



Mineralization of carbon, nitrogen, phosphorus and sulphur from different organic wastes in silty clay loam soils

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Abstract: Mineralization of carbon, nitrogen, phosphorus and sulphur was studied by incubating soil samples for 90 days at 30°C temperature with four different organic materials viz. Press mud, sugarcane trash, paper mill bagasse and pine needle. The results showed that the carbon mineralization in soil was significantly higher from sugarcane trash followed by press mud as compared to control. The cumulative percent of carbon mineralization increased with incubation period and maximum mineralization was recorded at 90 DOI (days after incubation). The maximum cumulative percent N-mineralization (16.88%) in soil was shown by paper mill bagasse followed by sugarcane trash and pine needle. The percent N-mineralization from all added organic amendments increased incubation period up to 45 days of incubation DOI (days after incubation) after then it gradually declined, while the pine needles showed maximum cumulative P-mineralization in soil followed by sugarcane trash while minimum was recorded from press mud. The paper mill bagasse showed highest cumulative S-mineralization in soil followed by sugarcane trash. Irrespective of organic wastes, cumulative S-mineralization significantly increased after 15 days of incubation up to 45 days later on it showed declined trend. Among the organic wastes, sugarcane trash showed maximum C-mineralization in soil exhibited fast decomposition in comparison to other wastes. So, it can be used for composting. The paper mill bagasse showed more N and S mineralization while maximum mineralization of P was found in pine needle. The press mud and sugarcane trash showed potential for short duration enriched compost.

Keywords: Mineralization, Paper mill bagasse, Press mud, Pine needle, Sugarcane trash

INTRODUCTION

The modern day intensive crop cultivation requires the use of chemical fertilizers, which are expensive in developing countries. Therefore, the current trend is to explore the possibility of supplementing chemical fertilizers with organic ones, particularly the recycling of organic wastes through composting. India has a vast resource of organic wastes with nutrient potential of about 6 million tonnes of nitrogen, phosphorus and potassium. About 2 million tonnes of press mud is being produced annually from sugar factories (Gaur *et al.*, 1990). Sundra (2002) indicated that press mud produced in a sugar mill is about 4 per cent of cane crushed. That is, a 2500 TCD mill produces about 100 tonnes of press mud per day and in a crushing season of 150 days the total quantity of press mud produced by such a mill is approximately 15000 tonnes.

Pal (1995) reported that the Pine (*Pinus roxburghii*) is a dominant species in U.P. hills (presently Uttaranchal State) and occupies about 30 per cent of the total forest area. Most of these organic wastes are either burnt or

used as fillers due to slow rate of decomposition. Sundra (2002) reported that sugarcane produces huge quantity of foliage, about 40 per cent of total biomass. On an average, the amount of sugarcane trash produced about 15 to 20 t ha⁻¹. However, quantity varies with variety and crop growth. The trash contains on an average 0.35% N, 0.13% P₂O₅ and 0.65% K₂O. That is for every tonne of sugarcane trash, nutrient availability is 3.5 kg N, 1.3 kg P₂O₅ and 6.5 kg K₂O. Thus, from a hectare of sugar cane crop, around 50 kg N, 20 kg P₂O₅ and 100 kg K₂O can be recovered from trash alone.

The use of these organic substances in agriculture is very low because they have low quantity of plant nutrients and also the rate of decomposing is very slow. For the proper utilization of these materials in agriculture, it is necessary to convert them in good quality compost. The use of organic waste in the amendment of agricultural soils can be beneficial for crops, and at the same time, provide an efficient and cost-effective method for its disposal. Many authors have reported that different types of organic waste can improve

physical, chemical, and biological properties of soils (Clark *et al.*, 1998; Whalen *et al.*, 2000). Adding organic wastes to the soil can increase total N, organic matter, microbial population, enzyme activity, moisture retention, pH buffering capacity and crop yields can be increased (Dick and Christ, 1995). The most immediate impact of organic waste application is on the availability of nitrogen to the subsequent crop, as a consequence of mineralization-immobilization processes (Hadas *et al.*, 2004). During the microbial decomposition of plant residues, the preservation of released biomolecules/inorganic nutrients is essential to avoid losses and enhance the efficiency of recycling (Canellasa *et al.*, 2010). The study on nutrient supply capacity of these organic wastes in silty loam soil is very few and possibilities to use in preparation enriched compost are not well known. Therefore, incubation study was conducted with specific objective to assess mineralization potential of different organic wastes.

MATERIALS AND METHODS

Incubation experiment was carried out using the upper layer (0–15 cm) of a Molisol. The soil, from Crop Research Centre (CRC), experimental farm at Govind Ballabh Pant University of Agriculture and Technology (GBUA&T) Pantnagar, particle size distribution of 18.5 g kg⁻¹ sand, 47.5 g kg⁻¹ silt and 34 g kg⁻¹ clay, was air dried at room temperature, and sieved to pass a 2 mm mesh. Four organic wastes, previously ground to pass a 0.75 mm sieve, and dried at 35 °C for 48 h were individually mixed with the soil. The organic wastes were composted pine leaves, press mud, paper mill bagasse and sugarcane trash. The soil and each waste were characterized chemically (Table 1).

Mineralization of organic wastes

Carbon mineralization: Mineralization of carbon was studied by incubating soil samples for 90 days at 30 °C temperature. The organic materials were added at the rate of 0.5 per cent carbon basis at 60 per cent moisture regime. Five treatment were evaluated with three replications viz. T₁: Un amended soil, T₂: Soil + Press mud, T₃: Soil + sugarcane trash, T₄: Soil + paper mill bagasse and T₅: soil + pine needle.

One hundred gram sieved (<2mm) air-dried soil was taken in a 500 ml conical flask and the above treatments were imposed. A tube containing 10 ml of 1N NaOH was hung in each flask with the help of a thread tied with tube mouth. The flasks were air tightly closed with a robber cork, sealed with wax and incubated at 30 °C. CO₂ evolution readings were taken daily for 1st week, trice in the 2nd week, twice in 3rd week and then taken at weekly intervals up to 90 days (Gaur *et al.*, 1971).

Mineralization of nitrogen, phosphorus and sulphur: Mineralization of N, P and S were studied by incubating soil samples at 30 °C temperature with four different organic materials viz. Press mud, sugarcane

trash, paper mill bagasse and pine needle added at the rate of 0.5 per cent carbon basis (Table 5) at 60 per cent moisture regime. Following five treatments were conducted in completely randomized block design (CRD) design with replication three.

T₁ Soil + Press mud

T₂ Soil + Sugarcane

T₃ Soil + Paper mill bagasse

T₄ Soil + pine needle

Ten gram soil was taken in the 100 ml capacity plastic bottles and above treatments was imposed. The incubation temperature was maintained at 30 °C and the observations were recorded at 1, 5, 10, 15, 30, 45, 60, 75 and 90 days. Separate bottles were removed at each interval and for each estimation of N, P and S.

Nitrogen mineralization: For mineral N extraction, 100 ml of 2M KCl was added to the bottle, shaken for 30 minutes, filtered through Whatman No. 42 filter paper and mineral N was determined in the extract by steam distillation method (Keeney and Nelson, 1982).

Phosphorus mineralization: For P extraction 200 ml of 0.5M NaHCO₃ (pH 8.5) and a spoonful of Darco G 60 Charcoal was added in the bottles and shaken for 30 minutes, filtered through Whatman No. 42 filter paper and P was determined by in the extract by method of John (1970).

Sulphur mineralization: For S extraction, 50 ml of 0.15 per cent CaCl₂ was added in the bottles and shaken for 30 minutes, filtered through Whatman No. 42 filter paper and S content in the extract was determined by method of Palaskar *et al.* (1981).

Statistical analysis: The experimental data were analyzed by using standard procedure for a completely randomized block design (CRD) with the help of a computer applying analysis of variance (ANOVA) technique (Snedecor and Cochran, 1971). The differences among treatments were compared by applying 'F' test of significance at 5 per cent level of probability.

RESULTS AND DISCUSSION

Carbon mineralization: It is evident from the data that mean carbon mineralization from different organic wastes in soil, irrespective of incubation period, was significantly higher than unamended soil. The pattern of carbon released from different amendments was in the order of sugarcane trash > press mud > paper mill bagasse > pine needle. The maximum mean carbon mineralization (33.55 per cent) was observed from sugarcane trash which was 99.46, 75.14 and 63.65 per cent, respectively more than pine needle, paper mill bagasse and press mud. The carbon mineralization was increased with incubation period irrespective of organic wastes up to 95 days. However, the significant increases in carbon mineralization were recorded after 4 days of incubation over initial day. The maximum cumulative carbon mineralization (36.78 %) was registered at 95th day of incubation. The added organic

Table 1. Chemical properties of different organic wastes.

Parameter	OC (%)	Total N (%)	C:N	Total P (%)	Total K (%)	Total S (%)
Press mud	40.29	1.22	33.02	0.536	0.436	0.127
Sugarcane trash	45.24	0.44	102.81	0.295	0.411	0.102
Pine needle	49.41	0.41	120.51	0.129	0.231	0.142
Paper mill bagasse	55.92	0.36	155.33	0.159	0.334	0.031

Table 2. Initial soil properties of incubated soil.

Properties	Value
Texture	Silty clay loam
pH (1 : 2, Soil : Water ratio)	7.20
Bulk density Mg m ⁻³	1.43
Electrical conductivity dSm ⁻¹ (1:2)	0.41
Organic carbon (%)	0.73
Available N (kg ha ⁻¹)	220.50
Available P (kg ha ⁻¹)	18.20
Available K (kg ha ⁻¹)	125.10

amendments showed significant interaction with incubation time. In un amended soil, significant C mineralization was observed after 55 days of incubation. The paper mill bagasse showed significant increase in C mineralization after 7th day, pine needle and press mud after 6th day and sugarcane trash after 4th day of incubation. On 5th day of incubation sugarcane trash showed 150.8 per cent significantly more carbon mineralization in comparison to paper mill bagasse, however, after 6th days sugarcane trash gave highest and significant C mineralization over other amendments. The press mud mineralized significantly higher carbon than pine needle after 41 days (Table 3).

The cumulative per cent carbon mineralization from soil added organic wastes (pine needle, paper mill bagasse, sugarcane trash and press mud) was significantly higher as compared to control. It may be due to microbial degradation of newly added organic amendments in soil which evolved more CO₂ upon oxidation, therefore more carbon was mineralized. Dutta (2001) and Paul and Solaiman (2002) have also reported more C mineralization from organic wastes incubated soil than the control. Results also indicated positive relationship between cumulative C mineralization and incubation period. It was probably because in the beginning of decomposition more complex materials were present in wastes and lesser microbial number as well activity was low as the decomposition preceded the microbial number and activity increased which increased cumulative C mineralization. These findings are in support of Paul and Solaiman (2002) and Pareek *et al.* (2003) who demonstrated increased C mineralization with increased incubation period and sugarcane trash have more carbon mineralization than the press mud. Among different wastes, sugarcane trash showed maximum C mineralization while minimum C mineralization was found with press mud. It might be due to low amount of cellulose and lignin contents in sugarcane trash, which are resistant for microbial attack while press mud may have already decomposed and complex carbohydrates and other chemicals, which reduced decomposition and finally C mineralization.

Anetta and Joanna (2014) reported that a long-term intensive use of the soil fertilised with manure cannot ensure a positive total organic carbon balance.

Nitrogen mineralization: The cumulative per cent nitrogen mineralization in soil increased irrespective of added organic amendments up to 45 days of incubation after then it gradually declined. The maximum N mineralization (20.19 %) was recorded at 45th day of incubation. The significant (P<0.05) increase in nitrogen mineralization was observed after 15 days up to 45 days of incubation in comparison to initial day. After 90 days it reached to its initial level i.e. first day. The slow rate of N mineralization may possibly be due to slow decomposition of organic wastes by micro organism because of presence of higher molecular weight compounds, later on decomposition rate increased due to increase in microbial population and activity by getting C and nutrients from organic wastes. After a certain period the available C and nutrients were exhausted by micro organisms and mineralization of N was decreased due to reduction in microbial population. Similar finding have been reported by Dhull *et al.* (1998) and Adeiran *et al.* (2003) who revealed that N mineralization increased with increase in incubation period up to a certain stage and then decreased. Moharana *et al.*, (2015) reported that the application of compost alone caused no immobilization of available N, indicating that organic manures having narrow C/N ratio enhances mineralization of soil N. Moreover, large proportion of N remains in the organic form in the compost treated soils, with time, this organic N undergoes mineralization and made available for plants. The pattern of mineralization depends on the N content of organic manure and amount applied.

Irrespective of incubation period, the per cent cumulative nitrogen mineralization was maximum (16.88 %) from paper mill bagasse followed by sugarcane trash and pine needle. The minimum nitrogen mineralization was exhibited from press mud. The addition of paper mill bagasse and sugarcane trash in soil showed 82.28 and 50.32 per cent significantly higher N mineralization than press mud. The interaction between amendments and incubation period were non significant (Table 4).

The maximum N mineralization was shown by paper mill bagasse, while press mud showed minimum N mineralization. This was possibly because of the presence of N in less complex compounds which released N at faster rate than other organic wastes while in press mud N may be present in more complex compounds. Pareek *et al.* (2003) also reported that N mineralization was more in paper mill bagasse than other organic

Table 3. Cumulative per cent carbon mineralization from the carbon added through different organic wastes at 60 per cent WHC.

Days	Organic amendments					
	Un amended	Paper mill bagasse	Pine needle	Press mud	Sugarcane trash	Mean
1	0.44	0.49	0.60	0.53	1.09	0.63
2	0.87	0.98	1.00	1.60	2.61	1.41
3	1.29	1.97	2.20	3.19	5.01	2.73
4	1.67	2.95	4.00	4.26	7.84	4.14
5	2.02	4.43	6.20	5.50	11.11	5.85
6	2.38	6.15	7.80	7.45	14.38	7.63
7	2.73	7.95	8.69	9.94	15.90	9.04
8	3.08	11.15	11.89	13.66	19.17	11.7
9	3.41	14.10	14.09	15.08	22.65	13.8
10	3.74	17.30	15.49	16.50	26.79	15.96
12	4.05	17.8	16.49	17.21	28.53	16.81
14	4.35	19.27	17.09	18.10	32.46	18.25
16	4.65	20.50	17.49	21.29	35.34	19.49
20	4.93	22.72	18.89	23.24	36.59	21.27
27	5.21	24.69	19.69	24.64	39.64	22.77
34	5.48	25.67	20.49	25.90	42.26	23.95
41	5.73	26.65	21.89	27.32	44.65	25.24
48	5.97	27.15	22.29	28.56	46.40	26.07
55	6.17	29.12	24.09	30.52	49.66	27.91
62	6.36	30.35	25.29	31.94	52.28	29.24
67	6.55	31.68	26.29	33.35	54.67	30.39
74	6.70	32.07	27.69	34.60	59.03	32.01
81	6.81	33.30	28.29	36.90	60.86	33.43
88	6.91	35.02	30.49	40.10	63.60	35.22
95	6.98	36.23	32.29	41.34	67.09	36.78
Mean	4.34	19.16	16.82	20.50	33.55	18.87
	SEm±				CD ($P=0.05$)	
	Days 0.417				Days 1.16	
	Organic wastes 0.934				Organic wastes 2.60	
	Days x Organic wastes 2.08				Days x Organic wastes 5.82	

Table 4. Cumulative per cent nitrogen mineralization from the nitrogen added through different organic wastes at 60 per cent WHC.

Treatment	Days									
	1	5	10	15	30	45	60	75	90	Mean
Soil + B	7.95	10.04	11.51	15.49	20.93	23.02	22.39	23.0	17.58	16.88
Soil + PN	7.44	8.57	13.08	19.84	16.68	22.54	9.02	11.3	9.02	13.05
Soil + PM	5.61	7.22	8.14	13.32	12.34	12.83	11.17	9.7	3.02	9.26
Soil + ST	6.17	12.17	13.88	17.74	19.28	22.37	16.58	10.2	6.56	13.89
Mean	6.79	9.50	11.65	16.60	17.31	20.19	14.79	13.55	9.04	
	SEm±						CD ($P=0.05$)			
	Days 2.26						Days 6.37			
	Organic wastes 1.50						Organic wastes 4.25			
	Days x Organic wastes 4.52						Days x Organic wastes 12.75			

B- Paper mill bagasse, PN- Pine needle, PM-Press mud, ST- Sugarcane trash

Table 5. Cumulative per cent phosphorus mineralized from the phosphorus added through different organic wastes at 60 per cent WHC.

Treatment	Days									
	1	5	10	15	30	45	60	75	90	Mean
Soil + B	6.43	9.79	10.76	11.63	12.07	16.52	7.13	8.14	3.48	09.55
Soil + PN	9.37	10.72	16.98	16.80	20.29	21.52	20.54	12.98	4.12	14.81
Soil + PM	5.15	6.11	6.90	8.27	9.22	11.09	5.76	6.97	8.96	07.60
Soil + ST	9.21	12.77	15.00	14.05	15.75	16.16	15.28	9.56	4.76	12.50
Mean	7.54	9.85	12.41	12.69	14.33	16.32	12.18	9.41	5.33	
	SEm±						CD ($P=0.05$)			
	Days 0.64						Days 1.82			
	Organic wastes 0.43						Organic wastes 1.21			
	Days x Organic wastes 1.29						Days x Organic wastes 3.65			

B- Paper mill bagasse, PN- Pine needle, PM-Press mud, ST- Sugarcane trash

Table 6. Cumulative per cent sulphur mineralized from the sulphur added through different organic wastes at 60 per cent WHC.

Treatment	Days									Mean	
	1	5	10	15	30	45	60	75	90		
Asoil+B	12.41	10.39	18.91	24.074	27.43	28.50	21.99	13.08	10.73	18.61	
Soil+PN	11.47	10.48	12.74	14.808	17.07	17.63	13.16	9.82	3.31	12.28	
Soil+PM	10.46	11.55	12.38	14.694	16.11	17.27	13.71	12.74	3.98	12.54	
Soil+ST	16.54	11.23	12.47	20.615	21.58	21.64	21.94	9.47	4.76	15.58	
Mean	12.72	10.91	14.12	18.55	20.55	21.26	17.70	11.28	5.69		
	SEM± Days 2.26					CD (<i>P</i> =0.05) Days 6.37					
	Organic wastes 1.50					Organic wastes 4.25					
	Days x Organic wastes 4.52					Days x Organic wastes 12.75					

B- Paper mill bagasse, PN- Pine needle, PM-Press mud, ST- Sugarcane trash

wastes.

Phosphorus mineralization: Perusal of the data cumulative phosphorus mineralization from paper mill bagasse, pine needle, press mud and sugarcane trash in soil differed significantly. The maximum phosphorus mineralization (14.84 %) was recorded with pine needle followed by sugarcane trash while minimum (7.60 %) from press mud. Pine needle showed 37.9 and 18.72 per cent more phosphorus mineralization in comparison to paper mill bagasse and sugarcane trash. Irrespective of added material, phosphorus mineralization was increased up to 45 days after incubation then it showed significantly declined trend up to 90 days of incubation. Maximum phosphorus was mineralized at 45th day which was significantly higher than the values of mineralized phosphorus recorded at different intervals. It may be due to production of more acids from pine needle by microbial attack because pine needle are acidic in nature and secreted organic acids solubilized more P in soil. On the other hand press mud was alkaline in nature, which did not release organic acids in sufficient amount; therefore, P mineralization was low.

The interaction effect between organic wastes and incubation period was found significant. The phosphorus mineralization significantly increased after 10 days of incubation from all the organic amendments, except press mud which significantly increased after 30 days of incubation than its initial level. However, all the amendments showed maximum mineralization up to 45th day. Paper mill bagasse and press mud exhibited significant reduction in phosphorus mineralization after 60 days of incubation while pine needle and sugarcane trash after 75 days of incubation.

Paper mill bagasse, pine needle and sugarcane trash demonstrated significantly higher P mineralization than press mud up to 45 days of incubation. At 60th day of incubation, both paper mill bagasse and press mud showed significant decline in phosphorus mineralization than pine needle and sugarcane trash. However,

press mud at 75th day of incubation and pine needle at 90th day of incubation gave lowest phosphorus mineralization (Table 5).

The cumulative percent phosphorus mineralization was also enhanced with incubation time up to a certain period. Thereafter, it decreased. The phosphorus mineralization depended on the phosphorus solubilisation due to production of organic acids by microbial decomposition of wastes, which increased up to 45 DOI only as decomposition of organic wastes slowed down after words. Pareek *et al.* (2003) also found increased P mineralization up to 45 days and thereafter declined was trend observed. Moharana *et al.*, (2015) observed that the Olsen-P in soil treated with any of the P sources declined up to 30 days of incubation which may be due to fixation of available P into unavailable forms.

Sulphur mineralization: It is evident from the table 6 that per cent cumulative sulphur mineralization of soil added paper mill bagasse was significantly higher than other organic wastes. The addition of sugar cane trash also mineralized significantly 24.2 and 26.87 per cent more sulphur, respectively significantly more in comparison to pine needle and press mud. However, both pine needle and Press mud were statistically comparable with each other. The pattern of sulphur mineralization from different amendments was in order of paper mill bagasse > sugarcane trash > press mud > pine needle. The paper mill bagasse showed 19.44, 51.54 and 48.4 per cent more sulphur mineralization than sugarcane trash, Press mud and pine needle, respectively. Irrespective of organic wastes, significant increases were recorded after 15 days of incubation over initial mineralization value. However, sulphur mineralization was increased up to 45 days of incubation. Then it showed significantly declined trend at all the intervals up to 90 days. The maximum sulphur mineralization of 31.26 per cent was registered at 45 days of incubation.

The interaction of different organic wastes in soil and

incubation period for sulphur mineralization was significant. The sulphur mineralization from paper mill bagasse significantly increased on 10th days of incubation. After 45 days of incubation it declined significantly up to 75 days of incubation and then non significantly trend up to 90 days. Pine needle and sugar cane trash gave significant increase in sulphur mineralization on 30th day of incubation. On the other hand, press mud exhibited maximum and significantly higher sulphur mineralization at 45th day of incubation. Sulphur mineralization from pine needle significantly reduced on 60th day of incubation and in sugarcane trash maximum sulphur mineralization was obtained 60 days of incubation then it demonstrated significantly declined at 90th days of incubation. Press mud showed significant decline in sulphur mineralization on 60th and 90th days of incubation. At initial stage sugarcane trash showed significantly more sulphur mineralization in comparison to other organic wastes. Paper mill bagasse gave maximum and significantly more mineralization at 10, 30, and 45th day after incubation than other amendments. However, on 15 and 60th day of incubation both paper mill bagasse and sugar cane trash showed significantly higher sulphur mineralization than pine needle and press mud. At 90th day, significantly more amount of mineralized sulphur was observed from paper mill bagasse when compared with other wastes (Table 6).

Higher S mineralization from paper mill bagasse might be related with more microbial oxidation of sulphur in comparison to press mud. Pareek *et al.* (2003) also reported that mean sulphur mineralization is more in sugarcane trash followed by bagasse and lowest in press mud. The S-mineralization decreased initially up to 5th days but after 15 day it increased significantly up to 45 days and declined later on. The decrease in S mineralization at initial stage may be due to immobilization of S because of wide C: S ratio, After some period it again increased due to the microbial activity. Later on the nutrients were consumed by microorganism and microbial number and activity was reduced which lowered the S mineralization. In the same manner, McGill and Cole (1981) also observed role of lignocellulosic micro organisms in S mineralization. Somani and Saxena (1975) reported that S mineralization decreased at initial stage of decomposition. Where as in contrast, Pareek (2000) concluded that initially S mineralization increased up to a certain period and after that declined very rapidly. Moharana *et al.*, (2015) reported that sulphur mineralization in the soil is typically attributed to either biological or biochemical processes. The biological route is governed by the microbes for searching their energy and the S is released as a by-product. The biochemical process is defined as the release of S from ester sulphates, through extracellular enzymatic hydrolysis.

Conclusion

The study showed that in respect of major findings cumulative percent of carbon mineralization increased with incubation period and maximum mineralization was recorded at 95 DOI. That indicates up to 90 DOI decomposition of C was found. The maximum cumulative percent N-mineralization (16.88%) in soil was shown by paper mill bagasse followed by sugarcane trash and pine needle. Pine needles showed maximum cumulative P-mineralization in soil followed by sugarcane trash while minimum was recorded from press mud. The paper mill bagasse showed highest cumulative S-mineralization in soil followed by sugarcane trash. Irrespective of organic wastes, cumulative percent of nitrogen, phosphorus and Sulphur-mineralization significantly increased up to 45 days of incubation later on it showed declined trend. These findings might be useful in to understand the release pattern of nitrogen, phosphorus and sulphur in soil and preparing enriched compost from these organic wastes. Sugarcane trash and press mud could be directly use in soil as organic amendment and good for the preparation of enriched compost.

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