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Biodegradation of Sugarcane Trash with Agro-Industrial and Farm Wastes for Value Added Organic Byproduct

Shaukat Ali Abro[1*], Nisar Ahmed[2], Mumtaz Ali[2], Shazia Tunio[2]

[1]Department of Soil Science, FCPD, Sindh Agriculture University, Tandojam, Paksitan
[2]Integrated Water & Agricultural Waste Management Institute, PARC, Tandojam, Pakistan

* Email: abro.shaukat@gmail.com

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Abstract: Arable land degradation, agro-waste management coupled with irrational use of chemicals has led to concern about soil and environmental health. The sugarcane crop generates lot of vegetative biomass after harvesting, which is burnt in field creating environmental implications. A research trail was conducted at green house premises department of soil and environment SAU Tandojam. The waste byproducts of the sugarcane trash was blended with pressmud, poultry and goat manure to have decomposed nutrient rich product subjected to 130 days decomposition/composting. Results revealed that the pH had significant relationship with organic substrate decomposition used for the compost preparation blended with sugarcane trash. The organic carbon loss or mineralization showed great variability and had relationship with the substrate used and decomposition time for a finished product. The more organic carbon (31.80%) was recorded for C_{spm} and (31.80%) C was found for C_{pm}. Compost product was rich in carbon potassium values corresponding (4.6%) for C_{spm} and (2.7%) K for C_{gm}. It was concluded that sugarcane trash can best be blended with sugarcane press mud of agro-industrial waste. Further it could be recycled with agro-industrial waste for waste management, reduce pollution, chemical fertilizers and used as organic soil amendment**.**

Keywords: Sugarcane trash, composting, organic carbon, soil amendment.

Introduction

The agro-waste management coupled with depleting fertility and declining soil health is grave issues of today's agriculture in world. Soil fertility is largely affected by human management practices. In Sindh sugarcane is cultivated on around 297045 hectares (GoP, 2020). The detrashing generates around 09 to 13 tons dry matter of dried leaves ha-[1]and farmers leave the cane trash on soil after cutting the cane (Krishnaveni et al*.,* 2020). The trash is a rich resource having 30.3% carbon, and essential plant nutrients as nitrogen, phosphorous and potash.. Burning of trash liberates 1240 kg CO_2 and other greenhouse gases and loss for nutrients (USDA, 2017). About 45 kg N lost/acre, environmental pollution, resource wastage soil biomass, soil fertility and soil health (Chang, 2019; Dalia et al., 2017;). Generally sugarcane trash is burnt because growers think that it is laborious, alters germination and cultivation pattern. The major research concerns are practical misappropriation of disposal of sugar trash produced during harvest of crop and effects of climate. Thus, the alternative climatically crop trash that is to be recycled is composting (Bruce et al., 2016). The agro waste and factories waste options of sugarcane making, as an climate green technology of organic fertilizer which is safe disposal (Dalia et al., 2017). Compost can enhance soil states and crop growth parameters as decreasing waste and humus to the soil (Prasanthrajan et al., 2011). There is problem that while decomposing sugarcane trash its stability and decomposition time is more (Miland et al., 2015; Rahmad et al., 2019).

Therefore blending with other available organic sources will be best option (Abro et al., 2019; Khokhar, 2020). Agro-industrial waste like sugarcane press mud is also available in huge quantities which are dumped around sugar mills in Sindh. Besides other farm wastes like goat manure and poultry farm waste is also in large quantities (Dalia et al., 2017). To our knowledge few studies are previously conducted on composting employing sugarcane crop trash and sugar cane press mud as an industrial waste. This resolves the waste management issue improving soil quality and soil health and mitigate climate change (Dotaniya et al., 2016). Present work is aimed at the observation of study area farmer's perception of burning with alternative of turning waste into compost blending with sugar cane trash with agro-industrial and farm waste to produce more stable compost product. Therefore this study was carried out with the objectives of survey of project area about sugarcane trash management and to prepare organic compost product and laboratory analysis of the product for macro nutrients as value added by product. The product manufactured is to reduce waste, stop burning waste, provision of organic fertilizer reduced use of chemical fertilizer safe environment and improve socio-economic conditions of the community.

Materials and Methods

The research trail was carried out at waste recycling area for composting near greenhouse net Department of Soil science (latitude 25º 25ˈ40.21 "N, longitude 6831.40" E of altitude: 26 m**).** Three districts were surveyed for farmer perception of sugarcane trash management. A questionnaire was developed for collecting the data on sugarcane trash management in project area. The sugarcane trash (tops, twigs leaves) was collected from

villages surveyed in project area. The sugar cane press mud was collected from Mehran sugar mills Tandoallahyar. The goat and poultry manures were collected from Faculty of Animal Husbandry & Veterinary Sciences, Sindh Agriculture University, Tandojam. The sugarcane trash was chopped into smaller pieces, placed in pit size of 1 meter l m deep, 3m length with 1 m dia. Then animal manure was superimposed as 3 inches layer. This alternate layering pattern continued until the pit was full. The composting recipe process was carried in following ratio i.e sugarcane trash (ST) with goat manure (80% ST+ 20% GM, 80% ST+ 20% PM, 80% ST+ 20% SPM).

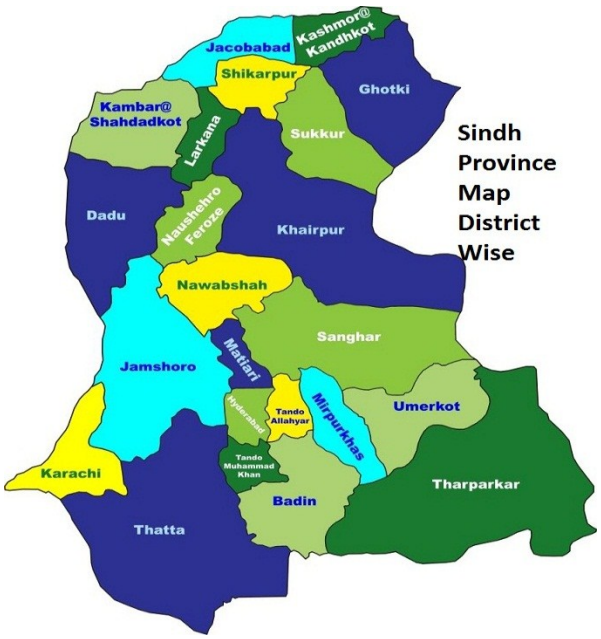

Fig. 1 Geographical map of Study area.

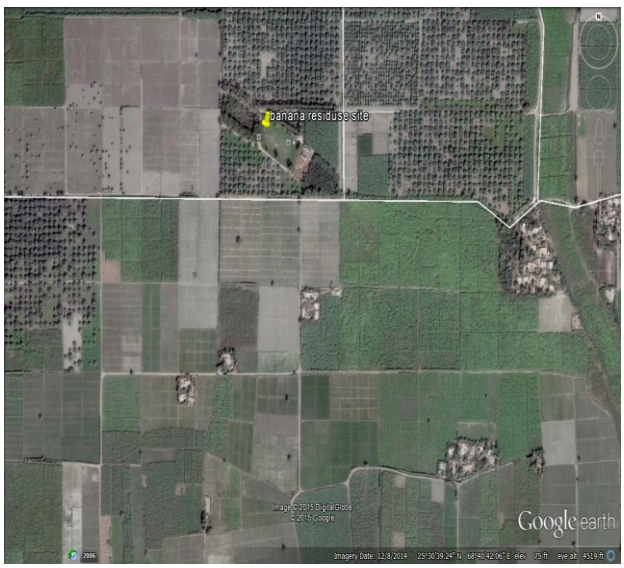

Fig. 2 GPRS coordinates of the study area.

Turning frequency was at 15 days interval, and temperature of composting material was monitored and moistened, if required. The process continued for five months and 15days stabilization with moisture at 50% of field capacity. All the recipes of compost were thoroughly pulverized after 2, 4 and 6 each week to and research trail lasted for 16 weeks. After four months, compost samples were collected from each pit and analyzed for EC, pH, total C and macro nutrients i.e. nitrogen, phosphorus and potassium contents (Manna et al., 2012). Analytical data of various composts were used to calculate descriptive statistics (mean and standard error).

Results and Discussion

It was noticed that the organic substances used for this research had higher amounts of organic carbon and particularly sugarcane trash used for this study (Table 1). These results are in agreement with the results found by the Chang et al. (2019); Krishnavane et al., (2020) while working on the sugarcane trash compost production.

Table 1 Physico-chemical and biological properties of the organic substances used.

Parameters	Sugarcane trash	Goat Manure	Sugar Press Mud
Density (kg/m^3)	110	750	650
Moisture content (%)	18	60	76
pH (1:10)	-	7.35	5
EC (1:10) (ds/m^2)	-	4.40	1.9
Total nitrogen (%)	0.54	1.38	1.84
Ammoniacal Nitrogen (ppm)	-	44	53
Nitrate Nitrogen (ppm)	-	12	28
Organic carbon (%)	51.90	43.34	39.29
Ash (%)	10.53	25.28	32.26
C/N ratio	96:1	31.4:1	21.4:1
Total phosphorus (P_2O_5) (%)	0.06	0.61	1.98
Total potassium (K_2O) (%)	0.54	0.88	0.28

Carbon Mineralization / Mass Loss

Turning of composting pits provided good mixing during water addition and aeration accelerated microbial decomposition and homogenous material. Moisture was regularly monitored. The carbon mineralization initially went rapidly thereafter coincided until determination of physical state of compost. These results are in accordance with the results found by Abro et al., (2019); Khokhar, (2020). The data in table clearly showed mass loss and carbon mineralization with passage of time from all compost treatments. The mineralization of organic carbon was directly related to composting time and addition of manures.

Table 2. Carbon mineralization in sugar-cane waste subsequent composting (130 days).

Recipes	15 days		30 days		60 days		130 days	
(control)	46.87	± 0.12	42.47	± 0.19*	47.18	± 0.18	46.63	± 0.01*
ST +GM	45.22	± 0.52*	40.54	± 0.02*	44.98	± 0.05*	56.63	± 0.18
ST + PM	44.62	± 0.12*	41.22	± 0.10*	44.97	± 0.16*	47.13	± 0.05*
ST + SPM	45.03	± 0.10*	44.11	± 0.01	44.73	± 0.05*	47.79	± 0.05

A decrease in carbon mineralization of approximately 20% occurred when the incubation temperature of soil decreased from 28 to 20ºC. Further the data depicts the decomposition pattern of the lingo-cellulosic material. Organic carbon increased in various recipes of compost of sugarcane trash blended with various animal and industrial wastes. The best results were obtained from sugarcane trash blending with sugar cane press mud. These findings are in complete agreement with results found by (Chang, 2019).

Table 3. Chemical analysis of sugarcane trash and three compost recipes for several of nutrients present in finished products.

Parameters	Sugarcane trash	ST + GM	ST + PM	ST + SPM
Carbon	52.04+0.06	51.19+0.19	52.03+0.18	53.05+0.01
Nitrogen	0.72+0.17	0.78+0.8	0.80+0.18	0.79+0.01
Phosphorus	0.49+0.03	0.56+0.03	0.50+0.01	0.53+0.01
Potassium	1.82+0.02	1.30+0.02	1.66+0.03	1.64+0.02

Total Organic Carbon

The soil fertility soil quality and soil health is usually determined by its key indicator of organic carbon (OC). The nutrient contents for various compost recipes were OC was observed to be increased in the compost pits with mean residence time. Similar pattern was recorded for nitrogen mineralization for compost products. These results match with the findings of Shweta et al. (2010). The organic manipulations have pivotal role in decomposition of organic trashes and rate may be accelerated by blending with other organic and agro-industrial wastes at large (Abro *et al.,* 2019; Khokhar, 2020).

Various organic materials are added to reduce the decomposition time of the main organic feedstock and hasten the process and also improve the quality of compost. Like sugar cane trash with animal manure and industrial waste (Chang, 2019; Franco et al., 2015) crop waste with poultry, animal and sugar industry waste (Shan et al., 2019) to decrease the decomposition time and for improving the quality of compost. The purpose was to test the other organic sources as decomposers and catalysts to expedite the microbial mediated process. However, Ramesh et al. (2016) observed and found that temperature 35ºC was optimal for simulation of decomposition of sugarcane crop trash in the composting for the value added by product.

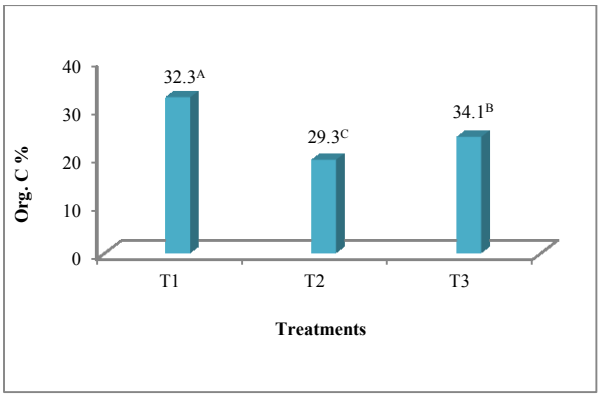

Fig. 3 Organic carbon contents of three recipes of sugarcane trash compost.

Nutrient (N P, K) Contents Compost Products

The results of this study trail revealed that higher nitrogen value was observed for T_1 whereas the lower value obtained for T_2. Data depicted highly significant difference ($p<0.05$) in different prepared compost products. Similar results are witnessed by the (Abro et al., 2019; Khokhar, 2020) while enriching crop residues with animal manures for finished compost products to improve soil fertility and soil health to counter climate change. The results for P were observed as 1.55%, 0.72% and 0.52%, respectively in three compost recipes. Fortes et al., (2015) also showed similar results in his experiment. A clear significance difference ($p<0.05$) was recorded for available P in sugarcane trash compost product. The results obtained are in complete agreement with the research work on sugarcane trash compost by Suma and Savitha (2015) and Krishnavene et al. (2020).

C/N, C/P & C/K ratio of compost

Regarding the C/N ratio results it was found that 13.63, 17.35 and 21.62% for ST with animal manure (80% ST+ 20% GM), (80% ST+ 20% PM) and (80% ST+ 20% SPM). A decrease in carbon mineralization of approximately 20% occurred when the incubation temperature of soil decreased from 28 to 20ºC in a study where the aerial parts of (C:N=28.7) was placed on soil surface (Dotaniya et al., 2016). Fresh sugarcane crop residues (green leaf, leaf roll and dry leaf) have on the average 391 to 452 g/kg of C and 4.7 to 6.o g/kg of

Nitrogen (Roles et al., 2016), obtained in broader C:N ratios less carbon mineralization over a substantial time.

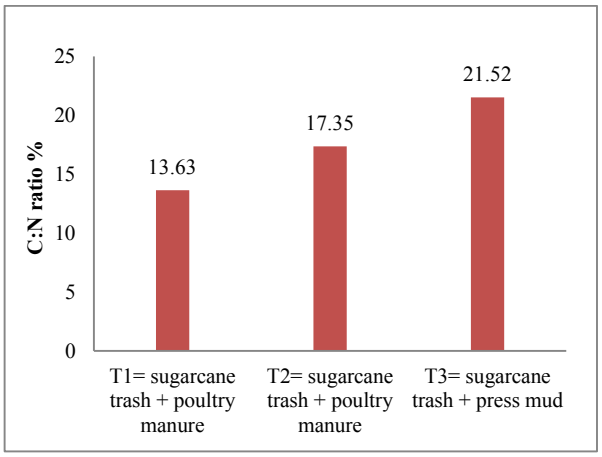

Fig. 4 Carbon to nitrogen (C/N) ratio of sugarcane trash compost blended organic wastes.

Thus it is reasonable to anticipate the addition of nitrogen to cane trash should increase decomposition of the latter for trash from other grasses**.** Furthermore, waste management is grave concern and a huge problem. If the best strategies are evolved, the waste could be managed in an economic and environment friendly manner.

Conclusion

It is concluded that sugarcane growers need to chop and shred the trash left behind pulverize with animal manure to prepare compost to be used as organic fertilizer product. Further one ha would produce about five tons of organic compost reducing around 10.6% of chemical fertilizers applied. This way chemical fertilizer and irrigation water usage will be reduced and overall cost of production decreased with provision of product.

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