The Pharma Innovation Journal 2018; 7(8): 31-34

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(8): 31-34

www.thepharmajournal.com
Received: 17-06-2018
Accepted: 19-07-2018

R Verma
Department of Soil Science and Agricultural Chemistry, SKN College of Agriculture, Jobner, Rajasthan, India

WP Badole
Agricultural Chemistry and Soil Science Section, College of Agriculture, Nagpur, Maharashtra, India

P Deewan
Department of Agronomy, SKN College of Agriculture, Jobner, Rajasthan, India

M Jajoriya
Department of Soil Science and Agricultural Chemistry, SKN College of Agriculture, Jobner, Rajasthan, India

Correspondence
R Verma
Department of Soil Science and Agricultural Chemistry, SKN College of Agriculture, Jobner, Rajasthan, India

Comparative study on granule size, humic substances, recovery and economics of wheat straw compost by different methods of composting

R Verma, WP Badole, P Deewan and M Jajoriya

Abstract
An experiment was conducted at college of agriculture, Nagpur during 2006-07 on comparative study the different methods of composting by using wheat straw. The experiment was laid out by randomized block design in seven treatments and replicated thrice. The different methods of composting were significant effect on granule size, humic substances, recovery and economics of wheat straw compost at maturity. The significantly highest humic and fulvic acid were recorded in Nagpur method (3.28 and 23.21%) followed by MA method (3.02 and 23.19%) and lowest in local method (1.66 and 20.34%), at maturity of compost. The recovery of compost was maximum in aerobic composting methods i.e. Nadep (54.33%), MA (48.52%), Nagpur (48.24%) and Heap (46.72%) than anaerobic composting methods i.e. Trench (42.95%), Pit (41.46%) and Local (27.99%). On the basis of initial construction cost the economics worked out, the maximum gross and net monetary return were recorded in Nagpur and MA composting methods Nadep, Trench, Pit, Heap and Local methods of composting. Similarly, maximum benefit: cost ratio was recorded by Nagpur and Ma (1.60) compost methods over other methods of composting.

Keywords: Granule size of mature compost, humic substances, recovery of compost, composting methods, wheat straw compost

Introduction

compost can be defined as the stabilized and sanitized product of composting, which has undergone an initial, rapid stage of decomposition, is beneficial to plant growth and has certain humic characteristics, making the composting of waste a key issue for sustainable agriculture and resource management (Gajalakshmi and Abbasi, 2008) [7] Composting is the natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting. Compost is a rich source of organic matter. Soil organic matter plays an important role in sustaining soil fertility, and hence in sustainable agricultural production. In addition to being a source of plant nutrient, it improves the physico-chemical and biological properties of the soil (Mahimairaja, S., 2008) [16]. Composting is becoming an increasingly important element of environmentally sound sustainable agriculture (Gorttappech, *et al.,* 2000) [9]. Composting is improved handling characteristics of manure by reducing volume and weight (Willson and Hummel, 1975) [24].

One way of improving the quality of applied wastes is composting, Benefits of composting range from a decrease in weight and volume of organic wastes, recycling of nutrients, maintaining or restoring organic matter and other important soil physical characteristics, reduction in land flling problems, and biodegradation of toxic compounds and other organic contaminants (Gomez, 1998) [8]. The result is the creation of a valuable, stable, end product through the increase of nutrient retention and availability, cation exchange capacity, humic components, vitamins, enzymes, antibiotics and growth hormones that serve as a source of organic matter (Sesay *et al.*, 1997) [21]. Quantification of amount of nutrient, carbon and weight loss during composting in field conditions is important to understanding the composting process and implementing methods for conservation of nutrients to reduce potential adverse environmental impacts. Total and runoff loss of nutrient, carbon, and weight during composting of wheat straw has not been quantified (Martins and Dewes, 1992) [17]. The objective of this study was to determine the amount of nutrient, carbon, and weight loss during composting of wheat straw by different methods. Now-a-days composting is becoming an increasingly important element of environmentally sound sustainable agriculture (Javed Akhtar, M., 2007) [14]. There are number of composting methods developed throughout the India amongst which Nadep, Indore and Bangalore method were popularly known but there are some limitations with these methods for proper composting. Therefore, the present investigation was aimed to develop new methods, which are easily adoptable by farmers, cheaper and cost effective; hence, these methods are compared with Nagpur compost method and MA (middle aeration) compost method newly developed by College of Agriculture, Nagpur.

Methods and materials

Comparative study of different methods of composting with wheat straw was conducted to study the effect of these methods on granule size, humic substances, recovery and economics during composting. Research work was carried during 2006-07 at Department of Animal Husbandry and Dairy Science farm, College of Agriculture, Nagpur with seven treatments viz., T1: Nadep compost method, T2: Nagpur compost method, T3: Ma (Middle aeration) compost method, T4: Trench compost method, T5: Pit compost method, T6: Heap compost method, T7: Local compost method, replicated thrice in RBD design. Common dose of cow dung and gypsum was added in each treatment @ 12.50 kg/tonne on oven dry basis (75 kg/tonne on wet basis) and gypsum @ 1% (10 kg/tonne). The cow dung and gypsum was mixed thoroughly in water and volume made 750 liters and then approximately 10% slurry in Nadep compost method (214 L), Nagpur compost method (184 L) and Ma compost method (184 L), Trench compost method (88 L) and Pit compost method (33 L), Heap compost method (14 L) and Local compost method (33 L) was sprinkled evenly on each layer of wheat straw. Before sprinkling slurry wheat straw was made wet by sprinkling about 40% of water over it. The pits were filled 1 ft. above top level and covered completely with soil + cow dung slurry. The granule size was determined from compost by sieve method using the different size of sieve as 2 mm, 1 mm, 0.5 mm, 0.25 mm and 0.1 mm weighted separately and calculated it (Leege and Thompson, 1997) [15]. Humic substances were determined from compost by centrifuging method with 0.5N NaOH solution followed by decantation and drying on hot water bath at 400C (Stevenson, 1982) [22] and recovery of composting methods was also estimated/calculated at compost maturity on that basis weight losses during composting. Economic studies of compost is based on the recovery of compost, gross monetrery return, net monetrery return, B:C ratio and initial construction cost of compost pit and cost of material used for composting. The compost produced from a ton of wheat straw and cost of its production was worked out by considering the cost of materials used for composting. Similarly, the gross monetary return was worked out by considering the local market price of the compost and accordingly net monetary return and benefit: cost ratio was worked out. The economics was calculated on the basis of raw material used for composting as cotton waste (Rs. 400 / ton), wheat straw (Rs. 500/ton), dry grass (Rs. 600/ton), cow dung (Rs. 500/ton), gypsum (Rs. 1200/ton) and labour (Rs. 300 each) and output of composting methods was also calculated on the basis of sale of compost with the cost as Nadep compost (Rs.500/ton) and other compost (Rs. 2500/ton).

Recovery of compost: It was done by sieving the decomposed organic residue through 5 mm sieve. The fully decomposed and partially decomposed organic residue was separately recorded and on that basis recovery of the compost was estimated.

$$\text{Recovery (\%)} = \frac{\text{Weight of fully decomposed compost}}{\text{Weight of total material taken}} \times 100$$

Statistical analysis: The data of various observations was analyzed by the standard statistical method. The null hypothesis was tested by F–test of significance to know whether treatments effect were real or not. The standard error (S.E.) and critical difference (C. D.) at 5% level was computed wherever ´F´ test was significant (Panse and Sukhatme, 1985) [19].

Result and Discussion

Effect on percent granule size: In the composting process, decomposition and microbial activity were rapid near the surface, as oxygen diffusion rate is very high, small particles have more surface area and can degrade more quickly (Hang, 1993) [12]. Since the microorganisms grow primarily on substrate surface, the availability of the substrate to the microorganism is a function of the surface area of the particles (Nakasaki *et al.*, 1987) [18]. A uniform mixture with relatively small, consistent particle increases the value of end product (Angers and Recous, 1997) [2]. The Leege and Thompson (1997) [15] have proposed to use 6 sieves and using both air dried/oven dried samples. Aerobic decomposition increase with smaller particle size, however smaller particle size reduces the effectiveness of the oxygen supply. The most preferable size of compost at maturity is 3 mm to 5 mm diameter. At the end of the process, the bulk density of compost would be expected to increase due to breakdown in the particle size of the material, resulting is more compact compost (Dey *et al.*, 1998) [6]. The granule size of matured compost was significantly influenced and maximum percentage of surface size was reduced in 0.5 mm followed by 1 mm, 2mm, 0.25 mm and 0.10 mm (table-1). The significantly maximum % granules diameter was reduced in MA method (40.33%) followed by Nagpur method (35.66%). Similar results were found by Hardy and Sivasithamparam, (1989) [11] and Villar *et al.*, (1993).

Effect on humic substances: Humic and fulvic acid content in wheat straw compost were significantly influenced by different methods of composting at the maturity and also the stability index parameter of the compost, respectively. During the composting, the content of amino acid N and amino sugar N increased in the wheat straw during the composting process by mineralization of organic matter and by incorporation of the added N is into microbial biomass and that metabolites. The increasing decay of wheat straw was accompanied by an accumulation of microbial tissue and reduced accessibility of the substrate to the microorganisms, as indicated by an increased quantity of humic and fulvic acids in compost during composting (Bannick and Ziechmann, 1991) [4]. Humic and fulvic acid are the most active fractions of organic matter. It has been demonstrated that the fluorescent intensity of humic acid and fulvic acid increased with decreasing molecular size (Aoyama, 2001) [3]. The fulvic acid fraction mineralized over twice as fast as the humic acid fraction, but less than one-third. The humification ratio was the percentage of total extractable humic-C as related to the total organic-C and reported that the total content of humic material extracted from separated cattle manure compost increased from 377 g/kg to 710 g/kg in organic matter. Humic material increased rapidly during the first 60 days and from 60 to 140 days, changed very gradually during the composting (Campbell *et al.*, 1967) [5]. The humic and fulvic acid were increased significantly upto the maturity of compost. The significantly highest humic and fulvic acid was recorded in Nagpur method (3.28 and 23.21%) followed by MA method (3.02 and 23.19%) and lowest in local method (1.66 and 20.34%), at maturity of compost (175 days). Similar results were reported by Velasco, (2004) [23], Qualls, (2004) [20], Hanninen *et al.*, (1995) [10] and Hue and Liu, (1996) [13].

Recovery of compost: The recovery of compost was worked out at complete maturity of compost *i.e.* at 175 days of incubation of wheat straw. The results were statistically significant on recovery of fully decomposed wheat straw compost (Table-2). Maximum recovery of compost was in all aerobic methods than anaerobic composting methods. The significantly maximum recovery of compost was recorded in Nadep method (54.31%) over all other composting methods followed by MA (48.52%), Nagpur method (48.24%) and Heap method (46.72%) over anaerobic methods i.e. Trench method (42.95%), Pit method (41.46%) and Local compost method (27.99%). In aerobic method, the yield of manure obtained was up to 38 to 47% (Acharya, 1939) [1].

Economic of different composting methods: Economics from wheat straw composting by different methods was significantly influenced due to following factors i.e. moisture, aeration, chemical and bio-inoculants, temperature, pH and EC, climatic condition etc. The results were found statistically significant and the data is presented in table 2. The quantity and quality of compost produced was significantly influenced due to methods of composting and significantly, maximum production of compost for a ton of wheat straw was recorded by Nadep compost method over all other composting methods. The maximum production of compost in the Nadep method was associated with the addition of soil in it. Nadep methods was produced significantly maximum compost produced followed by Nagpur and MA methods over Trench, Pit, Heap and Local methods of composting. On contrary significantly maximum gross and net monetary return and B:C ratio were recorded by Nagpur compost method (Rs. 2219.25, 833.24 and 1.60) over all other methods of composting except MA compost (Rs. 2217.17, 829.67 and 1.60) respectively. The significantly maximum B:C ratio 1.60 was recorded by Nagpur and MA compost method, respectively. In this method, we get additional benefits of Rs. 430.84 to 427.27l over Nadep compost method. The quality of compost of Nagpur and MA compost methods was also superior than Nadep, Trench, Pit, Heap and Local methods of composting.

Table 1: Effect of composting methods on granules size and humic substances of wheat straw compost at maturity

Composting methods	Granules size (%)					Humic substances (%)	
	2 mm	1 mm	0.5 mm	0.25 mm	0.10 mm	Humic acid	Fulvic acid
T-1 Nadep	20.16	16.33	34.50	13.66	11.00	1.92	21.82
T-2 Nagpur	17.83	24.00	35.66	11.50	6.50	3.28	23.21
T-3 Ma	12.5	17.33	40.33	13.16	10.66	3.02	23.19
T-4 Trench	13.33	17.83	38.16	14.16	10.83	2.36	22.17
T-5 Pit	15.83	18.66	34.50	14.33	11.33	2.65	20.86
T-6 Heap	17.00	19.50	28.50	16.00	11.50	2.64	20.88
T-7 Local	18.16	21.66	31.66	12.00	10.83	1.66	20.34
S.E.(m) ±	0.376	0.325	0.239	0.551	0.223	0.016	0.042
C.D. (p=0.05)	1.159	1.002	0.739	1.698	0.687	0.049	0.128

Table 2: Effect of composting methods on Recovery and economics of wheat straw compost at maturity

Composting methods	Total material taken for composting (Kg/Pit)	Production of compost (Kg/pit)	Recovery of compost (%)	Cost of compost production (Rs.)	Gross monetary return (Rs.)	Net monetary return (Rs.)	B:C ratio
T-1 NADEP	2118.5	1150.6	54.31	1324	1726.40	402.40	1.30
T-2 Nagpur	1840	887.7	48.24	1386	2219.25	833.24	1.60
T-3 MA	1840	890.2	48.38	1386	2217.17	829.67	1.60
T-4 Trench	877	376.3	42.95	632	941.75	309.75	1.49
T-5 Pit	329	136.4	41.46	260	341.00	81.00	1.31
T-6 Heap	128	59.8	46.72	130	149.50	19.50	1.15
T-7 Local	329	92.1	27.99	254	230.25	23.75	0.91
S.E.(m) ±	-	0.395	0.215	-	2.986	2.644	0.006
C.D. (p=0.05)	-	1.217	0.663	-	9.204	8.152	0.017

Conclusion

Composting is a self-decomposition process so that the granule size increased and reduced in the anaerobic composting methods than aerobic methods. All these methods high quality compost products were obtained from middle aeration (MA) and Nagpur compost methods the cow dung slurry inoculation was the most potential, so it is recommended to accelerate the biological process. Moreover, inoculated composting methods enhanced quality of compost in the final product. Nagpur and MA compost method improved the quality of compost by humic acid, fulvic acid increased and reduced the granule size in the anaerobic composting methods than aerobic methods. Considering the recovery and economics of the compost produced, maximum compost was produced by aerobic methods i.e. Nadep, Nagpur, Ma and Heap composting method than anaerobic method like Trench, Pit and Local. The maximum net monetary return and Benefit: Cost ratio was recorded by Nagpur and Ma composting methods. The MA (middle aeration) method have very low initial investment (Rs. 1440/) as compared to Nadep (Rs.10000/-) and Nagpur method (Rs.6170/-).

Acknowledgement
Rajhans Verma conducted a field trail to prepared wheat straw compost adopting different methods of composting and their analysed for quality characteristics under the supervision of W.P. Badole. First draft of the manuscript was written by Rajhans Verma and subsequently, manuscript was revised by Parvati Deewan and M. Jajoriya.

Reference
1. Acharya CN. Comparison of different methods of composting waste materials. Indian Journal of Agril. Sci. 1939; 9:565-572.
2. Angers DA, Recous S. Decomposition of wheat straw and rye residues as affected by particle size. Plant and Soil. 1997; 189(2):197-203.
3. Aoyama M. Do humic substances exhibit florescence understanding and managing organic matter in soil, sediments and waters. Proceeding of the 9th International conference of the International Humic Substances Society University, of Adelaide, Australia, 21st - 25th September, 1998, 2001.
4. Bannik CG, Ziechmann W. Huminstaffbidung wahrendder kompostierung. Zpflanzenernahr Bodebnkd, 1991; 154:233-236.
5. Campbell CA, Paul EA, Rennie DA, McCallum CJ. Factors affecting the accuracy of the carbon dating methods in soil humus stusies. Soil Science. 1967; 104:81-85.
6. Day M, Krzymien M, Shaw K, Zaremba L, Wilson WR, Botden C *et al*. An investigation of the chemical and physical changes accuring during commercial composting. Compost Science and Utilization. 1998; 6(2):44-66.
7. Gajalakshmi S, Abbasi SA. Solid waste management by composting: state of the art. Crit. Rev. Environ. Sci. Technol. 2008; 38:311-400.
8. Gomez A. The evaluation of compost quality. Trends in Analytical Chemistry 1998; 17:310-314.
9. Gorttappech AH, Ghalavand A, Ahmady MR, Mirnia SK. Effect of inorganic and organic fertilizer on quantitative and qualitative traits of different cultivars of sunflower (*Hellianthus annus* L.). Iran J Agri. Sci. 2000; 6(2):85-104.
10. Hannien KI, Kovalainen JT, Korvola J. Carbohydrates as chemical constituents of bio-waste composts and their humic and fulvic acids. Compost Science and Utilization, 1995; 3(4):51-68.
11. Hardy GEJ, Sivasithamparam K. Microbial, chemical and physical changes during composting of eucalyptus (*Eucalyptus calophylla* and *Eucalyptus diversicolor*) bark mix. Biology and Fertility of Soils, 1989; 8:260-270.
12. Haug RT. The practical handbook of compost engineering. Lewis Publishers, Boca Raton, Florida, 1993, 717.
13. Hue NV, Liu J. Predicting composting stability. Compost Science Utilisation, 1996, 8-15.
14. Javed Akhtar M, Asghar HN, Asif M, Zahir ZA. Growth and yield of wheat as affected by compost enriched With chemical fertilizer, l-tryptophan and rhizobacteria. Pak. J Agri. Sci. 2007; 44(1):136-141
15. Leege PB, Thompson WH. Test methods for the physical examination of compost and composting. In: Test Methods for the Examination of Composting and Compost, U.S. Composting Council, 1997.
16. Mahimairaja S, Dooraisamy P, Lakshmanan A., Rajannan G, Udayasoorian C, Natarajan S. Composting technology and organic waste utilization in Agriculture. A. E. Publications, P. N. Pudur, Coimbatore, 2008.
17. Martins O, Dewes T. Loss of nitrogenous compounds during composting of animal wastes. Bioresour. Technol. 1992; 42:103-111.
18. Nakasaki K, Nakano Y, Akiyama T, Shoba M, Kubota H. Oxygen diffusion and microbial activity in the composting of dehydrated sewage sludge cakes. J Fermentation Technology, 1987; 65(1):43-48.
19. Panse VG, Sukhatme PV. Statistical method for agriculture workers. Published by Publication and Information Divison, ICAR, New Delhi, 1985.
20. Qualls RG. Biodegradability of humic substances and other fractions of decomposting leaf litter. J Am. Soc. Soil Sci. 2004; 68:1705-1712.
21. Sesay AA, Lasaridi K, Stertiford E, Budd T. Controlled composting of paper sludge using the aerated static pile method. Compost Science and Utilization, 1997; 5:82-96.
22. Stevenson FJ. Humus chemistry. Jhon Wiley AND Sons, New York, 1982, 196.
23. Velasco MI, Campitelli PA, Ceppi SB, Havel J. Analysis of humic acid from compost of urban wastes and soil by florescence spectroscopy. AGRISCI-ENTIA. 2004; 23(1):31-38.
24. Willson GB, Hummel JW. Conservation of nitrogen in dairy manure during composting. In Managing livestock wastes. Proc. 3rd Int. Symp. on Livestock Wastes, Urbana- Champaign. 21-24 April 1975. ASAE, St. Joseph, MI, 1975, 490-496.