	6.6

The buildup in available P might be due to the influence of organic manures in increasing the labile P in soil though complexing of cations like Ca^{+2} and Mg^{+2} which are mainly responsible for fixation of P (Bajpai *et al.*, 2006). Tolanur and Badanur (2003) also supported that organic manures like FYM and green manuring with inorganic fertilizers had the beneficial effect on increasing the phosphate availability.

Available P of soil increased significantly with the application of fertilizer NPK along with organic manures (vermicompost/FYM/green manuring) as compared to fertilizer NPK applied alone. The appreciable buildup in available P with organics and inorganics might be attributed to the influence of organic manure in increasing available P in soil through complexing of cations, which were responsible for the fixation of P (Kamla *et al.*, 2005).

Available potassium

Data presented in table 1 revealed that the available K status after harvest of rice crop was decreased over initial status, the decrease was relatively higher in the treatment RDF alone whereas, the decrease in available K was minimal with the application of organic manures along with the recommended dose of NPK. These results were in agreement with the findings of kamla *et al.* (2005). The buildup of available K in soil was due to beneficial effect of organic manure on the reduction of K fixation, releasing K due to the interaction of organic matter with K resulting in addition of K to the available pool of K (Mallareddy and Devenderreddy, 2008).

The highest available K (891.63 and 879.22kg K_2O ha^{-1} in 2011 and 2012 *kharif* respectively) was recorded with the treatment of 10t FYM ha^{-1} along with recommended dose of NPK (M_2), followed by green manuring along with recommended dose of NPK (M_4) (876.39 and 869.99kg K_2O ha^{-1}). When the acid or acids forming compounds are added in the form of compost to the soil, those acids affect potassium availability. The effect is positive resulting in more availability of K to the plants. The hydrogen ions released from organic materials are exchanged with K on exchange site or set free from the fixed site of the clay micelle. Thus, the overall status of soil regarding availability of potassium content was improved (Selvakumari *et al.*, 2000; Swarup and Yaduvanshi 2000; Khoshgoftarmanesh and Kalbasi, 2002). Verma *et al.* (2002) also reported that continuous use of chemical fertilizers, FYM, compost and green manuring enhanced the potassium status in the soil.

Among the nutrient management treatments, application of NPK + FYM to rice recorded higher quantity of available soil NPK after crop harvest. This might be due to low release of nutrients in FYM and also due to the chelating effect of FYM. Similar results were reported by Rathore *et al.* (1995).

Exchangeable Ca

Perusal of the data given in the table 2 indicated that the effect of various organic amended treatments on exchangeable Ca was significant over RDF treatment during both the years of study. All the organic manure amended treatments were on par regarding exchangeable Ca. The highest exchangeable Ca in soil (33.40cmol (p+) kg^{-1}) recorded with the application of green manuring (M_4) in 2011 *kharif* whereas, it was highest (31.38cmol (p+) kg^{-1}) with the application of FYM (M_2) in 2012 *kharif.*

There was 16.7 and 12.2 per cent buildup in exchangeable Ca in soil after harvest of rice during the year 2011 and 2012, respectively in the treatment 100% NPK + green manuring over 100% NPK. It was reported that the significant and consistent increase in exchangeable Ca with the FYM application by Chander *et al.* (2007) and with vermicompost by Shrikanth *et al.* (2000).

Exchangeable Mg

The effect of various organic amended treatments on exchangeable Mg was significant over RDF treatment during both the years. The highest exchangeable Mg in soil (6.84 cmol (p+) kg^{-1}) recorded with the application of FYM (M_2) during both the years of study. All the organic manure amended treatments ware on par regarding exchangeable Mg.

There was 17.1 and 17.9 per cent buildup in exchangeable Mg in soil after harvest of rice during the year 2011 and 2012, respectively in the treatment 100% NPK + FYM over 100% NPK. These results were in accordance with the findings of Chander *et al.* (2007) who reported significant

Table 4. Nutrient content in organics applied during 1st year (2011-12).

Organics	%C	%N	$\%P_2O_5$	$\%K_2O$	%Ca	%Mg	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	C:N
FYM	26.60	0.71	0.25	0.54	0.90	0.50	1100	208	10	70	35.47
Vermi compost	12.54	1.80	0.81	0.72	2.38	0.67	627	262	180	45	6.97
Dhaincha	36.50	3.40	0.41	2.07	1.60	0.25	1008	144	22	42	10.74

Table 5. Nutrient content in organics applied during 2nd year (2012-13).

Organics	%C	%N	$\%P_2O_5$	$\%K_2O$	%Ca	%Mg	Fe(ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	C:N
FYM	26.00	0.65	0.20	0.74	0.84	0.47	1202	200	14	79	40.63
Vermi compost	13.00	1.80	0.79	0.81	2.29	0.67	651	275	207	56	7.22
Dhaincha	40.00	3.30	0.40	2.67	1.63	0.25	1120	142	20	49	12.12

increase in exchangeable Mg with the FYM application. Similar results were also found with vermicompost by Shrikanth *et al.* (2000).

Available Fe

Data presented in table 3 revealed that the available Fe status after harvest of rice crop was increased over initial status irrespective of the year of the study and the increase was highest in the treatment of 10t FYM ha^{-1} along with recommended dose of NPK. The highest available Fe (39.97 and 47.46ppm in 2011 and 2012, respectively) was recorded with the treatment of 10t FYM ha^{-1} in combination with RDF (M_2) which was significantly higher over NPK alone (M_1) (36.79 and 41.99ppm in 2011 and 2012, respectively).

An increase in the availability of Fe in soil with the application of FYM and green manuring in rice-wheat cropping system was reported by Kumar and Singh (2010). This might be due to formation of organic chelates which decreased their susceptibility to adsorption, fixation and precipitation resulting in their enhanced availability in soil (Kher, 1993). Increase in available Fe might be due to lowering of pH which is known to increase the solubility of metallic elements (Prasad *et al.*, 2010)

Available Mn

Close observation of the data presented in the table 3 indicated that the available Mn status after harvest of rice crop was increased over initial status in the organic amended treatments whereas, the treatment that received RDF alone could not able to increase the available Mn over initial. The significantly highest available Mn was recorded in the treatment M_2 with the values of 5.58 and 5.34ppm followed by M_4 with the values of 5.49 and 5.28ppm over M_1 (4.59 and 4.64ppm during first and second year, respectively).

Mn is soluble under relatively acid and reducing conditions like Fe. Solubility for Mn is much broader than that for Fe (Krauskopf, 1967). Most of the total Mn in soils was found in the Mn – oxide and organic fractions the later are more soluble and therefore, easier to redistribute in plant available forms than the Fe – oxide and residual forms (Das, 2000).

Available Cu

The higher available Cu in soil after harvest of rice was recorded with organic amended treatments viz. $M_{2,}$ M_3 and M_4 over M_1 during both the years of study and were at par with each other (Table 3). The organic fraction, in particular, seems to be a source of specific Cu – sorption sites in the soil, because of its unique ability to form inner – sphere complexes at a wide range of pH levels.

The organic matter present in the soil increased the availability of Cu in soils due to the formation of soluble complexing agents resulting decrease in the fixation of Cu in soils. Similar results were observed by Greval *et al.* (1999).

Available Zn

The DTPA extractable Zn content in soil increased with application of FYM, vermicompost or green manuring in combination with RDF as compared to RDF alone as a chemical fertilizer. The significantly highest available Zn (4.25 and 5.02ppm) was recorded with the treatment M_2 followed by M_4 (4.19 and 4.73ppm) over RDF alone (3.69 and 3.93ppm) during first and second year, respectively (Table 3).

An increase in the availability of Zn in soil with the application of FYM and green manuring in rice-wheat cropping system was reported by Sakal *et al.* (1996) and Kumar and Singh (2010). This might be due to formation of organic chelates which decreased the susceptibility of Zn adsorption, fixation and precipitation resulting in enhanced its availability in soil (Kher, 1993).

Conclusion

Residual fertility status of soil in terms of available nutrients (N, P, K, Ca, Mg, Fe, Mn, Cu and Zn) after harvest of rice crop was relatively higher in the treatments those received organics along with 100% NPK imposed than that of 100% NPK alone.

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