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Direct and Residual Effect of Sewage sludge, Urban compost and FYM on Organic Carbon and Organic matter fractions in Tomato – Cabbage Cropping Sequence*

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ABSTRACT

Direct and residual effect of sewage sludge, urban compost and FYM @ 0, 20 & 40 t ha^{-1} alone and in combination with inorganic fertilizers on yield, organic carbon, humic acid , fuvic acid content of soil in tomato-cabbage cropping sequence during *kharif –rabi season* of 2003-2004 under green house condition was studied. Yield, organic carbon, humic acid and fulvic acid content of soil were increased significantly with the increasing levels of fertilizers from zero to 100 percent RDF. Direct and residual effect of organic manures significantly increased the above said parameters compared to no manure application .Among the manures, the sewage sludge was superior in increasing the parameters mentioned earlier. Combined application of manures and fertilizers also increased the yield and organic matter fractions but significant effect confined to yield only. Among all the combinations, the highest yield, organic carbon and organic matter fractions of soil were obtained with the application of 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 : Cabbage, FYM, Organic Carbon, Sewage Sludge, Tomato, Urban Compost, Yield.

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. 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 direct and residual effect of sewage sludge, urban compost and FYM on organic carbon and organic matter fractions of the soil in tomato cabbage cropping sequence.

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 characteristics of Sewage sludge, urban compost and FYM were analyzed as per standard procedures. Table 1 represents the characteristics of sewage sludge, urban compost and FYM.

A pot experiment was conducted during *Kharif-rabi* 2003-04 on sandy loam soil at green house, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar, Hyderabad. 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 Kg ha $^{-1}$).The humic acid and fulvic acid contents were 3.6 and 1.4 g kg^{-1} respectively. The four fertilizer treatments viz., 0, 50, 75 and 100 per cent recommended dose of fertilizer (RDF) and seven manure 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 was 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 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. In the second season *(rabi)* cabbage crop was grown to study the residual effect of organic manures applied to the previous season tomato crop. After harvesting tomato, the pots were disturbed with kurpi and moistened with water. The treatments were maintained same as that of *kharif* experiment. Only difference was that no manures were applied. The RDF applied to cabbage crop was 80, 32 and 60 kg N, P_2O_5 and K_2O ha^{-1}respectively. The entire doses of phosphorus and potassium were applied as basal through SSP and MOP, respectively to individual pots as per the treatments. The cabbage seedlings @ three per pot were transplanted in each pot. Two plants were removed at 10 DAT and only one plant was maintained in each pot. Recommended dose of nitrogen was applied as per the treatments in the form of urea in three splits viz., 1/3 at basal, 1/ 3 at 30 DAT and 1/3 at 45 DAT.

At maturity, the yield of the both crops from each pot was recorded. Representative surface soil samples (0-15 cm) were collected before taking up the experiment and after harvest of crops from each pot. Soil samples analyzed for the organic carbon and for the organic matter fractions as per procedures out lined by Walkley and Black (1934) and Kononova(1966) 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 of crops

The fresh fruit/head yields of both tomato and cabbage crops (Tables 2 and 3) were increased significantly with increasing fertility levels from 0 to 100% RDF. 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.

Direct and residual effect 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 (Table 1), while increasing being15.17 (Table 2) per cent in cabbage crop. 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 (Sheeba and kumaraswamy, 2001).

Interaction effects of different manures and fertilizers on yield of both the crops 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})

Table 1. Characteristics of sewage sludge, urban compost and FYM.

S.No	Character	Sewage sludge	Urban compost	FYM
Total major nutrient status (%)				
1	pH	6.58	7.12	7.67
2	EC (dSm^{-1}).	2.12	1.52	0.96
3	OC (%)	36.70	22.46	10.49
4	N	1.92	0.92	0.56
5	P	0.82	0.34	0.18
6	K	0.68	0.56	0.52
Total micro nutrient& heavy metal status ($mg\ kg^{-1}$)				
7	Fe	6131	3250	1567
8	Mn	786	210	171
9	Cu	352	88.75	29.56
10	Zn	436	81.96	41.58
11	Cd	62.91	19.52	tr
12	Ni	67.83	12.24	6.62
13	Cr	95.50	58.33	2.36
14	Co	35.83	5.83	5.53
15	Pb	119	54	tr
DTPA extractable micronutrients and heavy metals ($mg\ kg^{-1}$)				
16	Fe	213	102	58.82
17	Mn	29.36	14.23	7.86
18	Cu	19.32	5.36	5.36
19	Zn	28.86	10.15	5.12
20	Cd	1.56	0.58	Tr
21	Ni	10.61	1.42	0.91
22	Cr	6.20	2.15	0.23
23	Co	3.12	0.18	0.20
24	Pb	4.21	5.62	Tr
Organic matter fractionation (%)				
25	Humic acid	13.63	9.68	8.86
26	Fulvic acid	3.12	2.28	2.18

but, it was on par with 75 and 50 per cent RDF at the same level of sludge application. Similarly, in cabbage crop also the highest mean fresh head yield was recorded with sewage sludge applied @ 40 t ha^{-1} along with 100 per cent RDF (332 g pot^{-1}), which was on par with 75 per cent RDF at the same level of sludge application (326 g pot^{-1}).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).

Organic carbon

Application of different levels of fertilizers significantly influenced by organic carbon (OC) of the soil in tomato crop (table 2). Further increase OC after harvest of cabbage crop was noticed (Table 3).The higher OC obtained at higher dose of inorganic fertilizers was due to the increased biomass production. Similar results were reported by Jeegadeeswari *et al*. (2001).

Application of manures also had significant influence on OC soil after harvest of both the crops. With increase in level of manure application from 0 to 40 t ha^{-1}, there was increase in OC of soil. The highest OC were recorded in sewage sludge treated plots @ 40 t $ha^{-1.}$ Similarly, the increase in OC due to the application of sewage sludge was also reported by Paramsivam (1997).

Table 2. Fruit yield, organic carbon, humic acid and fulvic acid content of soil as influenced by different treatments at harvest of tomato.

Treatments	Fruit yield (g pot^{-1})					Organic carbon (g kg $^{-1}$)				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	401	495	596	663	539	4.00	4.40	4.53	4.63	4.39
SS @ 20 t ha^{-1}	562	930	1032	1068	898	5.68	5.73	6.01	6.18	5.90
SS @ 40 t ha^{-1}	712	1110	1123	1142	1022	6.01	6.48	6.58	6.62	6.42
UC @ 20 t ha^{-1}	448	670	758	863	685	5.38	5.63	5.72	6.03	5.69
UC @ 40 t ha^{-1}	540	880	982	1034	859	5.78	6.02	6.21	6.39	6.10
FYM @ 20 t ha^{-1}	452	688	780	873	698	5.18	5.38	5.58	5.69	5.46
FYM @ 40 t ha^{-1}	550	910	1001	1049	878	5.63	5.98	6.18	6.28	6.02
Mean	524	812	896	956		5.38	5.66	5.83	5.97	
	S.Ed±			CD (0.05)		S.Ed±			CD (0.05)	
F	5			10		0.04			0.07	
T	6			13		0.05			0.01	
FxT	13			26		0.01			NS	

Treatments	Humic yield (g pot^{-1})					Fulvic carbon (g kg $^{-1}$)				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	2.16	2.20	2.30	2.34	2.25	1.38	1.46	1.51	1.54	1.47
SS @ 20 t ha^{-1}	3.10	3.21	3.32	3.36	3.25	1.56	1.68	1.69	1.73	1.67
SS @ 40 t ha^{-1}	4.38	4.18	4.23	4.34	4.28	1.89	2.01	2.04	2.05	2.00
UC @ 20 t ha^{-1}	3.06	3.11	3.19	3.21	3.14	1.46	1.56	1.58	1.6	1.55
UC @ 40 t ha^{-1}	3.96	4.02	4.11	4.19	4.07	1.71	1.83	1.94	1.98	1.87
FYM @ 20 t ha^{-1}	2.98	3.08	3.14	3.18	3.10	1.42	1.53	1.56	1.59	1.53
FYM @ 40 t ha^{-1}	3.91	3.98	4.08	4.16	4.03	1.73	1.81	1.88	1.93	1.84
Mean	3.36	3.40	3.48	3.54	2.25	1.59	1.7	1.74	1.77	
	S.Ed±			CD (0.05)		S.Ed±			CD (0.05)	
F	0.02			0.04		0.02			0.03	
T	0.03			0.05		0.03			0.05	
FxT	0.05			NS		0.05			NS	

F : Fertilizers
T : Treatments
FxT : Fertilizers x Treatments

Table 3. Curd yield, organic carbon, humic acid, fulvic acid content of soil as influenced by different treatments at harvest of cabbage.

Treatments	Curd yield (g pot^{-1})					Organic carbon (g kg -^{1})				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	102	160	184	204	163	4.10	4.58	4.68	4.71	4.52
SS @ 20 t ha^{-1}	180	258	298	310	262	5.90	6.28	6.31	6.49	6.25
SS @ 40 t ha^{-1}	193	308	326	332	290	6.31	6.70	6.82	6.91	6.64
UC @ 20 t ha^{-1}	151	213	228	234	207	5.40	5.80	5.90	6.21	5.83
UC @ 40 t ha^{-1}	181	255	290	304	258	6.20	6.51	6.60	6.68	6.50
FYM @ 20 t ha^{-1}	133	208	220	230	198	5.40	5.58	5.79	5.81	5.65
FYM @ 40 t ha^{-1}	176	243	273	293	246	5.98	6.30	6.41	6.61	6.33
Mean	159	235	260	272		5.61	5.96	6.04	6.20	
	S.Ed±		CD (0.05)			S.Ed±		CD (0.05)		
F	5		10			0.05		0.11		
T	6		13			0.07		0.14		
FxT	13		26			0.14		NS		

Treatments	Humic yield (g pot^{-1})					Fulvic carbon (g kg -^{1})				
	Fertilizer levels (% RDF)					Fertilizer levels (% RDF)				
	0	50	75	100	Mean	0	50	75	100	Mean
Control	2.21	2.28	2.33	2.39	2.30	1.42	1.51	1.54	1.58	1.51
SS @ 20 t ha^{-1}	3.13	3.26	3.38	3.41	3.30	1.59	1.69	1.71	1.74	1.68
SS @ 40 t ha^{-1}	4.43	4.36	4.48	4.52	4.45	1.93	2.06	2.08	2.18	2.06
UC @ 20 t ha^{-1}	3.11	3.18	3.26	3.29	3.21	1.5	1.59	1.61	1.63	1.58
UC @ 40 t ha^{-1}	4.06	4.14	4.21	4.28	4.17	1.78	1.86	1.98	2.01	1.91
FYM @ 20 t ha^{-1}	3.03	3.10	3.18	3.26	3.14	1.44	1.56	1.58	1.6	1.55
FYM @ 40 t ha^{-1}	3.99	4.04	4.18	4.20	4.10	1.76	1.82	1.92	1.99	1.87
Mean	3.42	3.48	3.57	3.62		1.63	1.73	1.77	1.82	
	S.Ed±		CD (0.05)			S.Ed±		CD (0.05)		
F	0.02		0.04			0.02		0.03		
T	0.03		0.05			0.02		0.05		
FxT	0.05		NS			0.05		NS		

F : Fertilizers
T : Treatments
FxT : Fertilizers x Treatments

Interaction effect of manures and fertilizers did not significantly influence OC content of soil. However, combined treatments increased the OC than individual treatments. The beneficial effects of fertilizers and organic manures application over control on the soil organic matter content may be due to better root growth and more plant residues left out in fertilized and manured plots. This reasoning is based upon the fact that fertilized plots, on an average, gave double the crop yields than control plots, which naturally added more biomass to the soil. In case of manured plots the additional reason for maintenance of higher level of organic matter is the direct addition of organic material through manures along with recommended dose of NPK.

Fractions of organic matter in soil

The results of the study showed that the application of organically rich compounds of either alone or in combination with different levels of fertilizers enhanced the contents of humic acid (HA) and fulvic acid (FA) fractions as compared to control after harvest of crops in tomato – cabbage cropping sequence (Table 2 & 3). The increase in organic carbon content may be due to the addition of organic manures, which are responsible for the higher activity of microorganism's thereby helping to increase the decomposition process of sewage sludge.

Among the manurial treatments, the highest contents of humic and fulvic acid fractions were recorded in treatment sewage sludge applied @ 40 t ha^{-1} followed by sewage sludge applied @ 20 t ha^{-1}. All the manurial treatments significantly increased the humic and fulvic acid contents over control.The superiority of sewage sludge application over urban compost and FYM applications was that the sewage sludge contained higher content of humic and fulvic acid fractions (Table 1). Similar increase in contents of humic and fulvic acid fractions by the addition of sewage sludge was also reported by Garcia Gil *et al*. (2004).

Combined application of manures and fertilizers did not show any significant influence on contents of humic and fulvic acid fractions in soil after harvest of both the crops. However the humic and fulvic acid contents increased with application of manure (from 0 to 40 t ha^{-1}) and fertilizer doses (from 0 to 50 per cent RDF). The highest humic and fulvic acid content was recorded in treatment with sewage sludge applied @ 40 t ha^{-1} along with 100 per cent RDF followed by sewage sludge @ 40 t ha^{-1} along with 75 per cent RDF .

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 of crops. Sewage sludge in combination with fertilizers gave higher yield; besides improve the organic carbon and organic matter fractions. Among all the combinations, the significantly highest yield, organic carbon, humic and fulvic acid content of soil were obtained with sewage sludge@40 tha^{-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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