QUALITY AND COST ANALYSIS OF COMPOST UNDER DIFFERENT COMPOSTING TECHNIQUE

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Abstract: The experiment was carried out during the December 2007 to March 2008, at instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur. Different composting techniques are used. Treatment under aerobic decomposition of paddy straw, soybean straw and fresh cow dung and soil were taken into 5:2 ratios for each pit. The progressive decrease in total organic carbon, and C/N ratio, cellulose, were found under the NADEP method of composting. Ash percent increased with days of decomposition progresses and maximum increase was found at 120 days. The significant increase in CEC was observed in all the methods under aeration and it was maximum [90.66 C mol (p+) kg^{-1}] under NADEP method of composting followed by turning method and three perforated pipe method of composting. The highest L/N ratio was recorded in NADEP method of composting (T_7) (6.95, 11.43, 12.56 and 14.64) at progressive days. While lowest ratio was recorded in traditional method (T_6) (7.10, 8.86, 10.66 and 10.78) at progressive days, respectively. The maximum CEC/TOC ratio was observed (2.55) in NADEP method of composting at 120 days. The maximum cost of production (553.75 Rs/pit) with NADEP method and minimum (212.00 Rs/pit) with traditional method of composting were estimated the frequency of NADEP method was recorded highest with preparation of composting within 4 months followed by turning method of composting.

Keywords: Cellulose %, nitrogen, organic carbon, lignin%

INTRODUCTION

In India food production through use of chemical fertilizers alone cannot sustain high growth rate in agriculture sector. Availability of organic sources of nutrients has to be augmented substantially in order to enhance nutrients supply for attaining 301 MT of food grain production by 2050 to feed 1.4 billion populations. Bio-solids generation in urban/rural sectors is increasing day by day. Production compost from biodegradable wastes would help in increasing the availability of manure and supply of nutrients to bridge the gaps between nutrient demands and supply in agriculture. There is a need to increase production of quality compost at minimum cost through adoption of appropriate technologies. The quality of compost prepared from different waste will need to be assessed through physical chemical and biological assays minimum content of phytotoxic compound and heavy metal content. However, the direct application of crop residue is possible in the presence of sufficient amount of soil moisture and direction for rapid decomposition. Therefore compositing is an alternative to direct incorporation in soil in semi arid sub humid regions. Hence, it is important to develop a suitable technique for preparation of minerals enriched compost by using low cost amendments in the shortest possibilities and evaluate its quality and maturity. Evidence suggests that the use of enriched compost may help in maintaining proper soil quality and crop productivity.

Traditional method take 6 month to 2 years, the processes of composting are mainly anaerobic decomposition results partial breakdown of organic matter and produces several obnoxious gases due to predominant of anaerobic organisms and traditionally no control, undoubtedly such practices for dealing with organic waste have a bad impact on quality of final product and leads to loss of nutrients through volatilization. Traditional methods in comparison with modern techniques relies an anaerobic decomposition with insufficient aeration. Hence it is important to develop a suitable technique for preparation of manures enriched compost by using low cost amendments and alternated perforated aeration technique in shortest possible time. Therefore an attempt has been made to find out the alternative composting technique for early and quality compost production

MATERIAL AND METHOD

The present experiment was conducted during the December 2007 to March 2008. Research farm of Indra Gandhi Krishi Vishwavidyalaya, Raipur. The experimental design included seven distinct experimental groups (T_1 One perforated pipe of 29.5 cm diameter, T_2 Two perforated pipe of 29.5 cm diameter, T_3 Three perforated pipe of 29.5 cm diameter, T_4 U shape perforated pipe of 29.5 cm diameter T_5 Manual turning of compost 15 day, T_6 Traditional way compost preparation and T_7 NADEP method of compost preparation). Each group is having three replications

Size of pits -The size of pits was 1x1x1 m length, width and height respectively. The pit was layered with the polythene sheet. Firstly 15 cm chopped paddy straw spread at bottom of pits. Then after this layer was moisten with 15-20 liter of water. Later 5 cm and 1 cm layer of cow dung and soil was spread over it. This sequence of layer was continued till its height reaches 15 cm above ground level. Finally this 15 cm raised layer was covered with5-10 cm thick soil.

Paddy straw, soybean straw, (126 kg of each, 5-6 cm long residue) were chopped with thresher / chaff cutter into small pieces (5-6 cm long) fielding up of the pits. 35 kg fresh cow dung and soil were taken into 5:2 ratio respectively for each pits.

Perforated Pipes- To enhance the aeration into the pits. 29.5 cm of diameter polyvinyl chloride pips were used. The hole were (2.5 cm diameter) made in the pipes for aeration. The number of holes varied according to treatments. A bulk composite sample 0.5 kg (moist) was collected for physical and chemical analysis. Randomly five samples were collected from each pit and then mixed together as a composite sample (0.5 kg from each pits). Collected samples were kept at room temperature for four weeks then analysis was carried out.

Compost sampling - The composite sample were collected at interval of 30, 60, 90 and 120 days of composting period

Estimation of total ash content

Ash contents were measured by the ignition method (Black,1965). Known quantity of compost samples were taken in previously weighed silica crucibles and burnt over an electric heater to remove the smoke. Then, the crucibles were kept inside the muffle furnace and ignited at 550°C for 4 hours. The loss of weight of the sample after ignition in the muffle furnace gave the weight of the total ash and was expressed as % on dry matter basis.

$$\%\ \text{Ash} = \frac{\text{Weight of ash + crucible} - \text{weight of empty crucible}}{\text{Weight of sample}} \text{ x } 100$$

Total organic carbon

Total organic carbon was determined by dry combustion method at 55 ^{0}C for 5 h. loss on ignition is an indicator of organic carbon content

% C = (% VS) /1.8

Where,

% Volatile Solids =100- % Ash

Lignin percent

Determination of lignin percentage was done as suggested by Goering and Van Soest, (1975). Refluxing the sample material with acid detergent solution remove the water soluble and material other than the fibrous component and left out material was weighed after filtration, dried then treated with 72% H_2SO_4 and filtered, dried then kept inside the muffle furnace and ignited at 550°C for 3 hours. Cool the crucible in desiccators. Calculate the ash content in the sample.

Given formula

% Acid Detergent Lignin =

$$\frac{\text{Weight of 72 \% H2SO4 washed fiber} - \text{Ash}}{\text{Weight of sample}} \text{ x } 100$$

Cellulose percent

Determination of cellulose was done as described by Rowland and Roberts (1994)

RESULT AND DISCUSSON

Colour was observed at end of the composting period. Dark brown colour was found one perforated pipe (T_1), two perforated pipe (T_2), three perforated pipe (T_3) and U shape perforated pipe (T_4) method of compost. While, the brown colour was found under NADEP (T_7), turning (T_5) and traditional (T_6) method of compost.

Dark brown colour was found which might due sun shine did not come directly because of pit was covered by thin layer of soil. However, result are supported by the Hug (1993) and Vuorinen (1999) suggested that the compost stabilizes it darkens to a dark brown or black colour.

Brown colour was comes which might due to pit was not covered and sun-shine come directly.

Total Organic Carbon Percent

the total organic carbon has significantly affected by different composting method at all the three stages *ie.* 60, 90 and 120 days with composting and 30 DAF of all the treatment showed non significant for total organic carbon percent. The highest total organic carbon percent was recorded (46.75, 42.30, 40.13 and 39.56) in the traditional (T_6) method of compost and lowest in NADEP (T_7) method of composting (46.73, 37.69, 36.41 and 35.55) which was at par with turning (T_5) method of compost (46.42, 38.90, 37.60 and 35.77) and three perforated pipe (T_3) method of compost (46.00, 39.22, 38.40 and 36.97) at 30, 60, 90 and 120 DAF, respectively.

Loss in carbon content might be due to decomposition of organic matter because in decomposition process the carbon of organic compound is oxidized to CO_2. These results are confirmed by Harada et al (1998) also.

Ash content

Percent ash content of different technique was observed at 30, 60, 90 and 120 days Percent ash content significantly affected by different composting method at all the three stages *ie.* 60, 90 and 120 DAF, respectively and 30 DAF of all the treatment showed non significant performance for ash content. Highest ash content percent was recorded in NADEP (T_7) method of compost (16.13, 32.03, 34.13 and 36.06) it was at par with the turning method (T_5) of compost (16.23, 29.96, 32.13 and 35.60) and three perforated pipe method (T_3) of composting (16.00, 23.73, 26.66 and 28.80), while the lowest ash content was recorded with traditional method (T_6) of composting (16.40, 23.73, 26.66 and 28.80) at 30, 60, 90 and 120 DAF, respectively.

The ash content kept increasing along with the composting process in all of the methods, owing to the loss of organic matter (OM) through microbial degradation. The highest ash content might be due to high aeration would have higher degradation rates. It provides the proper oxygen for the microorganism to aerobically decompose which results to higher loss of organic matter resulted to higher bulk density of material. Similar, finding also reported by Harada *et al.*(1998).

Total Nitrogen Percent

Total nitrogen of different composting technique was significantly affected by different composting method at 30, 60, 90 and 120 days. Table 4.6 shows that total nitrogen content was increases with days of interval. Highest nitrogen content was recorded in NADEP (T_7) method of compost (2.23, 2.33, 2.38 and 2.39 %) followed by turning (T_5) method of compost (2.17, 2.22, 2.27 and 2.27 %) at 30, 60, 90 and 120 days respectively. While, the lowest nitrogen content was observed in traditional (T_6) method of compost (2.0, 2.06, 2.10 and 2.13 %). Gotaas, (1956) reported the composting process fall of C/N ratio because the microorganism activities the conservation of nitrogen and transformation of carbon to CO_2 humic substance. At the end of the composting process, total nitrogen content would slightly increase. Since the rate of weight loss was increased. Higher nitrogen content in NADEP (T_7) method which, might due the proper aeration for the microorganism to aerobically decompose. Results in higher degradation rate. Further, Harada *et al.* (1998) also reported that the composting process total nitrogen content increases. Our results are same as above reports.

C/N Ratio

the carbon (C) and nitrogen (N) ratio calculated at the four stages of observation and it was noticed that lowest C/N ratio was recorded in the NADEP (T_7) method of composting (20.95, 16.17, 15.29 and 14.87) while, the highest C/N ratio was recorded in traditional (T_6) method of compost (23.37, 20.53, 19.10 and 18.57) at 30, 60, 90 and 120 DAF, respectively. The C/N ratio is considered to determine the degree of maturity of compost and to define agronomic quality of compost. Poincelot (1974) and Golueke (1981) reported that C/N ratio below 20 is indicative of acceptable maturity a ratio of (Juste, 1980). However, Hira *at al.* (1993) stated that C/N ratio cannot be used as an indicator of compost maturity. Since, it values show great variation due to the characteristics of composting techniques. Our results were in agreement with the above reports. Analysis showed that NADEP (T_5) method of compost had a lowest C/N of 15.12 followed by turning (T_5) method of compost.

Cellulose content (%)

Cellulose content was also observed at 30, 60, 90 and 120 DAF. The Cellulose % decreases with the time interval. Cellulose % significantly affected by different composting method at all the four stages *i e.* 30, 60, 90 and 120 days of observation. The lowest cellulose content was recorded (14.33, 13.66, 11.0 and 9.66) on the NADEP method (T_7) of compost. However, it was at par with turning method of compost (16.66, 14.00, 11.66, and 10.0) at 30, 60, 90 and DAF, respectively. While the highest cellulose content % was found in traditional method (T_6) of composting (19.0, 18.0, 15.3 and 13.33 %).High temperature favors cellulose degradation and growth of cellulolytic bacteria (Stutz *et al.* 1970 and Gazi *et al.*, 2007).

Lignin Per cent

Lignin content was recorded at 30, 60, 90 and DAF. Lignin content increased with day of composting period .Different composting technique significantly affected the per cent lignin content at all the three stages of in observation except 30 DAF showed no significant performance for lignin per cent. The highest lignin content was recorded (15.50, 26.66, 30.00 and 35.0 %) in the NADEP (T_7) method of composting. It was at par with the turning method of compost (14.50, 22.7, 29.6 and 33.0 %) while, the lowest lignin content was recorded in traditional method (T_6) of composting (14.20, 18.33, 22.40 and 23.0 %) at 30, 60, 90 and 120 DAF, respectively. the average value of lignin had increased due to aeration rate. Freeman *et al.* (2001) reported that the important enzymes in the process of lignin ion polyphenolic decomposition and contribute to the enzymes letch concept in which phenon oxide ions other hydrolytic enzymes are inhibited by low o_2 level, slowing carbon mineralization. Howevere, Van Soest, (1994) suggested lignin degradation is primarily an aerobic process, and in and anaerobic environment lignin can persist for very long period result in slow microbial degradation further Manna *et al.* (2000), and Harada *et al.* (1998) reported that the lignin content increased with maturation of composting time. Our results were in agreement with the above reports.

Lignin /nitrogen ratio

The Lignin /Nitrogen (L/N) ratio was calculated at all the four stages of observation and it was noticed that highest L/N ratio was recorded in NADEP method of composting (T_7) (9.95, 11.43, 12.56 and 14.64). While, lowest ratio was recorded in traditional method (T_6) (7.10, 8.86, 10.66 and 10.78) at 30, 60, 90 and 120 DAF, respectively.

Cation Exchange Capacity

Cation exchange capacity (CEC) of different composting technique was observed at 30, 60, 90 and 120 days after pit filling. The average values of CEC of these composting materials increased with time and different method of composting. The CEC has significantly affected by different composting method at all the three stages *ie.* 60, 90 and 120 days of composting, while 30 DAF showed no significant performance for Cation exchange capacity. The highest CEC was observed in NADEP (T_7) method of compost (41.00, 51.00, 67.00 and 90.66 C mol (p^+) kg $^{-1}$) and it was at par with the turning (T_5) method of compost (40.00, 47.00, 60.33 and 88.33 C mol (p^+) kg $^{-1}$). While the lowest CEC was recorded in traditional (T_6) method of compost (33.00, 40.00, 50.33, and 64.00 C mol (p^+) kg $^{-1}$) at 30, 60, 90 and 120 days after composting, respectively.

At the end of maturation that is at the completion of decomposition process the compost become fully matured this is evident from the increase in values of CEC. The results are in conformity with those of Mathur *et al.* (1993).

The high CEC in NADEP (T_7) method which might be due to aerobically microbiological decomposition due to proper aeration results in the greater loss of weight and greater increase of humic substances yielding greater CEC similar founding also reported by Lux *et al.* (1986).

CEC/ TOC Ratio

The cation exchange capacity (CEC) and Total organic carbon ratio (TOC) calculated at all the four (30, 60, 90 and 120 days) stages of observation and it was noticed that highest CEC/TOC ratio was recorded on the NADEP(T_7) method of composting (0.87, 1.35, 1.84 and 2.55). While the lowest ratio was recorded in traditional (T_6) method of compost (0.70, 0.94, 1.25 and 1.61) at 30, 60, 90 and 120 DAF, respectively. The CEC/TOC ratio can be useful as an index of maturity. This observation is in accordance with those of Lux *et al.* (1986).

Cost Economics of Different Composting Technique

As evident from the results obtained the maximum cost of production (553.75 Rs/pits) was calculated with NADEP method and minimum cost of production (212.00 Rs/pits) with traditional method of composting were estimated. In between the two cost of production followed with turning method , three perforated pipe method, U shape perforated pipe method, two perforated pipe method, and One perforated pipe method with (470.5 Rs/pit), (508.00 Rs/pit), (459.5 Rs/pit), (407.5 Rs/pit) and (310.00 Rs/pit), with cost of production, respectively. However, the frequency of NADEP method was recorded highest with preparation of composting within 4 months followed by turning method of composting.

The highest duration for composting was recorded 8-10 month with traditional method of composting as far as preference of the method for composting was recorded, it was concluded that NADEP method (T_7) should be preferred over traditional method (T_6) and all other methods of composting as it gives earliness and bulk composting can be obtained as the composting method of only 4 months duration which will enable to get 3 composting annually compared to others which facilitates only one or twice composting annually.

Cost benefit analysis does not show positive result with current year analysis as in pre investment stage infrastructure investment is included which is much higher than production profit / benefit so with long term production it may be mitigate with benefits pre-investment is recovered and after some stage it will show purely benefit projection.

Table 1. Effect of total nitrogen content on different composting techniques at 30, 60, 90 and 120 days

Treatment	Total nitrogen percent			
	30	**60**	**90**	**120**
I perforated pipe method	2.02	2.12	2.17	2.18
II perforated pipe method	2.11	2.17	2.19	2.21
III perforated pipe method	2.07	2.18	2.21	2.22
U Shape perforated pipe method	2.14	2.18	2.20	2.20
Turning method	2.17	2.22	2.27	2.27
Deshi method	2.00	2.06	2.10	2.13
NADEP method	2.23	2.33	2.38	2.39
SEm ±	**0.03**	**0.05**	**0.02**	**0.02**
CD	**0.11**	**0.17**	**0.08**	**0.08**

Table 2. Effect of cellulose content with day of intervals at 30, 60 90 and 120 days

Treatment	Cellulose percent			
	30	**60**	**90**	**120**
I perforated pipe method	17.66	16.33	13.00	11.00
II perforated pipe method	17.00	15.33	12.66	11.33
III perforated pipe method	16.66	14.33	11.66	10.73

U Shape perforated pipe method	17.00	14.66	12.00	10.90
Turning method	16.66	14.00	11.66	10.00
Deshi method	19.00	18.00	15.33	13.33
NADEP method	14.33	13.66	11.00	9.66
SEm ±	**0.73**	**0.86**	**0.66**	**0.62**
CD	**2.22**	**2.61**	**2.02**	**1.88**

Table 3. Changing of CEC/TOC ratio with day of interval at 30, 60, 90 and 120 days of composting period

Treatment	**CEC/TOC**			
	30	**60**	**90**	**120**
I perforated pipe method	0.79	1.02	1.33	1.95
II perforated pipe method	0.81	1.07	1.38	2.12
III perforated pipe method	0.84	1.15	1.52	2.36
U Shape perforated pipe method	0.83	1.16	1.45	2.25
Turning method	0.86	1.20	1.60	2.46
Deshi method	0.70	0.94	1.25	1.61
NADEP method	0.87	1.35	1.84	2.55

Table 4. Effect of total nitrogen content on different composting techniques at 30, 60, 90 and 120 days

Treatment	**Total nitrogen percent**			
	30	**60**	**90**	**120**
I perforated pipe method	2.02	2.12	2.17	2.18
II perforated pipe method	2.11	2.17	2.19	2.21
III perforated pipe method	2.07	2.18	2.21	2.22
U Shape perforated pipe method	2.14	2.18	2.20	2.20
Turning method	2.17	2.22	2.27	2.27
Deshi method	2.00	2.06	2.10	2.13
NADEP method	2.23	2.33	2.38	2.39
SEm ±	**0.03**	**0.05**	**0.02**	**0.02**
CD	**0.11**	**0.17**	**0.08**	**0.08**

Table 5. Effect of lignin content at 30, 60, 90 and 120 days of composting period

Treatment	**Lignin percent**			
	30	**60**	**90**	**120**
I perforated pipe method	14.23	19.83	22.83	28.33
II perforated pipe method	14.76	21.00	24.66	29.00

III perforated pipe method	15.06	21.70	26.53	30.66
U Shape perforated pipe method	14.50	21.40	25.56	29.33
Turning method	14.50	22.76	29.6	33.00
Deshi method	14.20	18.33	22.40	23.00
NADEP method	15.50	26.66	30.00	35.00
SEm ±	**-**	**1.02**	**1.69**	**0.89**
CD	**NS**	**3.10**	**5.13**	**2.72**

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