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Studies on effect of cellulolytic fungi on decomposition of sugarcane trash

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Abstract
An attempt was made for study the efficiency of cellulolytic fungal isolates and their effect on organic carbon, nitrogen, C:N ratio and loss in weight of sugarcane trash compost. The application of seven cultures *viz. Trichoderma sp., Penicillium sp., Aspergillus sp., Paecilomyces sp., Rhizopus sp.,* mixture of fungal isolates and university (MPKV) composting culture were used in the experiment. The application of these fungal cultures shows significantly accelerated the rate of decomposition than control. However mixture of fungal culture proved to be most effective over uninoculated control. The mixture of fungal isolates recorded significant decrease in C:N ratio (16.3), loss in weight (38.0%), organic carbon content (17.5%) and increase in nitrogen content (1.07%) of sugarcane trash compost over uninoculated control treatment.
The decomposing fungal culture also showed beneficial effects on chemical and biological properties of sugarcane trash compost. There was an increasing trend of fungal and bacterial population up to 60 days after inoculation and decreased thereafter up to 120 days of composting. The actinomycetes population was also increased during composting at later stage.

Keywords: cellulolytic, fungal, composting, C:N ratio

Introduction
Sugarcane is one of the important cash crops in India and plays pivotal role in both agricultural and industrial economy of the country. Greater attention is given only in improving the sugarcane yield and not much in managing the cane trash. In India approximately 6.5 million tonnes of sugar cane trash are being produced every year and most of the residues are usually burnt in the field due to lack of proper composing techniques. Besides the loss of organic matter and plant nutrients, burning of crop residues also causes atmospheric pollution due to the emission of toxic gases methane, carbon dioxide that poses threat to human and ecosystem. The sugarcane trash incorporation in the soil influences physical, chemical and biological properties of the soil. There is a reduction in soil EC, improvement in the water holding capacity, better soil aggregation and thereby improves porosity in the soil. Sugarcane trash incorporation reduces the bulk density of the soil and there is an increase in infiltration rate and decrease in penetration resistance. The direct incorporation of chopped trash increases the availability of nutrients leading to soil fertility. Sugarcane trash can be easily composted by using the fungi like *Trichurus*, *Aspergillus*, *Penicillium* and *Trichoderma*. Addition of rock phosphate and gypsum facilitates for quicker decomposition.

Material and method
A pit trial experiment was conducted at the Department of Plant Pathology and Agricultural Microbiology, College of Agriculture, Pune during 2011-2013. The cement concrete pits of uniform size (1mx1mx1m) available at Biological Nitrogen Fixation Scheme used for experiment were surface sterilized with 5 % $CuSO_4$ and filled with sugarcane trash chopped 10-15 cm length, cow dung slurry, urea @ 80 gm, SSP @ 100 gm and 10ml respective fungi culture layer by layer for each pit and sugarcane trash @ 10 kg/pit and same were marked according to treatments. The treatments offered were : T_1 : *Trichoderma sp.*(FS-1), T_2 : *Aspergillus sp.*(FS-2), T_3 : *Rhizopus sp.*(FS-3), T_4 : *Penicillium sp.*(FS-4), T_5 : *Paecilomyces sp.*(FS-5), T_6 : Mixture of FS– 1 to FS-5, T_7 : University decomposing culture, T_8 : Absolute control
Observations on different parameters viz, total carbon content, total nitrogen content, C:N ratio, loss in weight of sugarcane trash, temperature during decomposition, microbial count of bacteria, fungi and actinomycetes of sugarcane trash during composting. The experiment was conducted in Completely Randomized Design (CRD) with three replications, comprising eight different treatments.

Results and discussion

The sugarcane trash decomposing efficiency of fungal isolates was evaluated and compared in terms of decrease in organic carbon content, C:N ratio, percent loss in weight and increase in nitrogen content.

The changes in organic carbon during the decomposition process indicated that the rate of decreasing carbon content was higher up to 90 days and reduced slowly thereafter 120 days. The maximum carbon content was observed in the treatment of mixture of fungal culture followed by university MPKV composting culture i.e. 17.5% and 18.4% respectively whereas lowest reduction in (24.9%) of carbon content was observed in uninoculated control.

Gupta (2004), *Robertson et al.* (2007) reported decrease in the organic carbon when organic residues were composted.

The nitrogen content was increased with increasing days of decomposition. The increase in nitrogen content during composting might be a direct manifestation of mass loss, carbon loss and microbial protein (Singh, 1992; Goyal, 2005; Ieshita, 2012).

The result of sugarcane trash decomposing efficiency of fungal isolates recorded revealed that the various treatments of inoculation of fungal strains significantly decreased the C:N ratio of sugarcane trash over uninoculated control. Maximum decrease in C:N ratio (16.3) of sugarcane trash during composting was observed by inoculation with mixture of fungal strains. The decrease in C:N ratio of sugarcane trash during decomposition due to inoculation of cellulolytic fungal cultures.

Jagadeesh *et al*., 1996; Murkate, 1992 and Singh (1992) have suggested that inoculation of fungal cultures resulted in rapid decomposition with decreases in C:N ratio. Saidi *et al.*(2008) reported that a stable C:N ratio could be achieved after 95 days of decomposition.The present result is therefore, in conformity with the earlier results.

Maximum loss in weight of sugarcane trash during composting was observed by inoculation with mixture of fungal strains. The reduction in weight was more significant during the first 45 days. Andrea *et al.* (1998), measured a weight loss of 29%, and Gautam *et al.* (2010) observed weight loss over a 45 day period.

Effect of cellulolytic fungi on decomposition of sugarcane trash upto 30 days of composting temperature was maximum and then it decreases upto120 days after composting. Sugarcane trash inoculated with mixture of fungal culture showed maximum temperature through ought decomposition period over uninoculated control which is significant than other treatments.

Gowda (1996) reported that during decomposition of wastes, the microbes consume more O_2 to break down the organic compound and release heat energy through respiration process, which caused the temperature to raise in decomposition of organic matter.

Table 1: Effect of different cellulolytic fungi on carbon content (%), nitrogen content (%), C:N ratio and loss in weight (%) of sugarcane trash during decomposition

Treatment	Carbon content at			Nitrogen Content at			C:N Ratio			Loss in weight at		
	60 day	90 day	120 day	60 day	90 day	120 day	60 day	90 day	120 day	60 day	90 day	120 day
T1	26.0	23.4	20.2	0.70	0.72	0.73	37.1	32.6	27.7	8 (20%)*	7.7 (23%)*	6.85 (31.5%)*
T2	25.4	22.3	19.5	0.78	0.79	0.81	32.6	28.3	24.1	8.1 (19%)*	7.75 (22.5%)*	6.97 (30.3%)*
T3	28.0	23.4	20.5	0.68	0.70	0.71	41.2	33.5	28.9	8.2 (18%)*	8 (20%)*	7.10 (29%)*
T4	25.9	22.0	19.0	0.86	0.87	0.90	30.1	25.3	20.9	7.9 (21%)*	7.45 (25.5%)*	6.7 (33%)*
T5	28.9	24.5	20.9	0.66	0.68	0.70	43.8	36.0	29.9	8.44 (15.6%)*	8.17 (18.3%)*	7.2 (28%)*
T6	23.4	20.5	17.5	1.03	1.05	1.07	22.8	19.5	16.3	7.4 (26.1%)*	7 (30%)*	6.2 (38%)*
T7	24.0	21.5	18.4	0.98	0.99	1.00	24.5	21.7	18.4	7.5 (25.1%)*	7.2 (28%)*	6.45 (35.5%)*
T8	30.1	26.4	24.9	0.62	0.64	0.66	48.5	41.2	37.7	9.65 (3.5%)*	9.42 (5.8%)*	9.35 (6.5%)*
SE ±	0.90	0.24	0.23	0.05	0.05	0.01				0.40	0.43	0.44
CD (0.05)	2.71	0.73	0.70	0.16	0.16	0.03				1.21	1.29	1.33

The microbial population density during sugarcane trash decomposition was higher up to 60 days and decreased thereafter at 120 days. During the process of decomposition the bacterial population were increased in sugarcane trash up to 60 days indicating the maximum thermophillic activity by bacteria and decreased after 60th day due to the thermophillic stage of the composting process which eliminated the mesophillic population over larger period of decomposition. (Bertoldi *et al.*1988; Beffa *et al.* 1996; Ravankar *et al.* 2000)

The fungal population showed a gradual increase as decomposition process and attained a maximum population density on 60th day of decomposition. The fungal population was maximum in sugarcane trash compost indicates the occurrence of the thermophillic, spore forming fungi at higher level. At 60th day the population has reached stabilization then decreased upto 120 days.

Actinomycetes population was not significant at the initial stage of decomposition and gradually increased even after 60 days. The rate of increase of actinomycetes population was found to be higher due to thermophillic stage of composting as thermophillic actinomycetes develop during the heating phase of decomposition.

Table 2: Bacterial, fungal and actinomycetes population (CFU X 10^5/g) in sugarcane trash

Treatment	Bacterial population at				Fungal population at				Actinomycetes population at			
	30 day	60 day	90 day	120 day	30 day	60 day	90 day	120 day	30 day	60 day	90 day	120 day
T1	52	81	62	33	8.5	11.6	10.0	4.9	20	29	55	64
T2	50	80	60	30	7.5	12.2	9.9	5.0	18	28	54	62
T3	49	78	58	29	7.6	11.9	9.6	4.7	17	27	50	58
T4	56	83	66	34	7.8	12.4	10.0	5.3	21	30	55	65
T5	46	77	55	27	7.1	11.8	9.5	4.8	17	26	47	57
T6	59	88	69	37	9.2	12.8	10.7	5.7	26	34	61	71
T7	54	85	64	35	8.8	12.5	10.3	5.4	23	32	59	68
T8	35	50	40	21	3.4	6.1	4.8	1.5	12	24	43	51

In general, the microbial populations of different groups showed maximum on 60th day and reduced considerably at 120th day except actinomycetes. The population of actinomycetes was found continuously increased up to 120 days after inoculation. It indicate that population density was found to be stabilized by 60 days. Tang *et al*. (2004) reported that microbial community diversity increased continuously during the composting process.

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