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Influence of Sewage Sludge, Urban Compost and FYM on Yield, Available Major Nutrient Status and Enzyme Activities of Soil in Tomato (*Lycopersicon esculentum Mill*)

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ABSTRACT

Effect of sewage sludge, urban compost and FYM @ 0, 20 and 40 t ha^{-1} on yield, available major nutrient status and enzyme activities (urease, dehydrogenease, acid phosphatase and alkaline phosphatase) of soil in tomato during *kharif season* of 2003 under green house condition was studied. Results showed that increasing levels of fertilizers from zero fertilizer application to 100 per cent recommended dose of fertilizers (RDF) as well as manure (0 to 40 t ha^{-1}) addition significantly increased the yield, major nutrient status and enzyme activities of soil. Among the manures, the sewage sludge was superior in increasing the parameters mentioned earlier. Combined application of manures and fertilizers also significantly increased the above said parameters. Among all the combinations, the highest yield, major nutrient status and enzyme activities of soil were obtained with sewage sludge @40 t ha^{-1}along with 100 per cent RDF, closely followed by sewage sludge @40 t ha^{-1}along with 75 per cent RDF.

Key words : Sewage Sludge, Urban Compost, FYM, Tomato, Major nutrient status and Enzyme activities of soil.

Organic manures play a vital role in maintenance of physical, chemical and biological conditions of soil and supply macro and micronutrients to crops. Besides, they also help in maintaining the organic matter status in soil. In India, FYM remains to be the most popular organic manure applied to fields and it can potentially supply about 6.8 million tonnes of N, P and K per year (Sarkar and Rattan, 1995). In the present scenario of intensive agriculture, green manuring seems to be difficult and organic manures like FYM have become scarce due to mechanization and farmers have to maintain good number of animals to supplement the needed FYM which involves high expenditure for maintaining the animals. So, recycling of different organic wastes as composts would not only ensure the hygienic disposal of the organic wastes but also make them useful manures. Sewage sludge and urban compost are rich in organic matter and plant nutrients (Jeevan Rao and Shantaram ,1996 ; Khankhane and Yadav, 2003). Thus, these are the potential resources for soil amelioration and crop production. This paper reports the influence of sewage sludge, urban compost and FYM on yield, major nutrient status and enzyme activities of soil in tomato.

MATERIAL AND METHODS

Sewage sludge was collected from municipal sewage treatment plant, Amberpet, Hyderabad. Urban compost was collected from "SELCO International composting unit", Gandhamguda, Ranga Reddy district while FYM was collected from Dairy Farm, College of Veterinary Science, Rajendranagar, Hyderabad. The field experiment was conducted on sandy loam soil at College Farm, College of Agriculture, Rajendranagar, Hyderabad. Total N, P ,K and Organic Corban (O C) contents were 1.92, 0.82 and 0.68 , 0.92, 0.34 and 0.56 and 0.56, 0.18 and 0.52 per cent for sewage sludge, urban compost and FYM , respectively .The experimental soil was slightly alkaline (7.86),low in organic carbon (4.5 g kg^{-1}), available nitrogen (196.3 kg ha $^{-1}$) available P_2O_5(21.16 kg ha $^{-1}$) and medium in available potassium (305.3 kg ha $^{-1}$).The enzyme activities of soil were 3.16 µg of NH_4^+ N released g^{-1} soil h^{-1} 0.16 mg of TPF produced g^{-1} soil d^{-1} 35.42 and 48.16 µg of p-nitrophenol released g^{-1}d $^{-1}$ for urease, dehydrogenase ,acid phosphatase and alkaline phosphatase,respectively.

A pot experiment was conducted during *kharif*, 2003 on sandy loam soil at green house, Department of Soil Science and Agricultural

Table 1. Fruit yield and major nutrient status of soil in tomato as influenced by different treatments.

Treatments	Fruit yield (g pot^{-1})					Available N (kg ha^{-1})				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	401	495	596	663	539	173	178	184	189	181
SS @ 20 t ha^{-1}	562	930	1032	1068	898	202	224	236	242	226
SS @ 40 t ha^{-1}	712	1110	1123	1142	1022	216	232	246	258	238
UC @ 20 t ha^{-1}	448	670	758	863	685	197	206	220	225	212
UC @ 40 t ha^{-1}	540	880	982	1034	859	209	223	229	234	224
FYM @ 20 t ha^{-1}	452	688	780	873	698	194	202	212	218	207
FYM @ 40 t ha^{-1}	550	910	1001	1049	878	197	219	225	231	218
Mean	524	812	896	956		198	212	222	228	
	S.Ed±		CD (0.05)			S.Ed±		CD (0.05)		
F	5		10			1.17		2.34		
T	6		13			1.55		3.10		
FxT	13		26			3.09		6.19		

Treatments	Available P_2O_5 (kg ha^{-1})					Available K_2O (kg ha^{-1})				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	16.73	17.80	19.20	19.59	18.33	253	263	274	278	267
SS @ 20 t ha^{-1}	22.08	23.34	26.80	27.45	24.92	300	336	353	362	338
SS @ 40 t ha^{-1}	25.04	27.00	27.36	28.23	26.91	320	368	392	406	372
UC @ 20 t ha^{-1}	20.90	22.28	22.48	22.90	22.14	305	310	323	329	317
UC @ 40 t ha^{-1}	23.28	23.91	24.52	25.30	24.25	310	333	342	356	335
FYM @ 20 t ha^{-1}	20.42	21.71	22.07	22.39	21.65	293	305	314	320	308
FYM @ 40 t ha^{-1}	22.30	23.20	23.64	24.04	23.30	303	321	336	334	323
Mean	21.54	22.75	23.72	24.27		298	320	333	341	
	S.Ed±		CD (0.05)			S.Ed±		CD (0.05)		
F	0.13		0.25			1.77		3.54		
T	0.17		0.33			2.34		4.68		
FxT	0.33		0.67			4.67		9.36		

F : Fertilizers
T : Treatments
FxT : Fertilizers x Treatments

Chemistry, College of Agriculture, Rajendranagar, Hyderabad. The four main treatments viz., 0, 50, 75 and 100 per cent recommended dose of fertilizer (RDF) and seven sub treatments viz., two levels (20 and 40 t ha^{-1}) of each sewage sludge (SS), urban compost (UC), FYM and control (without manure) and combinations of fertilizer levels along with organic manurial levels, thus, total of 28 treatments, each replicated thrice was in Completely Randomized Design. The soil in each of the pots thoroughly mixed with required quantities of organic manure needed as per the treatments at 10 days before transplanting. Soil was maintained in moist condition by adding water up to transplanting. Thirty days old seedlings were planted @ 3 seedlings per pot on 10th July 2003. After 10 days, two plants were removed and incorporated in the same pot. Only one plant was maintained in each pot. The RDF applied to tomato crop was 150, 60 and 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively. Nitrogen, phosphorus and potassium were applied through urea, SSP and MOP, respectively. Phosphorus and potassium were applied as basal whereas nitrogen was applied in three equal splits viz., as basal, at flowering and at fruit formation. At maturity, the yield of the tomato fruits from each pot was recorded. Representative surface soil samples (0-15 cm) were collected were after harvest of crops from each pot. Soil samples analyzed for the major nutrients as per the standard procedures out lined by Jackson (1973).Fresh soil samples were immediately analyzed for the enzyme activities as per procedures out lined by Dorich and Nelson (1983) for urease, Eivaz and Tabatabai (1977) for acid and alkaline phosphatase,Casida *etal* (1964) for dehydrogenease respectively .The data was subjected to statistical analysis (CRD-two way factorial) as per the procedures outlined by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Yield

The data revealed that there was significant increase in the fresh fruit yield with increasing levels of fertilizers from zero fertilizer application to 100 percent RDF (Table 1). The increase of tomato fruit yield in 100 per cent RDF over zero fertilizer application was 45.18 per cent. This may be due to increase in the availability of nutrients for plant absorption by the direct application of chemical fertilizers. Similar results were reported by Hanumanthappa and Shivaraj (2003) with the application of 100 per cent NPK in sesamum.

Application of organic manures significantly increased the yield over control. There was significant increase in the yield with increasing levels of manure application up to 40 t ha^{-1}. Among manures, the highest yield was obtained with sewage sludge application @ 40 t ha^{-1}. At 40 t ha^{-1} level increase in tomato fruit yield with sewage sludge over FYM was 14.09 per cent. Sewage sludge application was superior to FYM and urban compost because sewage sludge contains higher concentrations of nutrients than FYM and urban compost. Similarly, the sewage sludge application proved to be superior in increasing the yield than FYM and biogas slurry in tomato and brinjol under pot culture conditions (Khankhane and Yadav, 2003). The direct and residual effects of organic manures on yield might be due to the release of nutrients through mineralization, good aggregation and improved soil physical conditions (Laxminarayana, 2006).

Interaction effects of different manures and fertilizers on yield were significant. Combined application of manures and fertilizers significantly increased the mean fruit yield than applied alone. Of all the combinations, sewage sludge combinations were superior in increasing yield. Among all the treatments sewage sludge application @ 40 t ha^{-1}along with 100 per cent RDF resulted in the highest mean fruit yield (1142 g pot^{-1}) but, it was on par with 75 and 50 per cent RDF at the same level of sludge application. The effect of sludge coupled with higher dose of inorganic fertilizer in increasing the yield of vegetables was also reported by Paulraj and Sreeramulu (1994).

Major nutrient status and enzyme activities of soil

Similar to yield, the available major nutrients status and enzyme activities of soil were also significantly increased with increase in fertilizer application and also due to manure application (Table 1& 2). Among manures, the highest nutrient status and enzyme activities were obtained with sewage sludge applied @ 40 t ha^{-1} followed by sewage sludge @ 20 t ha^{-1}. At 40 t ha^{-1} level increase in available N, P and K status in soil with sewage sludge over FYM were 8.40, 13.41 and 13.14, while the enzyme activities of soil were 12.38, 27.58, 16.43 and 8.60 per cent for urease, dehydrogenase, acid phosphatase and alkaline phosphatase, respectively. The increase in the available N was due to direct addition of N through mineralization of organic matter present in manures. The build up of

Table 2. Enzyme activities of soil as influenced by different treatments.

Treatments	Urease (NH_4^+-N released h^{-1} g^{-1} soil)					Dehydrogenase (mg of TPF produced d^{-1} g^{-1} soil)				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	3.32	3.98	4.64	4.85	4.20	0.181	0.262	0.323	0.441	0.302
SS @ 20 t ha^{-1}	4.56	5.23	5.48	5.62	5.22	0.312	0.561	0.682	0.712	0.567
SS @ 40 t ha^{-1}	4.73	5.84	5.92	6.10	5.65	0.421	0.742	0.801	0.862	0.707
UC @ 20 t ha^{-1}	4.18	4.73	4.99	5.23	4.78	0.261	0.463	0.521	0.623	0.467
UC @ 40 t ha^{-1}	4.34	5.01	5.38	5.64	5.09	0.351	0.642	0.681	0.712	0.597
FYM @ 20 t ha^{-1}	4.01	4.68	4.91	5.10	4.68	0.232	0.422	0.481	0.562	0.424
FYM @ 40 t ha^{-1}	4.30	4.96	5.16	5.38	4.95	0.301	0.532	0.612	0.643	0.522
Mean	4.21	4.92	5.21	5.42		0.294	0.518	0.586	0.651	0.512
	S.Ed±		CD (0.05)			S.Ed±		CD (0.05)		
F	0.020		0.041			0.003		0.006		
T	0.031		0.063			0.004		0.008		
FxT	0.063		0.123			0.008		0.016		

Treatments	Acid phosphatase (μg of PNP released d^{-1} g^{-1} soil)					Alkaline phosphatase (μg of PNP released d^{-1} g^{-1} soil)				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	38.23	43.42	51.60	58.42	47.92	52.18	61.24	62.28	65.31	60.25
SS @ 20 t ha^{-1}	53.34	63.36	68.32	73.42	64.61	73.52	85.48	86.12	88.16	83.32
SS @ 40 t ha^{-1}	61.36	74.56	80.62	82.13	74.67	76.32	92.58	95.12	97.34	90.34
UC @ 20 t ha^{-1}	44.41	52.34	59.86	60.34	54.24	65.42	72.32	75.18	80.64	73.39
UC @ 40 t ha^{-1}	48.61	61.23	64.86	69.32	61.01	72.32	81.18	85.24	87.34	81.52
FYM @ 20 t ha^{-1}	46.63	53.16	61.23	62.86	55.97	64.28	71.18	74.72	79.81	72.50
FYM @ 40 t ha^{-1}	51.34	63.28	64.14	70.82	62.40	73.36	82.81	86.20	87.92	82.57
Mean	49.13	58.76	64.38	68.19		68.20	78.11	80.69	83.79	
	S.Ed±		CD (0.05)			S.Ed±		CD (0.05)		
F	0.75		1.51			0.31		0.61		
T	1.00		2.00			0.44		0.88		
FxT	2.00		4.00			0.88		1.76		

available phosphorus with manure application might be due to organic acids, which were formed during microbial decomposition of organic matter helped in the solubility of native phosphates, besides this appreciable quantities of carbon dioxide released during decomposition of organic matter might have formed carbonic acids, which enhances the solubility of phosphates resulting in higher P availability in pots treated with manure. The beneficial effect of manures on the available K was also due to the reduction in potassium fixation and release of K due to interaction of organic matter with clay, besides the direct K addition to the available K pool (Rukmangada Reddy *et al*. 2007).

The increase in enzyme activity with increase in level of manure application may be due to possible increase in population of microorganisms like bacteria etc., due to increased availability of substrate. However, the highest enzyme activities were recorded in treatment with sewage sludge applied @ 40 t ha^{-1} followed by sewage sludge @ 20 t ha^{-1}. Similar increase in the enzyme activities by the application of sewage sludge was also reported by Martens *et al*. (1992) and Baran and Bielinksa (1998).

Interaction effect of manures and fertilizers was also significant for available major nutrient status and enzyme activities of soil. Among all the treatments, sewage sludge application @ 40 t ha^{-1} along with 100 per cent RDF resulted in the highest nutrient status and enzyme activities of soil, closely followed 75 and 50 per cent RDF at the same level of sludge application .The effect of sludge coupled with higher dose of inorganic fertilizer in increasing major nutrient status of soil was also reported by Paulraj and Sreeramulu (1994).

The results also indicated depletion of available N, P_2O_5 and K_2O in control plots (0, 50, 75 and 100 per cent RDF) when compared with initial soil. All the treatments either with manure alone or in combination with fertilizers were showing more available major nutrient status when compared with initial soil, indicating its appreciable building up due to either with manuring alone or in combination with fertilizers and in case of control (only fertilizer treated plots) no build up may be due to easy losses of nutrients and crop uptake.

Although heavy metals have been tied with sewage sludge and urban compost as a source of pollution, present study showed that sewage sludge and urban compost @ 40 t ha^{-1} did not have been deleterious effect on yield and enzyme activities of soil. Sewage sludge in combination with fertilizers gave higher yield; besides improve the major nutrient status and enzyme activities of soil in tomato. Among all the combinations, the significantly highest yield and major nutrient status and enzyme activities of soil in tomato were obtained with sewage sludge @ 40 t ha^{-1} along with 100 percent RDF, closely followed by 75 and 50 per cent RDF at the same level of sludge application .However, the results will have to be confirmed by conducting extensive field trails in farmer's fields on long term basis.

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