An Asian Journal of Soil Science
Volume **12** | Issue 1 | June, 2017 | 66-70 | e ISSN–0976–7231 ■ Visit us : www.researchjournal.co.in

Research Article

DOI : 10.15740/HAS/AJSS/12.1/66-70

Quality evaluation of chemically-enriched compost, vermicompost and conventional compost

■ SYED SHUJAT HUSSAIN, JAHANGEER A. BABA, MOHD ZUBAIR, RUHUL NISSA AND F.A. MISGER

Received : 31.01.2017; **Revised :** 14.04.2017; **Accepted :** 26.04.2017

MEMBERS OF RESEARCH FORUM:

Corresponding author :
SYED SHUJAT HUSSAIN, Krishi Vigyan Kendra, Extension Training Centre (SKUAST-K.) Malangpora, PULWAMA (J&K) INDIA
Email: drshujat07@ gmail.com

Co-authors :
JAHANGEER A. BABA, MOHD ZUBAIR, RUHUL NISSA, F.A. MISGER Krishi Vigyan Kendra, Extension Training Centre (SKUAST-K.) Malangpora, PULWAMA (J&K) INDIA

Summary

The main objective of conducting the current study was to evaluate the chemical compositions of different chemically-enriched composts prepared by the methods of pit and heap and compare it with conventional compost. The various composts *viz.,* phosphocompost (PC), nitrogen-enriched phosphocompost (NPC), phosphorus-enriched vermicompost (PVC) and vermicompost (VC) were compared with conventional compost. These composts were produced by using chemical amendment in case of chemically- enriched compost whereas vermicompost was prepared by inoculating the epigeic earth worms (*Eisenia foetida*) with and without rock phosphate. Mineral matter content, ash and moisture were higher in all enriched composts and vermicompost in comparison to conventional compost whereas as total organic carbon, water soluble carbon and C: N were higher in conventional compost. There was higher variation in the content of nutrients in different composts as that of the conventional one but nitrogen and phosphorus were higher in nitrogen enriched phosphorus-compost and phosphorus enriched vermicompost. Zinc was higher in nitrogen enriched phosphorus-compost, vermicompost and phosphorus enriched vermicompost whereas manganese was higher in vermicompost and phosphorus enriched vermicompost. The time period of decomposition was almost similar (120±5) among the enriched composts, whereas in case of conventional compost, decomposition period was (160±10). Biochemical quality stated that conventional compost had lesser amount of total phenol, alkaline and acid phosphatase enzyme activity but higher dehydrogenase activity than those of enriched composts. The more dehydrogenase activity in conventional compost is an indicator of partial decomposition of the compost. The vermicompost was better than conventional compost; it could be still further improved by rock phosphate enrichment.

Key words : Earth warm, Conventional composts, Chemically-enriched compost, Biochemical quality, Enzymes, Time period

How to cite this article : Hussain, Syed Shujat, Baba, Jahangeer A., Zubair, Mohd, Nissa, Ruhul, and Misger, F.A. (2017). Quality evaluation of chemically-enriched compost, vermicompost and conventional compost. *Asian J. Soil Sci.,* **12** (1) : 66-70 : **DOI : 10.15740/HAS/AJSS/12.1/66-70.**

Introduction

Widespread, serious and continuing degradation of India's natural resource base is now reflected in increasing difficulties in achieving growth rates in agriculture. Over 120 million hectares have been declared degraded or problem soils (National Academy of Agricultural Sciences, 2010). But this seems to be a minor problem in the face of the massive and prolonged loss of organic matter and C in most of the arable lands in India, which have been under the plough for over 2000 years (Royal Commission on Agriculture in India, 1976). Given that for the country in general, crop response or incremental yield per unit of nutrients tends to be lower with increasing fertilizer use per hectare, the evidence for soil organic matter depletion being a prime cause for declining soil health and soil productivity is mounting (Sharda *et al.*, 2010).

Due to the increasing cost of chemical fertilizers and concern for sustainable soil productivity and ecological stability have been emerged as important issues in Asia, so the search for alternative sources of plant nutrients is imperative (Aulakh and Singh, 1997). The diversification of organic sources of plant nutrients as different composts is becoming popular these days and has become an important input in the integrated use of plant nutrient resource sustainability (Rajesh *et al*., 2003). In agricultural and horticultural fields, the recycling of crop residues makes significant contribution in improving the soil properties and crop productivity. Low organic matter is one of the major constraints affecting the productivity of the soils. Organic matter is an important component in improving soil properties and sustaining the productivity of soils in temperate regions where there is a low input of organic matter (Kumar *et al*., 2014). Composts affect crop growth and yield either directly by supplying nutrients or indirectly by modifying soil properties and stimulating plant growth (Darwish *et al*., 1995). Increasing the decomposition of organic wastes by enrichment of chemical amendment like rock phosphate, pyrite and urea are some of the modern developments in composting technology. The chemical enrichment accelerates the breakdown of organics into the soluble and mineralized nutrient forms.

Composting has been recognized as a low cost and environmentally sound process for treatment of many organic wastes (Hoitink, 1993). Compost-treated soils had lower pH and increased levels of organic matter, primary nutrients and soluble salts (Bevacqua and Mellano, 1993). Other benefits from the use of compost include the possible reduction of hazards from nitrate leaching into groundwater compared to those from inorganically fertilized controls (Maynard, 1989). Furthermore, composting and composts have been reported to suppress plant pathogens.

The overall phosphorus and nitrogen use efficiency of applied nitrogen and phosphate inorganic fertilizer is lower than optimal either because of the formation of insoluble P compounds in soil or leaching of highly soluble nitrogen forms (Prasad, 2014 and Chintala *et al*., 2013). Although composting is an old technique, but improving its nutritional and quality status by blending it with inorganic N (urea), rock phosphate and biologically active substance is a novel approach. Keeping in view, the situation with reference to organic nutrient sources, low fertility index and low productivity potential, it is directly needed that use of composts enriched with different elements be promoted. Thus, the present study was undertaken to assess the quality of different enriched composts and their impact on crop yield.

Resource and Research Methods

Raw materials of paddy straw and fresh cow dung were collected and mixed in the ratio of 1:1 on dry weight basis for making of different types of composts. Conventional compost (CC), phospho compost (PC), nitrogen enriched phosphocompost (NPC), vermicompost (VC) and phospho enriched vermicompost (PVC) were prepared in the pits. For PC, rock phosphate (2.5% P_2O_5) and AG pyrite (5%) were applied, for NPC in addition to enrichment of rock phosphate (2.5% P_2O_5) and pyrite (5%), the nitrogen (0.5%) was added as urea. For preparation of VC (*Eisenia foetida*) earthworms were introduced to partially decompose organic matter in the pit after 50 days when the temperature reached 28 to 32^{o}C. In PVC, rock phosphate (2.5% P_2O_5) was applied at the time of earthworm inoculation. The dimension of the heap was about 0.5m high, 1.0m wide and 2.0m long. In VC and PVC, one thousand earthworms were inoculated per square meter on the 50th day after the start of the experiment. The decomposition period of PC, NPC, VC and PVC was similar (120±5days) while for CC it was (160±10 days).

Nutrient composition and moisture content in raw materials were analyzed by following the procedures of association of official agricultural chemists (A.O.A.C., 1970). The total organic carbon in the compost was determined by dry combustion at 600^{o}C for 8 hours and the per cent of carbon was calculated following the equation explained (Waggoner, 1972 and Chintala *et al*., 2013). Water soluble carbohydrates (WSC) were analyzed by using the method of Brink *et al.* (1960). The nitrogen content in the compost sample was determined by Macro- Kjeldahl method (Jackson, 1973). Phosphorus, potassium and micronutrients were determined by using 1 g of dry compost sample and digested with tri-acid mixture (HNO_3:$HClO_4$:H_2SO_4in 9:3:1 ratio) on a hot plat at 180-200°C. Phosphorus extracted solution was estimated by spectrophotometer method (Jackson, 1973), potassium was determined by flame photometer method given by Toth *et al*.(1948) and the micro-nutrients (Zn,Mn, Cu and Fe) were estimated by using atomic absorption spectrophotometer method (Lindsay and Norvell, 1978). Lignin and cellulose content was fractioned by following the procedure given by (Rowland and Roberts, 1994). The total phenol content, dehydrogenase enzyme activity and acid-alkaline phosphate activities in compost samples were estimated by using recommended methods (Bray and Thrope, 1954; Casida *et al*., 1964 and Tabatabai and Bremner, 1969).

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Quality evaluation of different composts :

Raw materials of paddy straw and fresh cow dung used for composting were analyzed for characterization of constitutions like ash, total organic carbon, total N, C:N, total phenol, lignin,cellulose and L/C ratio. The data showed (Table 1) that the initial composition of paddy straw was ash6.05 per cent TOC 43.2 per cent, TN0.75 per cent C/N ratio 57.6, phenol 46.5µg^{-1}, Lingnin 10.5 per cent, cellulose 36.5 per cent and L/C 3.45, whereas in cow dung these values were 28 per cent, 34.5 per cent, 0.59 per cent 58.5,15.5µg^{-1},8.03 per cent, 13.4 per cent and 0.60, respectively

Chemical compositions of diverse composts at the completion of decomposition processes were assessed and results are shown in Table 2. There was no significant

Table 1: Initial chemical composition of paddy straw and cow dung used for composting

Raw materials	Ash (%)	Total C (%)	Total N (%)	C/N ratio	Phenol (µg^{-1})	Lignin (%)	Cellulose (%)	L/C ratio
Paddy straw	6.05	43.2	0.75	57.6	46.5	10.5	36.3	3.45
Cow dung	28.0	34.5	0.59	58.5	15.5	8.03	13.4	0.60

Table 2: Chemical compositions of different composts at the final stage of decomposition

Composts*	Moisture (%)	WSC g kg^{-1}	Ash (%)	TC g kg^{-1}	C/N Ratio	N g kg^{-1}	P_2O_5 g kg^{-1}	K g kg^{-1}	Mn mg kg^{-1}	Zn mg kg^{-1}	Cu mg kg^{-1}
CC	42.0a	2.05 a	47.6 b	23.8 a	20.5 a	1.16 e	1.84 e	0.69 b	287 c	81 b	41b
VC	46.5a	0.92 b	52.0 a	21.6 b	12.8 b	1.69 cd	2.00 d	0.82 a	325 b	100 a	49 a
PVC	48.2 a	0.84 b	54.5 a	20.9 b	11.7 d	1.79 b	3.83 a	0.85 a	370 a	104 a	52 a
PC	43.8a	1.09 b	53.1 a	21.0 b	12.2 c	1.72 c	3.63bc	0.80 a	320 b	81 b	48 a
NPC	44.4a	0.95 b	54.3 a	20.6 b	11.3 e	1.83 a	3.75ab	0.84 a	325 b	104 a	54 a

Values sharing similar letter (s) in a column are non-significant at $P< 0.05$, according to Duncan's multiple range test.
*CC is conventional compost, VC is vermicompost, PVC is phosphorus enriched vemricompost, PC is phosphorus compost and NPC is nitrogen enriched phosphorus compost

Table 3: Biochemical components of various types of compost

Composts*	Total phenol (mg kg^{-1} compost)	Dehydrogenase (mg TPF kg^{-1} compost hr^{-1})	Alkaline phosphatase (mg p-nitro phenol kg^{-1} compost hr^{-1})	Acid phosphatase (mg p-nitro phenol kg^{-1} compost hr^{-1})
CC	86.0 ±1.14	51.0 ±0.85	445.2 ±4.68	384.0 ±7.63
VC	94.0 ±1.80	46.0 ±0.50	503.1 ±5.82	406.0 ±5.42
PVC	102.5 ±0.65	43.6 ± 0.29	576.0 ±4.90	436.2 ±4.86
PC	104.1 ±1.14	47.2 ±0.47	541.1 ±5.60	461.0 ±5.73
NPC	109.5 ±2.63	44.7 ±1.09	566.2 ±11.09	439.0 ±5.93

*CC is conventional compost, VC is vermicompost, PVC is phosphorus enriched vemricompost, PC is phosphorus compost and NPC is nitrogen enriched phosphorus compost variation in moisture per cent of different types of composts. Data showed that water soluble carbon (WSC) value was almost double in conventional compost (CC) than those of chemically enriched composts and vemicompost. The least WSC of 0.84 was found in phosphorus enriched vermicompost (PVC) followed by value of 0.92 in vemicompost (VC) and maximum WSC of 1.09 in case of phosphorus compost (PC), the results agree with the earlier findings reported by (Singh and Ganguly, 2005) who revealed that well enriched composts have lesser amount of WSC than those of conventional composts.The ash content was higher in different enriched composts and vermicomposts as compared to the conventional compost. However, total organic carbon values and C:N were lower in the different enriched composts and vermicomposts than that of CC. The difference in C:N was because of higher nitrogen content of diverse chemically enriched and vermicomposts. NPK content in CC was less than those of enriched compost. The phosphorus content of the enriched composts ranged from 2 to3 per cent and were higher than in CC due to addition of rock phosphate in all three composts. However, PVC showed slightly higher P value, similar to earlier work by Sharma *et al.* (2004). Micronutrient content (Mn, Zn, Fe and Cu) was higher in enriched compost as compared to CC which was also observed in previous studies (Rajesh *et al*., 2003).

The data in Table 3 revealed that the increase in phenol content in different enriched composts is one of the indicators of completion of humification' and the composts had reached to the maturity level, while higher dehydrogenase activity in CC indicates that the compost is still being decomposed and hence, it exhibited higher microbial activity. In fully matured compost decomposition is slowed down and hence, dehydrogenase activity is lower. Alkaline phosphatase indicates of phosphorus mineralization power by the micro-organisms involved in P-cycling. The PC, NPC, VC and PVC had higher values of alkaline phosphatase than that of CC; similar was reported by Hussain *et al.* (2015). The higher values of alkaline and acid phosphatase enzyme activity in the PC, NPC, and PVC may be due to the use of rock phosphate amendment in the composting process which may accelerate the growth of micro-organisms related to phosphorus mineralization.

Conclusion :

The decomposition period was reduced to 70±5 days in chemically- enriched compost and vermincompost as compared to conventional compost. Phospho-compost (PC), nitrogen-enriched phospho-compost (NPC), vermicompost and phospho-enriched vermicompost (PVC) were observed to be higher in nutrients status and enhanced the soil biological quality compared to conventionally produced compost. NPC and PVC are more promising composts and enhanced the growth and yield parameters of wheat equivalent to inorganic fertilizer treatment.

Acknowledgement :

Highly thankful to the Programme Co-Coordinator KVK/ETC Malangpora, Pulwama, J&K and Co-principal investigator NICRA project for providing necessary facilities he is one of the auther.

Literature Cited

A.O.A.C. (1970). *Official methods of analysis,* Association of Official Agricultural Chemists, WASHINGTON, D.C.

Aulakh, M.S. and Singh, B. (1997). Nitrogen losses and fertilizer nitrogen use efficiency in irrigated porous soils. *Nutr. Cycl. Agroecosyst.*, **7** : 1–16.

Bray, H.G. and Thorpe, W.V. (1954). Analysis of phenolic compounds of interest in metabolism. *Methods Biochem. Anal.*, **52**: 1-27.

Bevacqua, R.F., Bray, H.G. and Thrope, W.V. (1954). Analysis of phenolic compounds of interest in metabolism. *Methods Biochemistry Analysis,* **1** : 27-52.

Bevacqua, R.F. and Mellano, V. (1993). *Sewage sludge compost's cumulative effects on crop growth and soil properties.* Compost Science and Utilization. Spring,34-37pp.

Casida, L.E., Klein, D.A. and Santoro, T. (1964). Soil dehydrogenase activity. *Soil Sci.,* **98** : 371-376.

Chintala, R., Mollinedo, J., Schumacher, T.E., Malo, D.D., Papiernik, S., Clay, D.E., Kumar, S. and Gulbrandson, D.W. (2013). Nitrate sorption and desorption by biochars produced from microwave pyrolysis. *Microporous & Mesoporous Materials* , **179** : 250-257.

Chintala, R., Schumacher, T.E., McDonald, L.M.,Clay, D.E., Malo, D.D., Clay, S.A., Papiernik, S.K. and Julson, J.L. (2014). Phosphorus sorption and availability in biochars and soil biochar mixtures. *CLEAN-Soil Air Water,* **42**(5) : 626-634.

Darwish, O.H., Persaud, N. and Martens, D.C. (1995). Effect of long-term application of animal manure on physical properties of three soils. *Plant & Soil,* **176** : 289-295.

Deshmukh, S.C. and Tiwari, S.C. (1996). Efficiency of slow releasing nitrogen fertilizer in rice on partially reclaimed vertisols. *Indian J. Agron,* **41** : 586–590.

Duncan, D.B. (1955). Multiple range and multiple F-test. *Biometrics*, **11** : 1-42.

Hoitink, H.A.J. (1993). *Proceedings review: International symposium on composting research.*Compost Science and Utilization, Spring, pp. 37.

Hussain,S.S., Ara, T., Raina, F.A., Gani, G., Hussain,N., Hussain, M. and Dar, S.R. (2015). Quality evaluation of different forms of compost and their effect in comparison with inorganic fertilizers on growth and yield attributes of wheat (*Triticum aestivum* L.) . *J. Agric. Sci.*, **7** (1) : 154-160.

Jackson, M.L. (1973). *Soil chemical analysis.* Prentice Hall of India Pvt. Ltd; NEW DELHI, INDIA.

Kumar, S., Nakajima, T., Mbonimpa, E.G., Gautam, S., Somi Reddy, U.R., Kadono, A., Lal, R., Chintala, R., Rafique, R. and Fausey, N. (2014). Long-term tillage and drainage influences on soil organic carbon dynamics, aggregate stability and carbon yield. *Soil Sci. & Plant Nutr.,* **60** (1) : 108 - 118.

Lindsay, W.L. and Norvell, W.A. (1978). Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Sci. Soc. America J.,* **52** : 421-428.

Maynard, A. (1989). Agricultural composts as amendments reduce nitrate leaching. *Frontiers Plant Sci.,* **24**:2-4.

Mellano, V. (1993). *Sewage sludge compost's cumulative effects on crop growth and soil properties*. Compost Science and Utilization, Spring , pp.34-37.

NAAS (2010). *Degraded and wastelands of India;status and spatial distribution*, Directorate of Information and Publications of Agriculture, ICAR, Pusa, NEW DELHI, INDIA.

Prasad, R. (2014). Using nitrogen and phosphorus budgets as effective tools for assessing nitrogen and phosphorus losses from agricultural systems. Ph.D. Thesis, University of Florida, Gainesville.

Rajesh, C., Reddy, K.S., Naidu, M.V.S. and Ramavataram, N. (2003). Production and evaluation of compost and vermicompost from solid organic wastes. *Asian J. Microbiol. Biotechnol.& Environ. Sci.,* **5** : 307-311.

Rowland, A.P. and Roberts, J.D. (1994). Lignin and cellulose fraction in decomposition studies using acid detergent fibre methods. *Communic. Soil Sci. & Plant Anal.,* **25** : 269-277.

Royal Commission on Agriculture in India (1976). Agricole Publishing Academy, NEW DELHI, INDIA.

Ryan, J., Estefan, G. and Rashid, A. (2001). Soil and plant analysis: Laboratory Mannual. Int. Centre Agri. Res. in Dry Areas (ICARDA) Aleppo. 172p.

Sharda, V.N., Dogra, P. and Prakash, C. (2010). Assessment of production losses due to water erosion in rainfed areas of India. *J. Soils & Water Conservation,* **65** (2) : 79-91.

Sharma, Vivek., Kanwar, Kamla and Dev, S.P. (2004). Efficient recycling of obnoxious weed plants (*Lantana camara* L.) and congress grass (*Parthenium hysterophorus* L.) as organic manure through vermi composting. *J. Indian Soc.Soil Sci.,* **52** : 112-114.

Singh, A.B. and Ganguly, T.K. (2005). Quality comparison of conventional compost, vermicompost and chemically-enriched compost. *J. Indian Soc. Soil Sci.,* **53** (3): 352-255.

Steel, R.G.D., Torrie, J.H. and Dicky, D.A. (1997). Principles and procedures of statistics- A biometrical approach (3rd Ed.) McGraw-Hill Book International Co., Singapore. pp. 204-227.

Tabatabai, M.A. and Bremner, J.M. (1969). Use of nitrophenyl for assay of soil phosphatase activity. *Soil Biol.& Biochem.,* **1** : 301-307.

Toth, S.S., Prince, A.I., Wallace, A. and Mikkelsen, D.S. (1948). Rapid quantitative determination of eight mineral elements in plant tissue by a systematic produce involving use of a flame photometer, *Soil Sci.,* **66** : 459-466.

Waggoner, P.E. (1972). *Bull Connecticut.* Agricultural Experimental Station, 754.