Journal of Advances in Biology & Biotechnology
6(3): 1-7, 2016; Article no.JABB.24975
ISSN: 2394-1081

SCIENCEDOMAIN *international*
www.sciencedomain.org

Chemical Properties and Nutrient Composition of Composted Cow Dung as Affected by Duration of Composting and Bulking Plant Materials

A. F. Adekunle[1*], C. O. Adejuyigbe[2], O. A. Babalola[2] and I. O. O. Aiyelaagbe[3]

[1]Agricultural Technology Programme, Federal College of Agriculture, P.M.B. 5029, Moor Plantation, Ibadan, Nigeria.
[2]Department of Soil Science and Land Management, College of Plant Science and Crop Production, Federal University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria.
[3]Department of Horticulture, College of Plant Science and Crop Production, Federal University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JABB/2016/24975
Editor(s):
(1) Tapan Kumar Mondal, Ph.D (IHBT, Palampur) and Post Doc (UCR,USA) and Visiting fellow (UIUC, USA), Senior Scientist (Plant Biotechnology), National Research Center on DNA Fingerprinting, National Bureau of Plant Genetic Resources, Pusa, New Delhi -110012, India.
Reviewers:
(1) Joseph Tanimu, Federal University Wukari, Taraba State, Nigeria.
(2) Ajayi Asishana Stanley, Ahmadu Bello University, Nigeria.
Complete Peer review History: http://sciencedomain.org/review-history/14764

Original Research Article

Received 11th February 2016
Accepted 10th March 2016
Published 24th May 2016

ABSTRACT

A composting experiment was conducted at the Institute of Agricultural Research And Training (I.A.R&T), Moor plantation, Ibadan to evaluate the effects of duration of composting (DC) of cow dung with four plant materials on the chemical properties and nutrient composition of composts. Four cow - dung based composts were made on-farm with siam weed (*Chromolaena odorantum* L), Tridax (*Tridax procumbens* L), guinea grass (*Panicum maximum* L.) and maize (*Zea mays* L.) stover as composting plant materials (CPM) using the indore method. Composts were sampled at 1, 2, 3, 4 and 5 months after composting and analysed for the pH, organic carbon, effective cation exchange capacity (ECEC), water soluble carbon (WSC), total N, available P, exchangeable cations (K, Ca, Mg and Na). Results showed significant effects of both DC and CPM on chemical properties of composts except available P. The pH, total N, organic carbon and WSC and C: N ratio of compost decreased with increasing DC. Highest levels of total N (6.7 g kg^{-1}) were observed in compost at

**Corresponding author: E-mail: talk2nikeadekunle@yahoo.com;*

three months DC. Guinea grass compost (GGC) was highest in pH and WSC. Compost materials and duration of composting therefore need to be considered in formulating compost for organic fertilizers in organic farming.

Keywords: Duration of composting; composting plant materials; chemical properties; organic fertilizers.

1. INTRODUCTION

Application of organic fertilizer constitutes a practice for the maintenance of soil fertility and conserving soil entity before the advent of inorganic fertilizer [1]. Utilization of organic wastes is fast becoming a pathway for sustainable agricultural systems. This can be profitably used for replenishing soil organic matter which plays an important role in the physical, chemical and biological soil condition [2,3]. A low level of soil organic matter is responsible for low yield and low quality of agricultural crops which in turn results into low economic returns for farmer. It is therefore essential to maintain and improve organic matter level of soil by recycling of nutrients and energy through organic materials in order to increase soil fertility and to achieve sustainable cropping systems [4].

Composting is one method by which nutrients in organic wastes are recycled for crop production [5]. Decomposition of organic matter is influenced by optimal moisture supply, adequate aeration and high temperature. Neutral to slightly alkaline pH or low Nitrogen supply tend to favor bacteria while low pH or low nitrogen level favor fungi. An acidic medium tends to decrease the breakdown of organic residue and under acidic anaerobic condition it virtually stops [6]. Compost applied as soil amendments improve organic content, water and nutrient retention in soil susceptible to leaching and stabilize soil pH [7]. It strengthens soil resistant to crop pest and a source of macro and micro nutrients in soil [8].

Transformations of substrates are based on its degradability which is conditioned by organic matter content among other factors during compositing processes. For instance, amino acids, fats and simple carbohydrates which are labile organic compounds degrade quickly in the first stage of compositing than the more resistant organic substrates such as cellulose, hemicelluloses and lignin which degrade partially and transformed at a lower rate [7,8]. These properties affect decomposition rate, gas emission, duration and extent of the process and oxygen requirement. Composting therefore involves a partial mineralization of the organic substrate, leading to carbon losses throughout the processes [6]. Although residue decomposition in the soil is a direct responsibility of fungi and bacteria; macro-, meso- and macro –fauna also play important roles in the decomposition. Microarthropods, mainly mites (Acari) and sprintails (Collembola) represent soil mesofauna which are involved in the breakdown of plant tissue and nutrient mineralization [8]. Micro arthropods comminute plant residue, graze microflora decomposers, and regulate population of microfauna. This study was conducted to assess the chemical properties of composts on different composting duration and to determine the effect of different plant materials on the chemical composition of composts.

2. MATERIALS AND METHODS

2.1 Composting and Compost Sampling

Four different types of composts were prepared using four different plant materials with cow dung at the ratio of 3:1 combination of each plant material with the animal manure. Plant materials included the following: *Tridax procumbens, Panicum maximum, Chromolaena odoratum* and stovers of *Zea mays*. The plants were cut fresh from the field after which each was chopped into smaller particles of below 5cm with chaff cutter in order to increase the surface area for decomposition. Indore hot heap method of composting the organic materials was adopted. The walls were lined with black polythene sheet and the materials were laid out in ratio 3:1 *plant materials* to cow dung manure (Adediran *et al.,* 1999). Each compost pile was 1.5 m in length, by 1.0 m in breadth, and 1.0 m in height. The temperature of each compost pile was monitored with the use of soil thermometer and turning was done manually with the use of garden fork whenever the temperature becomes low. Composting process proceeded for five months and each pile was sampled immediately after turning at 2, 3, 4 and 5 months of composting for nutrient analysis.

2.2 Laboratory Analysis

The composts samples taken for nutrient analysis were air dried at room temperature and analysed for chemical compositions. The pH of the compost was determined in water and KCl using pH meter glass electrode [9]. Organic matter of the compost was determined by loss on ignition method at 430ºC for 24 hrs. [10]. Total nitrogen and carbon of the compost were determined by automatic microanalysis [11]. Water-soluble C was determined by extraction method following [12] procedure. Exchangeable bases were extracted using 1M Ammonium acetate following the method of [13], sodium and potassium were determined by flame photometry while calcium and magnesium by atomic absorption spectrometry. Available phosphorus was determined after HNO_3 digestion colorimetrically as molybdovanadate phosphoric acid.

2.3 Statistical Analysis

The data collected were analysed using analysis of variance (ANOVA) statistical analysis system and the means were separated by Tukey highest significant difference (HSD) at 5% probability.

3. RESULTS AND DISCUSSION

The analysis of chemical properties of the cow dung and plant materials used for composting as presented in Table 1 showed that maize stover had the highest C/N ratio followed by guinea grass. The two dicotyledonous weeds (i. e. tridax and siam weed) had lower C/N ratios. Tridax had the lowest organic carbon and phosphorus levels. It also had the highest nitrogen, potassium, calcium and sodium levels. Siam weed had the highest phosphorus level with moderate concentration of other nutrients. Guinea grass and maize stover had high levels of organic carbon, the lowest sodium level but moderate in the concentration of other nutrients. Cow dung had medium concentrations of each nutrient and this implies that each of these organic materials can complement one another in composting. The pH level of composts that were in the alkaline range (Fig. 1) was in line with the observations of [14] and [15] which stated that pH of compost or composting material can exceed 7.5, and rise to 9.2 at the thermophilic period which result from the gaseous loss of ammonia.

Nutrient composition at different duration of composting showed that as duration of composting increased, the concentrations of pH, OC, C: N, K and P decreased. Total nitrogen on the other hand increased as composting duration increased up to 3 month duration before a gradual decrease from 4 to 5 months duration of composting (Table 2). The decreasing concentration of organic carbon in composts with increasing duration of composting was due to mineralization of organic C by the feeding activities of microorganisms in the compost. This led to a decrease in the weight of pile as well as reduction in the C:N ratio of the composts. This was in line with the findings of [16] which stated that Low C/N ratios can be corrected by adding a bulking agent to provide degradable organic C. During the active phase of the composting process the organic-C decreases in the material due to decomposition of the organic matter by the microorganisms. Decrease in carbon to nitrogen ratio with increased duration was directly related to that of organic carbon (Fig. 2). However, total nitrogen concentration increased as composting duration increased due to concentration effect (Fig. 4). This was also in line with the review of [6] because the rate of utilization of organic carbon by the decomposers for their metabolism was higher than that of nitrogen such that the C:N ratio of compost decreased, three months of composting appeared to be the best to achieve highest total nitrogen concentration. The levels of available phosphorus which were not significantly different throughout the composting durations could be attributed to the fact that phosphorus is highly stable and not mobile in soil therefore it's not prone to leaching away fromcompost regardl ess of the duration of composting. The result obtained at four months of composting fell within the ideal range of C:N ratio reported by [14] and [6] among others. [6] reported that adequate C/N ratio for composting is in the range 25–35, because it is considered that the microorganisms require 30 parts of C per unit of N, also [16] suggested that C/N ratios ranging between 25:1 and 35:1 is ideal for composting The initial increase in water soluble carbon of composts may be attributed to the solubility of the initial product of microbial decomposition (Fig. 3). These compounds are precusors to synthesis of more stable organic compounds in the composts at later period. Thus there was gradual reduction in water soluble C with time after two month duration. Result showed that application of compost of two months duration during periods of high rainfall may lead to loss of organic matter

and constituent nutrients by leaching. Results also showed that choice of composting material would affect the levels of the water soluble carbon in the compost at any time. This is also applicable to C:N ratio of composts. Water soluble carbon was high with guinea grass compost and C: N ratio was high with siam weed compost. Concentration of most nutrients was highest in guinea grass compost although it is comparable to maize stover compost (Table 3).

Table 1. Nutrient composition of the organic materials used for composting

Compost materials	Total N	OC	P	K	Ca	Na	C/N ratio
				(g/kg)			
Cow dung	17.5	228.0	8.34	39.10	55.60	9.70	13.00
Tridax weed	32.8	163.0	0.48	63.80	57.80	10.40	5.00
Siam weed	29.5	264.0	9.21	46.90	23.10	9.70	9.00
Maize Stover	7.5	333.0	2.55	51.30	23.60	7.50	44.40
Guinea grass	11.6	358.0	4.34	48.40	36.10	7.50	30.90

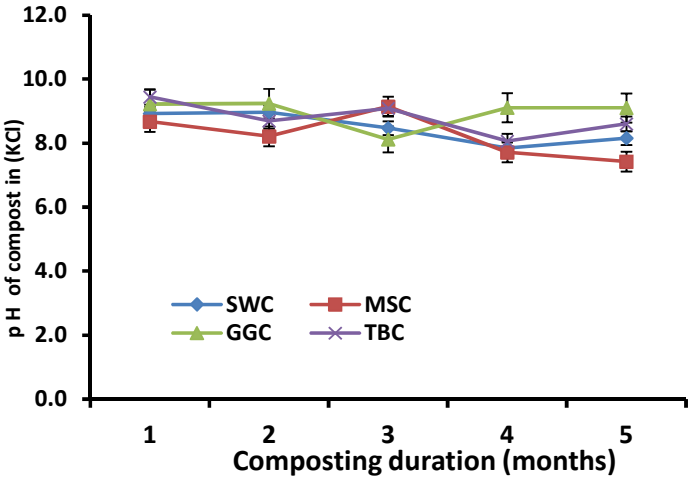

Fig. 1. pH level of different types of compost at different duration of composting

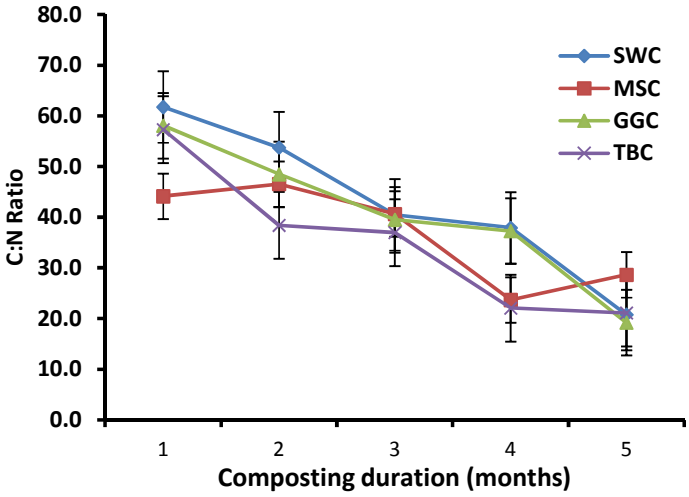

Fig. 2. Carbon to nitrogen level of different types of compost at different duration of composting

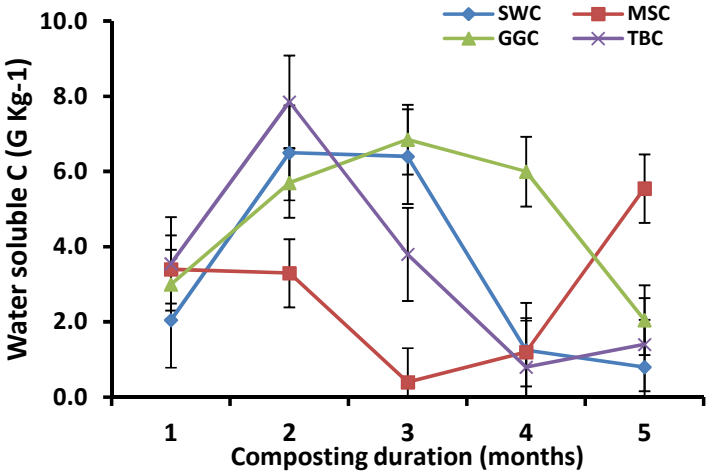

Fig. 3. Water soluble carbon level of different types of compost at different duration of composting

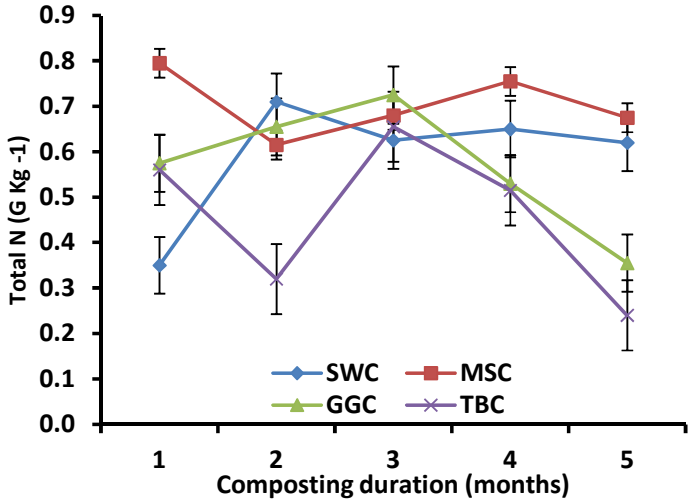

Fig. 4. Total Nitrogen concentration of different types of compost at different duration of composting

Where: SWC = Siam weed compost; TBC-= Tridax based compost; GGC = Guinea grass compost; MSC = Maize stover compost

• The strokes indicates error bar with standard deviation

Table 2. Effects of compositing duration on some chemical properties of composts

Duration of composting (Month)	pH (KCl)	OC g kg^{-1}	N g kg^{-1}	P mg kg^{-1}	K c mol kg^{-1}	Ca c mol kg^{-1}	Mg c mol kg^{-1}	H2O soluble c g kg^{-1}	C:N ratio
1	9.06a	276.58a	0.57ab	0.84	1.85a	0.69b	36.0ab	3.00c	55.32a
2	8.78b	234.00b	0.58ab	0.86	1.77a	1.25a	34.4b	5.84a	46.80b
3	8.71b	197.00b	0.67a	0.78	1.81a	0.79ab	37.5a	4.36b	39.40c
4	8.19c	151.00c	0.61a	0.80	1.40b	0.88ab	26.6c	2.31d	30.24d
5	8.32c	112.00c	0.47b	0.72	1.49b	0.90ab	28.1c	2.45dc	22.44e

Means values with the same letters along the same column are not statistically different at P = 0.05

Table 3. Effects of compositing duration on the chemical properties of composts

Compost types	pH (KCl)	OC g kg^{-1}	N g kg^{-1}	P mg kg^{-1}	K c mol kg^{-1}	Ca c mol kg^{-1}	Mg c mol kg^{-1}	WSC g kg^{-1}	C:N ratio
SWC	8.48b	214.72a	0.59b	0.78	33.03b	1.75a	7.62a	3.40b	42.94a
MSC	8.23c	183.66ab	0.70a	0.81	30.02c	1.61ab	7.09b	2.77c	36.73ab
GGC	8.96a	202.56ab	0.57b	0.84	36.7a	1.76a	8.18a	4.72a	40.51ab
TWC	8.78a	175.84b	0.46c	0.78	30.02c	1.53b	7.98a	3.48b	35.17ab

Means values with the same letters along the same column are not statistically different at P = 0.05
SWC- Siam weed compost; MSC- Maize stover compost; WSC- Water soluble carbon; GGC- Guinea grass compost; TWC- Tridax weed compost

4. CONCLUSION

It is therefore concluded that Compost made with Maize stover of 3 and 4 months of composting and guinea grass compost of 4 and 5 months performed better among all other compost types and durations. It is possible to achieve customized compost of optimum fertilizer value using organic resources that are available in the farm.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFRENCES

1. Adediran JA, Taiwo LB, Akande MO, Lawal BO, Oluokun JA. Working manual on compost technology and utilization. Institute of Agricultural Research Training; 2009.
   ISBN: 978-070-108-7.
2. Alasiri KO, Ogunkeyede OO. Effects of Different levels of poultry manure on seed yield of okra. Proceedings on the 25th Annual Conference; Soil Science society of Nigeria. 1997;102-108.
3. Tian G, Salako FK, Ishda F. Replenishment of C, N and P in a degraded alfisol under humid tropical conditions. Effects of fellow species and litter polyphenols. Soil Science. 2001;166: 614-621.
4. Robertson FA, Morgan WC. Effect of management history and legume green manure on soil microorganisms under “organic” vegetable production. Aust. J. Soil Res. 1996;34:427-40.
5. Benito M, Masaguer A, Arrigo N, Palma RM, Effron D. Evaluation of maturity and stability of pruning waste compost and their effect on carbon and nitrogen mineralization in soil. Soil Science. 2005; 170(5):360-370.
6. Haug RT. The practical handbook of compost engineering. Lewis Publishers, Boca Raton, FL; 1993.
7. Bernal MP, Alburquerque JA, Moral R. Composting of animal manure and chemical criteria for compost maturity assessment. Biotech. 2008;11:0227.
8. Adejuyigbe CO, Tian G, Adeoye GO. Influence of soil microarthropods on the decomposition of Legimunous plant residues. ASSET Series A. 2006;6(1):259-269.
9. Gazzetta Ufficiale. Metodi ufficiali di analisi chimica dei suoli. DM 11 maggio 1992, suppl. G. U. 121, 25 maggio 1992. Official Gazette of the Italian Republic. Official methods for chemical analysis of soils. Ministerial Decree 05-25-1992; 1992.
10. Navarro AF, Cegarra J, Roig A, Garcia D. Relationships between organic matter and carbon contents of organic wastes. Biores. Technol. 1993;44:203-207.
11. Navarro AF, Cegarra J, Roig A, Bernal MP. An automatic microanalysis method for the determination of organic carbon in wastes. Commun. Soil Sci. Plant Anal. 1991;22:2137-2144.
12. Sanchez Monedero MA, Roig A, Martinez Pardo C, Cegarra J, Paredes C. A microanalysis method for determining total organic carbon in extracts of humic substances. Relationships between total organic carbon and oxidable carbon. Biores. Technol. 1996;57:291-295.
13. Lax A, Roig A, Costa F. A method for determining the cation-exchange capacity of organic materials. J. Plant and Soil. 1986;94:349-355.
14. Center for Integrated Agriculture System CIAS. The Art and Science of composting. Leslie Cooperband University of wiscosin-madison; 2002.

15. Chukwujindu M. A. Iwegbue, Egun AC, Emuh FN, Isirimah NO. Compost maturity evaluation and its significance to agriculture. Pakistan Journal of Biological Sciences. 2006;9:2933-2944.

16. Danielle NA, Horwath W, Vander Gheynst JS. Comparison of several maturity indicators for estimating phyto-toxicity in compost amended soil. Elseveir Waste Management. 2007;28:2070-2076.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/14764