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Impact of In-situ Composting of Sugarcane Trashes on Soil Nutrients and Fertility

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ABSTRACT

Background: Sugarcane is one of the important commercial crops in India. Sugarcane trashes are considered as a problem to the farmers, because of the cost of labour for its disposal. Farmers wishes to compost in the field itself to reduce the cost. A field experiment was conducted for the in-situ composting of sugarcane trashes at the Sugarcane Research Station, Cuddalore.

Methods: The sugarcane trashes have wide C:N ratio, which is not suitable for the microbial degradation. Hence, for the in-situ composting of sugarcane trashes, a combination of Rock phosphate: gypsum: urea in the ratio of 5:4:1 (named as SRS mixture) was added to narrow the C:N ratio. For the quick degradation, the microbial consortia namely Tamil Nadu Agricultural University Bio mineralizer, (TNAU Bio mineralizer) commercially available Effective Microbes (EM) solution and the cow dung slurry were compared.

Result: During the degradation period, the pH was slightly reduced and subsequently increased to neutral; reduction in EC, organic carbon, Carbon: Nitrogen ratio and increase in the nitrogen content was also noted. Field soil analysis indicated increase in the primary nutrient content especially in the treatments with TNAU bio mineralizer and commercial EM solution. For the in-situ composting of sugarcane trashes, SRS mixture 100 kg t^{-1} followed by TNAU bio mineralizer 2 kg t^{-1} may be applied immediately after the harvest of the canes.

Key words: Bio mineralizer, Composting, Cow dung slurry, EM solution, Sugarcane trashes.

INTRODUCTION

Sugarcane is one of the important commercial crops in tropics and sub-tropics. It is the foremost responsible crop for the production of sugar in India. There are nearly 50 million sugarcane farmers in India. Sugarcane is cultivated in India as an annual irrigated crop, over an area of 4.4 million hectares. The production in India is around 310 million tonnes with a productivity of 70 tonnes/ha. Over population and limited field area naturally requires more productivity. Although, increased level of production can be achieved by increased use of inorganic fertilizers alone but it may lead to pollution problem and deterioration of soil characteristics and soil fertility (Gaur and Kumawat, 2000). Yield of cane is influenced by various factors like weather condition, varieties, planting time, type of crop, fertilizer source and dose, irrigation, pest and diseases and also the method of disposal of sugarcane trashes. Summer sugarcane showed lower uptake than the rainy season sugarcane. (Singh and Yadav, 1992). Optimum nutrient management for sugarcane crop establishes vigorous stubbles, which affects the ratoon yield (Shukla, 2007). Sugarcane trashes are used as mulch or fuel. Burning of sugarcane trashes lead to air pollution by the release of gases like carbon dioxide, nitrogen oxides, sulphur oxides and also the loss of nutrients into the atmosphere. Major nutrients lost are nitrogen, phosphorus and sulphur. Ever though, potassium remains in the ash, nearly 20% of K is also lost into atmosphere. The uptake of potassium was season dependent being low in cool winter months (Vijayasankar babu *et al*., 2007). Composting provides a good model of microbial communities to study ecological issues such as diversity succession and competition during the biodegradation and bioconversion of organic matter with thermal gradients. The typical batch composting process proceeds via four major thermal stages, *i.e*., the mesophilic, thermophilic, cooling and maturation phases, each of which has a particular microbial community structure developing in response to temperature and other environmental conditions. In the first stage, organic substances are decomposed by mesophilic microorganisms at moderate temperature. Then, the temperature is increased by self-heating as a result of vigorous microbial activity. In the thermophilic phase, the temperature reaches 80°C, which not only stimulates the proliferation of thermophilic microorganisms, including mesophilic pathogens. After the thermophilic progression of waste decomposition, the microbial activity lowers due to the limited availability of degradable organic substances. This cooling phase leads to a decline of temperature and allows mesophilic microorganisms to predominate again.Some farmers are converting these wastes into compost (Youssef Salama

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Table 1: Initial characteristics field soil sample.

pH	EC (dSm^{-1})	Avail.N kg ha^{-1}	Avail. P kg ha^{-1}	Avail. K kg ha^{-1}	Total Carbon %	C:N ratio	Bulk Density Mg m^{-3}
7.81	0.38	218	38	331	0.71	67.8	0.27

et al, 2016). But, the labour requirement for the collection, assembling and composting is very high and costly. Hence, an in-situ method of composting can reduce the cost, labour and save time for the farmers and holds advantage in the sense that the overall expenditure for the farmers on chemical fertilizers can be reduced. The high cost of fertilizers and the widening gap between supply and demand and the adverse effect of chemicals on the environment has led agricultural scientists to look for alternate sources. The concept of organic waste management and its recycling for plant nutrient supply is becoming more essential for meeting partial requirement of plant nutrients and sustaining soil health through improvement of physicochemical properties and microbial diversity of soil. The sugarcane trashes after the harvest of the canes can be a problem to farmers. By in-situ composting of sugarcane trashes, soil characters can be improved and also the nutrient requirements for the field application can be reduced. This approach provides mulch, resulting in reduced soil compaction, improved soil structure, greater water and nutrient retention and microbial status of the soil, reduction of fertilizer demand and ultimately increased cane yield.

MATERIALS AND METHODS

According to organic waste management, one field experiment was conducted at Sugarcane Research Station, Cuddalore for the in-situ decomposition the sugarcane trashes. The soil sample was collected initially from the field. Immediately after the mechanical harvest of the crop, next day the trashes were spread in the field and the treatments were imposed. The five treatments were fixed and each replicated four times following the randomized block design. The sugarcane trashes were also collected for the chemical analysis. During the composting period, the trashes samples were collected on 30^{th} and 60^{th} days of treatment imposed.

Table 2: Initial biological characteristics of field soil sample.

Phosphate Solubilizer Bacteria X 10^4 cells g^{-1}	Fungi X 10^3 cfu g^{-1} of soil	Actinomycetes X 10^4 cfu g^{-1} of soil
9.80	6.10	8.70

Treatments

T_1 - Control.
T_2- SRS mixture 100kg t^{-1}. (5:4:1 ratio of Rock phosphate: Gypsum: Urea).
T_3- Cow dung slurry 250kg t^{-1}+ SRS mixture 100kg t^{-1}.
T_4- TNAU bio mineralizer 2 kg t^{-1}+ SRS mixture 100kg t^{-1}.
T_5 - EM solution 2 lit t^{-1}+ SRS mixture 100kg t^{-1}.
The treatments were imposed on 06.09.2016.

The soil sample collected were initially analyzed for the physical and chemical characteristics and are given in Tables 1, 2 and 3.

RESULTS AND DISCUSSION

In the sugarcane trashes during the composting period, slight reduction in pH was noted followed by neutralization. (Table 4). According to Ndegwa *et al.* (2000), the shifting of pH to lower levels could be attributed to mineralization of nitrogen and orthophosphates and bioconversion of organic materials into intermediate species of organic acids. There was a continuous reduction in EC, during the composting period in all the treatments. (Table 4). The decrease in EC during bio composting process may be due to utilization of soluble salts by micro-organisms for the synthesis of microbial biomass (Talashilkar, 1986). Compost maturity was tested based on the Carbon:Nitrogen ratio of the final product. In all the treatments compost maturity was obtained after 60 days of decomposition except control. The C/N ratio

Table 3: Initial characteristics of Sugarcane trashes.

pH	EC(dSm^{-1})	Total N %	Total P %	Total K %	Total Carbon %	C:N ratio	Total Calcium %	Total Magnesium %
7.26	1.32	0.64	0.51	0.48	43.4	67.8	0.27	0.19

Table 4: Characteristics of sugarcane trashes during the composting period.

Treatments	pH of the sample			EC of the sample (dSm^{-1})		
	Initial	After 30 days	After 60 days	Initial	After 30 days	After 60 days
T_1	7.14	7.08	7.23	1.43	0.92	0.36
T_2		6.63	7.16		0.48	0.25
T_3		6.91	7.62		0.52	0.31
T_4		6.48	7.71		0.24	0.17
T_5		6.45	7.66		0.22	0.18
SED		0.11	0.15		0.13	0.08
CD (p=0.05)		0.21	0.32		0.25	0.14

Table 5: Characteristics of sugarcane trashes during the composting period.

Treatments	Total carbon %			Total Nitrogen %			C:N ratio		
	Initial	After 30 days	After 60 days	Initial	After 30 days	After 60 days	Initial	After 30 days	After 60 days
T_1	40.72	33.70	22.93	0.58	0.72	0.98	70.2	46.8	23.4
T_2		27.72	19.79		0.83	1.02		33.4	19.4
T_3		26.29	21.12		0.84	1.10		31.3	19.2
T_4		28.13	21.80		0.98	1.26		28.7	17.3
T_5		28.03	21.20		0.96	1.24		29.2	17.1
SED		1.10	1.04		0.02	0.05		0.70	0.60
CD (p=0.05)		2.14	2.02		0.04	0.11		1.20	1.01

Table 6: Field soil characteristics after the composting period.

Treatments	pH	EC (dSm^{-1})	Organic carbon%	Avail. N kg ha^{-1}	Avail. P kg ha^{-1}	Avail. K kg ha^{-1}
T_1	7.4	0.24	0.58	230.00	30.00	310.00
T_2	7.1	0.25	0.68	248.00	33.00	316.00
T_3	7.0	0.24	0.71	271.00	38.00	320.00
T_4	7.1	0.26	0.63	268.00	38.00	317.00
T_5	7.2	0.26	0.67	275.00	37.00	314.00
SED	2.1	0.02	0.04	4.30	1.80	5.30
CD (p=0.05)	NS	NS	0.08	8.2	3.50	NS

is considered to be one of the simple indices to evaluate any organics for its suitability for soil application and it is the index traditionally used to establish maturity degree of the compost (Bernal *et al.,* 1998).

There was a significant increase in the available nitrogen content of the soil in the treatments applied with cow dung slurry, TNAU bio mineralizer and EM solution (Table 5). The increased microbial activity on the added organic matter might have increased the available nitrogen level of the soil (Bose *et al.,* 2002). Significant increase in the available phosphorus content of the soil was noted in the treatments applied with cow dung slurry, TNAU bio mineralizer and EM solution (Table 6). This was in accordance with the result of Mahimairaja and Bolan (2004) in which they reported that significant increase in the available phosphorus of the soil is due to the addition of Phosphorus and production of organic acids during decomposition. There was a significant increase in the total nitrogen content of the sugarcane trashes after composting. This is in accordance with the results of Vasanthi and Kumaraswamy (1999), in which they have reported that the macro and micronutrients were more by many times in composted materials compared to their contents in raw materials.

CONCLUSION

The above detailed study reveals that the sugarcane trashes can be composted in the field itself by utilizing the nutrient sources and microbial consortia. The highly decomposed compost materials had pH of 7.16 to 7.71. As far as the EC is concerned, there was a reduction in the EC when the composting proceeds. The composted materials EC ranged from 0.17 to 0.36 dsm^{-1}. The maturity of compost was high and early (within 60 days) in the SRS mixture and TNAU Bio mineralizer applied and also SRS mixture and EM solution applied treatments. High nitrogen value compost was obtained from the SRS mixture and TNAU Bio mineralizer applied treatment. Significant increase in the available phosphorus content of the soil was noted in the treatments applied with cow dung slurry, TNAU bio mineralizer and EM solution. There was no significant difference in the available potassium content of the soil after the composting of sugarcane trashes. The results of the study reveal that the treatments T_4 - TNAU bio mineralizer 2 kg t^{-1}+ SRS mixture 100kg t^{-1} and T_5 - EM solution 2 lit t^{-1} + SRS mixture 100kg t^{-1}. Performed well by the quicker decomposition of sugarcane trashes. Within 60 days of application of the inoculants the complete decomposition was achieved which was confirmed by the C:N ratio of the compost.

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