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Effect of Substrate Particle Size on Chemical Properties and C/N ratio of Compost Prepared from Different Crop Residues with Spent Wash

R. MUTHURAJU
Department of Agricultural Microbiology, College of Agriculture, UAS, GKVK, Bengaluru-560 065

ABSTRACT

A laboratory experiment was conducted to study the effect of substrate particle size on pH, EC, organic carbon, C/N ratio and nutrient content of compost prepared from different crop residues. This experiment was carried out in a completely randomized design with three crop residues (maize stalk, sunflower stalk, and sugarcane trash) and four particle sizes (powder form, 1.25 cm, 2.50 cm and 3.75 cm) in three replications. Five kilo gram of each substrate with different size fractions was taken separately in a plastic container for bio-composting. The microbial consortia of ligno-cellulolytic organisms were inoculated layer by layer at the rate of 2.5 kg per ton of substrate. The substrate to spent wash ratio was 1:3 and the initial quantity of spent wash added was equivalent to maintain the moisture level approximately at 60 per cent level. Samples were drawn at 30, 60, 90 and 120 days during composting from all the treatments and analyzed for various parameters. From the results, it was concluded that the powder form and 1.25 cm size of all crop residues were found to be ideal for composting.

CROP residues are the non-economic plant parts that are left in the field after harvest. The harvest refuses include straws, stubble, stover and haulms of different crops. The greatest potential as a biomass resource appears to be from the field residues of sorghum, maize, soybean, cotton, sunflower, sugarcane etc. Indian agriculture produces about 500-550 million tonnes (Mt) of crop residues annually (NAAS, 2012). These crop residues are used as animal feed, soil mulch, manure, thatching for rural homes and fuel for domestic and industrial purposes and thus, are of tremendous value to farmers. There are several other options such as composting, energy generation, biofuel production and recycling in soil to manage the residues in a productive and profitable manner. Use of crop residues as soil organic amendment in the system of agriculture is a viable and valuable option. Composting has been used as a means of disposal of organic wastes like paddy straw, sugarcane trash and other agricultural wastes. Composting of agricultural residues through the action of lingo-cellulolytic microorganisms is easier to manage and it recycles the lingo-cellulosic waste with high economic efficiency. The recycled material when applied to soil, improves soil fertility and health. During the composting process, microorganisms transform organic raw materials into compost by breaking them down to simple compounds and reforming them into new complex compounds (Mohammad *et al*., 2008). The final product is stable, free of pathogens and plant seeds and can be beneficially applied to land.

Decomposition occurs primarily on or near the surfaces of particles where oxygen diffuse into the aqueous films covering the particle is adequate for aerobic metabolism, and the substrate itself is readily accessible to microorganisms and their extracellular enzymes. Small particles have more surface area per unit mass or volume than large particles, so if aeration is adequate small particles will degrade more quickly. Experiments have shown that the process of grinding compost materials can increase the decomposition rate by a factor of two (Gray and Sherman, 1970). Gray *et al*. (1971) recommend a particle size of 1.3 to 7.6 cm (0.5 to 2 inches), with the lower end of this scale suitable for forced aeration or continuously mixed systems, and the upper end for windrow and other passively aerated systems. The spent wash generated from distilleries is rich in nutrients and therefore, by using the spent wash, the crop residues could be enriched with these nutrients and thus, help in faster decomposition and be converted in to valuable compost for their safe utilization by employing microbial cultures. The crop residues available cannot be used as such because they cannot imbibe the spent wash. Therefore, there is a need to standardize the size of substrates with spent wash for bio-composting.

MATERIAL AND METHODS

In order to standardize the optimum size of substrates for bio-composting, the experiment was carried out under laboratory conditions. The experiment contained twelve treatments with three replications using maize stalk, sunflower stalk, and sugarcane trash as alternate substrates with the following size fractions - powder form, 1.25 cm, 2.50 cm and 3.75 cm. Chemical characteristics of the raw material used in the study are given in the Table I. Composting was carried out in plastic containers by using 5 kg of each substrate with four different size fractions. A consortium of microorganisms consisting of four efficient ligno-cellulolytic fungi (*Phanerochaetechrysosporium, Pleurotus sajor- kaju, Trichoderma harzianum* and *Trichurus spiralis*) was selected for hastening the process of decomposition in bio-composting experiments. The selected strains were subjected to compatibility test by dual and triple inoculations *in vitro* on PDA plates. These selected cultures were grown separately in potato dextrose broth for seven days till a population of 47×10^8 CFU per ml was attained. These four cultures were homogenized and mixed at 1:1:1:1 in a lignite based carrier to get a fungal consortium.

TABLE I

Chemical characteristics of raw materials used in the study

Parameter	Maize stalk	Sun flower stalk	Sugar cane stalk	Distillery spent wash
pH	7.31	8.53	7.23	7.51
EC (dSm^{-1})	0.92	7.06	1.13	16.5
OC (%)	42.5	56.0	51.2	NA
Total N (%)	0.93	1.12	0.53	0.16
Total P (%)	0.41	0.53	0.32	0.02
Total K (%)	0.98	0.96	0.85	0.70
C:N ratio	45.7	50.0	96.6	NA

Note: NA-Not analysed

The microbial consortia of ligno-cellulolytic organisms were inoculated layer by layer at the rate of 2.5 kg per ton of substrate. The substrate to spentwash ratio was 1:3 and the initial quantity of spentwash added was equivalent to maintain the moisture level approximately at 60 per cent level. The remaining quantity of spentwash was distributed up to 60 days of composting by adding equal quantity to each container once in two days. Composting was carried out for 120 days by regularly turning the containers once in 15 days and maintaining the moisture approximately at 60 per cent level by adding water under controlled conditions. Samples were drawn at 30, 60, 90 and 120 days during composting from all the treatments and analyzed for various parameters. Chemical properties of the compost were determined by following the standard procedures given by jackson (1973). The data obtained were subjected to Duncan Multiple Range Test (DMRT) for the test of significance using MSTAT - C statistical software.

RESULTS AND DISCUSSION

Effect of substrate particle size on pH and EC of compost : The results on changes in pH of compost materials during bio-composting of crop residues of different sizes using distillery spent wash are presented in Table II. The analysis of samples at different intervals revealed that there was a marginal change in the pH values irrespective of treatments, but, showed no clear trends. There was an increase in pH of all the substrates up to 90th day of decomposition, then a slight decrease in pH was observed in all the treatments during 120th day of decomposition. However, among all the substrate samples, powder form recorded marginally lower pH values and increased with increase in the size of the substrates irrespective of crop residues. At the final stage of composting, the lowest pH was observed in sugarcane trash of powder form (pH 7.97) and it was on par with the 1.25 cm of the same substrate size (pH 8.03), while, the highest pH was observed in sunflower stalk of 3.75 cm (pH 8.20) and it was on par with 2.50 cm (pH 8.19) of the same substrate, 1.25 cm (pH 8.15) and 3.75 cm of maize (pH 8.19) and 2.50 cm (pH 8.17) and 3.75 cm (pH 8.16) of sugarcane trash. The data on electrical conductivity (EC) revealed that there was a significant

TABLE II

Changes in pH and EC (dSm^{-1}) during bio-composting of crop residues of different sizes with distillery spent wash

Crop Substrate	Size	pH				EC (dSm^{-1})			
		Period of decomposition (days)				Period of decomposition (days)			
		30	60	90	120	30	60	90	120
Maize	Powder form	6.86 ^{cde}	8.26 ^{bc}	8.60 ^{a}	8.11 ^{bcd}	3.11 ^{a}	2.83 ^{a}	2.59 ^{ab}	2.40 ^{a}
stalk	1.25 cm	6.74 ^{e}	8.31 ^{b}	8.53 ^{abc}	8.15 ^{abc}	2.31 ^{cd}	2.38 ^{cd}	2.42 ^{c}	2.28 ^{b}
	2.50 cm	6.95 ^{abcd}	8.44 ^{a}	8.50 ^{abc}	8.09 ^{bcd}	2.28 ^{cd}	2.29 ^{de}	2.22 ^{e}	1.92 ^{e}
	3.75 cm	6.82 ^{de}	8.24 ^{bc}	8.53 ^{ab}	8.19 ^{a}	2.18 ^{d}	2.22 ^{ef}	2.13 ^{f}	1.70 ^{f}
Sunflower	Powder form	6.84 ^{de}	8.17 ^{cd}	8.31 ^{d}	8.08 ^{cd}	2.69 ^{d}	2.78 ^{a}	2.65 ^{a}	2.33 ^{b}
stalk	1.25 cm	6.83 ^{de}	8.00 ^{f}	8.29 ^{d}	8.06 ^{d}	2.39 ^{c}	2.42 ^{bc}	2.46 ^{c}	2.04 ^{d}
	2.50 cm	6.85 ^{de}	8.23 ^{bc}	8.58 ^{ab}	8.19 ^{a}	1.88 ^{e}	2.23 ^{ef}	2.31 ^{d}	1.87 ^{e}
	3.75 cm	7.00 ^{abc}	8.16 ^{cd}	8.46 ^{bc}	8.20 ^{a}	1.63 ^{f}	2.05 ^{g}	2.17 ^{ef}	1.64 ^{f}
Sugar cane	Powder form	6.88 ^{bcde}	8.13 ^{cde}	8.33 ^{d}	7.97 ^{e}	2.20 ^{d}	2.83 ^{a}	2.55 ^{b}	2.28 ^{b}
trash	1.25 cm	7.00 ^{abc}	8.19 ^{bcd}	8.40 ^{cd}	8.03 ^{de}	1.82 ^{e}	2.50 ^{b}	2.43 ^{c}	2.11 ^{c}
	2.50 cm	7.04 ^{a}	8.06 ^{def}	8.51 ^{abc}	8.17 ^{ab}	1.68 ^{f}	2.18 ^{f}	2.25 ^{de}	2.06 ^{cd}
	3.75 cm	7.03 ^{ab}	8.03 ^{ef}	8.46 ^{bc}	8.16 ^{ab}	1.56 ^{f}	1.85 ^{h}	2.18 ^{ef}	1.88 ^{e}

Note : Mean values followed by the same superscript letter in each column do not differ significantly at P=0.05 level by DMRT

decrease in the values of EC with increase in size of the substrate in all the crop residues (Table II). There was an increase in EC values of all the treatments up to 90th day, there after there was a marginal decrease at 120th day of decomposition. At the final stage of composting, the lowest EC was observed in sunflower stalk of 3.75 cm size (1.64 dSm^{-1}) and was on par with maize stalk with 3.75 cm size (1.70 dSm^{-1}), while, the highest EC was observed in powder form of maize stalk (2.40 dSm^{-1}) and was significantly different from other substrate sizes of other crop residues. Variation in pH and EC may be attributed to the size of substrates. The powdered crop residues owing to their higher surface area absorbed and retained higher quantity of added spent wash. There was an increase in pH and EC values up to 90th day of decomposition that could be due to production of organic acids and a decrease in ammonification during the process of decomposition. Later on, pH was stabilized that could be due to the buffering nature of humic substances formed during composting. However, according to Verdonok (1988), the optimal value of pH for decomposition of compost material is between 5.5 and 8.0. Thampan (1993) reported that the pH of composting material decreased initially and attained near neutral conditions as the decomposition proceeded further. Whereas, trend in changes of EC in the present study confirms the results obtained by Preethu (2004) while composting of coffee pulp effluent with coffee husk. The substrate size has a major effect on the rate of decomposition. Allison (1973) observed that shredding accelerated the decomposition of crop residues, not only due to the fact that more surface area is exposed, but, also because of a larger percentage of each plant constituent (*e.g.* cellulose, lignin, waxes or gums) that may have been largely protected from microbial attack will be exposed for the microbial attack. This upholds the results obtained in the present study, where the decomposition was accelerated upon shredding the crop residues to different sizes.

Effect of substrate particle size on organic carbon content and C/N ratio of compost : The data on changes in OC (%) content of compost materials at different periods of composting of different substrate sizes of crop residues are presented in Table III. In general, the OC content of treatments decreased with increase in the period of decomposition and there was increase in OC content with increase in the size of substrates. At 120th day of composting, the lowest OC content was observed in treatment with maize stalk in powder form (18.9 %) which was on par with powder forms of sugarcane trash (19.3 %) and sunflower stalk (19.3 %, while, the highest OC content was observed in treatment with sunflower stalk of 3.75 cm size (25.2 %) which was on par with sugarcane trash of 3.75 cm size (25.0 %). Significant decrease in C:N ratio of different crop residues was observed with decrease in the substrate size of all the crop residues and also the decrease was notable with the period of decomposition in all the treatments. At 120th day of composting, the lowest C:N ratio was observed in crop substrate of sugarcane trash of powder form (9.6) which was significantly different from all other treatments, while, the highest C:N ratio was observed in crop substrate of maize stalk with 3.75 cm size (15.5) and it was on par with crop residues of sugarcane trash (15.5) and sunflower stalk (15.3) of the same substrate size.

Effect of substrate particle size on total N, P and K content of compost : The results on changes in total N, P and K content of compost materials during bio-composting of crop residues of different sizes using distillery spent wash are presented in Table IV. The results indicated that there were significant differences among the treatments and increase in total N content at different intervals throughout the period of decomposition. In general, there was an increase in total N content as the size of crop residue was reduced. At the final stage of composting, the highest total N

TABLE III

Changes in OC (%) and C/N ratio during bio-composting of crop residues of different sizes with distillery spent wash

Crop Substrate	Size	OC (%)				C/N ratio			
		Period of decomposition (days)				Period of decomposition (days)			
		30	60	90	120	30	60	90	120
Maize	Powder form	23.6 ^{j}	21.5 ^{g}	20.3 ^{g}	18.9 ^{g}	14.1 ^{h}	12.3 ^{i}	11.2 ^{h}	10.5 ^{f}
stalk	1.25 cm	25.5 ^{gh}	23.5 ^{f}	22.6 ^{f}	20.0 ^{f}	16.0 ^{e}	14.5 ^{f}	13.6 ^{f}	12.1 ^{d}
	2.50 cm	28.0 ^{e}	27.0 ^{c}	24.4 ^{d}	22.1 ^{c}	19.3 ^{d}	18.0 ^{b}	15.9 ^{c}	14.5 ^{b}
	3.75 cm	32.1 ^{b}	28.3 ^{b}	25.1 ^{c}	23.0 ^{b}	22.6 ^{b}	19.3 ^{a}	16.9 ^{b}	15.5 ^{a}
Sunflower	Powder form	24.1 ^{ij}	22.6 ^{f}	20.5 ^{g}	19.3 ^{g}	13.6 ^{c}	12.6 ^{h}	10.9 ^{i}	10.0 ^{g}
stalk	1.25 cm	26.0 ^{fg}	25.5 ^{e}	23.4 ^{e}	20.2 ^{ef}	16.3 ^{e}	15.7 ^{d}	13.9 ^{e}	12.0 ^{d}
	2.50 cm	29.4 ^{d}	26.1 ^{cde}	24.4 ^{d}	21.1 ^{d}	19.1 ^{d}	16.4 ^{c}	14.5 ^{d}	12.6 ^{c}
	3.75 cm	33.9 ^{a}	30.2 ^{a}	28.3 ^{a}	25.2 ^{a}	22.1 ^{c}	19.5 ^{a}	17.5 ^{a}	15.3 ^{a}
Sugarcane	Powder form	24.9 ^{hi}	23.5 ^{f}	20.3 ^{g}	19.3 ^{g}	12.7 ^{j}	11.6 ^{j}	10.1 ^{j}	9.6 ^{h}
trash	1.25 cm	26.8 ^{f}	25.7 ^{de}	23.6 ^{e}	20.5 ^{e}	14.9 ^{g}	13.9 ^{g}	12.9 ^{g}	11.1 ^{e}
	2.50 cm	28.0 ^{e}	26.5 ^{cd}	24.3 ^{d}	22.3 ^{c}	15.4 ^{f}	14.8 ^{e}	13.5 ^{f}	12.4 ^{cd}
	3.75 cm	30.6 ^{c}	28.4 ^{b}	26.8 ^{b}	25.0 ^{a}	23.5 ^{a}	18.1 ^{b}	16.7 ^{b}	15.5 ^{a}

Note: Mean values followed by the same superscript letter in each column do not differ significantly at P=0.05 level by DMRT

TABLE IV.

Changes in total N, P and K during bio-composting of crop residues of different sizes with distillery spent wash

Crop Substrate	Size	N				P				K			
		Period of decomposition (days)				Period of decomposition (days)				Period of decomposition (days)			
		30	60	90	120	30	60	90	120	30	60	90	120
Maize	Powder form	1.63^{c}	1.75^{c}	1.80^{c}	1.82^{c}	1.07^{d}	1.13^{d}	1.25^{e}	1.51^{b}	1.49^{b}	1.60^{b}	1.72^{c}	1.79^{d}
stalk	1.25 cm	1.59^{c}	1.62^{d}	1.65^{de}	1.65^{de}	0.95^{g}	1.01^{e}	1.15^{f}	1.44^{c}	1.38^{c}	1.49^{c}	1.64^{d}	1.77^{d}
	2.50 cm	1.48^{de}	1.50^{fg}	1.54^{f}	1.55^{f}	0.89^{i}	0.89^{g}	1.01^{g}	1.17^{e}	1.28^{e}	1.35^{d}	1.60^{de}	1.65^{e}
	3.75 cm	1.42^{e}	1.46^{g}	1.47^{g}	1.48^{g}	0.75^{k}	0.82^{h}	0.94^{h}	1.06^{f}	1.17^{f}	1.27^{e}	1.45^{g}	1.47^{g}
Sunflower	Powder form	1.77^{b}	1.80^{bc}	1.90^{b}	1.95^{b}	1.31^{a}	1.49^{a}	1.64^{a}	1.74^{a}	1.59^{a}	1.72^{a}	1.78^{b}	1.88^{b}
stalk	1.25 cm	1.60^{c}	1.63^{d}	1.68^{d}	1.70^{d}	1.16^{c}	1.44^{a}	1.55^{b}	1.69^{a}	1.47^{b}	1.63^{b}	1.75^{bc}	1.85^{bc}
	2.50 cm	1.56^{cd}	1.60^{de}	1.66^{de}	1.68^{d}	1.02^{e}	1.25^{c}	1.41^{c}	1.55^{b}	1.34^{cd}	1.50^{c}	1.58^{e}	1.68^{e}
	3.75 cm	1.54^{cd}	1.56^{ef}	1.62^{e}	1.65^{de}	0.92^{h}	1.12^{d}	1.17^{f}	1.25^{d}	1.28^{e}	1.33^{d}	1.59^{f}	1.59^{f}
Sugarcane	Powder form	1.94^{a}	2.00^{a}	2.02^{a}	2.03^{a}	1.21^{b}	1.32^{b}	1.45^{c}	1.54^{b}	1.55^{a}	1.74^{a}	1.88^{a}	1.94^{a}
trash	1.25 cm	1.80^{b}	1.83^{b}	1.84^{c}	1.85^{c}	1.16^{c}	1.20^{c}	1.34^{d}	1.52^{b}	1.45^{b}	1.69^{a}	1.85^{a}	1.90^{ab}
	2.50 cm	1.83^{b}	1.79^{bc}	1.80^{c}	1.80^{c}	0.97^{f}	1.01^{e}	1.23^{e}	1.30^{d}	1.32^{de}	1.58^{b}	1.70^{c}	1.80^{cd}
	3.75 cm	1.29^{f}	1.56^{e}	1.60^{e}	1.62^{e}	0.85^{j}	0.95^{f}	1.06^{g}	1.10^{f}	1.19^{f}	1.35^{d}	1.61^{de}	1.69^{e}

Note : Mean values followed by the same superscript letter in each column do not differ significantly at P=0.05 level by DMRT content was observed in the treatment with sugarcane trash of powder form (2.03 %) which was significantly different from other sizes of crop residues, while, the lowest in the treatment with maize stalk of 3.75 cm (1.48%) which was significantly different from other sizes of crop substrates. The results on changes in total P (%) content of compost materials are presented in Table V. The results indicated significant differences among various treatments. In general, there was an increase in total P content with increase in the period of decomposition and also there was an increase in total phosphorus content as the size of the substrates decreased. At the final stage of composting, the highest total P was observed in the treatment of sunflower stalk in powder form (1.74 %) and was on par with 1.25 cm size (1.69 %) of the same substrate, while, the lowest was observed in treatment of maize stalk with 3.75 cm (1.06 %) which was on par with sugarcane trash of 3.75 cm size (1.10 %). The results on changes in total K (%) content of compost materials at different intervals are presented in Table VI. The data indicated trends that are similar to that of total P content. At the final stage (120th day) of composting, the highest total K content was observed in crop residue of sugarcane trash of powder form (1.94 %) which was on par with the 1.25 cm substrate size (1.90 %) of the same substrate, while, the lowest was observed in crop residue of maize stalk with 3.75 cm substrate size (1.47 %) which was significantly lower than all other treatments.

In the present study, the OC content and C:N ratio decreased with increase in the period of decomposition. In general, both the parameters decreased with decrease in size of crop residues. Irrespective of type of crop residue, the powder form recorded lower OC and C: N ratio. However, it was on par with 1.25 cm size of crop residues. These changes might be attributed to the size of the substrates, which has a major effect on decomposition. Similar results have also been reported earlier by Gaur (1999) and Choi (1999) with different crop residues. Further, addition of distillery spentwash containing significant amount of nitrogen could be one of the reasons to the decrease in OC content and C: N ratio due to higher microbial degradation throughout the period of

TABLE V

Changes in chemical parameters after 120 days bio-composting of crop residues of different sizes with distillery spent wash

Crop substrate	Size	Chemical Parameters						
		pH	EC	OC	N	C : N	P	K
Maize	Powder form	8.11 ^{bcd}	2.40 ^{a}	18.9 ^{g}	1.82 ^{c}	10.5 ^{f}	1.51 ^{b}	1.79 ^{d}
stalk	1.25 cm	8.15 ^{abc}	2.28 ^{b}	20.0 ^{f}	1.65 ^{de}	12.1 ^{d}	1.44 ^{c}	1.77 ^{d}
	2.50 cm	8.09 ^{bcd}	1.92 ^{e}	22.1 ^{c}	1.55 ^{f}	14.5 ^{b}	1.17 ^{e}	1.65 ^{e}
	3.75 cm	8.19 ^{a}	1.70 ^{f}	23.0 ^{b}	1.48 ^{g}	15.5 ^{a}	1.06 ^{f}	1.47 ^{g}
Sunflower	Powder form	8.08 ^{cd}	2.33 ^{b}	19.3 ^{g}	1.95 ^{b}	10.0 ^{g}	1.74 ^{a}	1.88 ^{b}
stalk	1.25 cm	8.06 ^{d}	2.04 ^{d}	20.2 ^{ef}	1.70 ^{d}	12.0 ^{d}	1.69 ^{a}	1.85 ^{bc}
	2.50 cm	8.19 ^{a}	1.87 ^{e}	21.1 ^{d}	1.68 ^{d}	12.6 ^{c}	1.55 ^{b}	1.68 ^{e}
	3.75 cm	8.20 ^{a}	1.64 ^{f}	25.2 ^{a}	1.65 ^{de}	15.3 ^{a}	1.25 ^{d}	1.59 ^{f}
Sugarcane	Powder form	7.97 ^{e}	2.28 ^{b}	19.3 ^{g}	2.03 ^{a}	9.6 ^{h}	1.54 ^{b}	1.94 ^{a}
trash	1.25 cm	8.03 ^{de}	2.11 ^{c}	20.5 ^{e}	1.85 ^{c}	11.1 ^{e}	1.52 ^{b}	1.90 ^{ab}
	2.50 cm	8.17 ^{ab}	2.06 ^{cd}	22.3 ^{c}	1.80 ^{c}	12.4 ^{cd}	1.30 ^{d}	1.80 ^{cd}
	3.75 cm	8.16 ^{ab}	1.88 ^{e}	25.0 ^{a}	1.62 ^{e}	15.5 ^{a}	1.10 ^{f}	1.69 ^{e}

Note : Mean values followed by the same superscript letter in each column do not differ significantly at P=0.05 level by DMRT decomposition. These observations are in confirmation with the results highlighted by other workers (Sunil, 2002; Bangar and Patil, 1980; Bishop and Godfrey, 1983).

From the experiment conducted to standardize the optimum substrate size for bio-composting using different crop residues *viz*., maize stalk, sunflower stalk and sugarcane trash of various sizes *viz.*, powder from, 1.25 cm, 2.50 cm and 3.75 cm size, the substrates in powder form followed by 1.25 cm size of all crop residues were found to be ideal for composting. Considering the energy required for powdering the crop residues, optimum C: N ratio and major plant nutrients, 1.25 cm size of crop residues was considered ideal for bio-composting.

In the present study, all major plant nutrients showed a significant increase over the period of decomposition at different intervals. In general, total NPK content increased with decrease in size of the crop residues. The highest total N and K (2.03 and 1.94 %, respectively) are observed in treatment with ST of powder form, while, it was in treatment with SS of powder form with regard to total P (1.74 %). This increase could be attributed to absorption of higher amounts of distillery spent wash coupled with higher rates of microbial degradation that resulted due to decrease in size of substrates. The incorporation of additional major plant nutrients through distillery spent wash helped in increasing the biological activity especially in a system where C:N ratio was very wide. The increase in total NPK during composting process might be a direct manifestation of mass loss during decomposition as lot of carbon from substrate gets oxidized to carbon dioxide. Similar observations were also noted by different workers (Sunil, 2002; Lekshmi, 2002), while working on composting of pressmud, sugarcane trash, sunflower stalk, yeast sludge, and coir waste using distillery spent wash.

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