ISSN 2250-3153

Nutrient Quality Assessment of Phosphocompost Under Two Fortification Methods

Adetunji O.A, Adetunji D.A, Omodehin O.A, Abayomi R.E
Plant Bioresources Unit
Bioresources Development Centre
Kwara State Nigeria.
Email: adetunjioluwadami@gmail.com

DOI: 10.29322/IJSRP.9.01.2019.p85107
http://dx.doi.org/10.29322/IJSRP.9.01.2019.p85107

Abstract

Phosphocompost was prepared with the mixture of different organic materials to give four compost types: RB+PM+BM+GL, SD+PM+BM+GL, RB+PM+GL and SD+PM+GL. Where RB = Rice bran, SD = Sawdust, BM = Bone meal (Fortifying agent) and GL = Glyricidia sepium. The nitrogen and carbon sources were combined in the ratio 3:1 and moisture content is maintained. On a daily basis, the ambient and pile temperature was taken, fortnightly; samples were picked from each pile and were taken to the laboratory to check pH and electrical conductivity. After maturation of compost, post composting fortification was done to give additional two compost types: RB+PM+GL (post) and SD+PM+GL (post) making 6 compost types altogether. These were used for germination test which involved the usage of the compost extract as a growth media for maize seed.

The composting process lasted for 84 days, RB+PM+BM+GL and RB+PM+GL entered the curing stage around 60 days while SD+PM+BM+GL AND SD+PM+GL attained the curing stage around 75 days of composting. This showed that rice bran based compost cured faster than sawdust based compost. The compost types showed that bone meal improved compost quality with RB based compost being better than sawdust based compost. SD+PM+BM+GL, RB+PM+BM+GL, SD+PM+GL (post), RB+ PM+GL (post), SD+PM+GL, RB+PM+GL compost types had N:P:K values of 0.68:1.19:1.47, 0.55:1.38:1.42, 0.54:3.90:1.28, 0.52:2.56:1.08, 0.68:1.22:1.42, 0.51:1.07:1.38 respectively. Composting bone meal with composting feedstock helped to reduce C/N of the resultant compost, it also enhances N and K content while addition of bone meal after composting tend to increase P content.

Keywords; Phosphocompost, Fortification

INTRODUCTION

Food scraps and yard waste currently make up 20 to 30 percent of what we throw away, and should be composted instead. Making compost keeps these materials out of landfills where they take up space and release methane, a potent greenhouse gas (Bernal *et al.*, 2007). Compost is dark in color and filled with nutrients, it's more than just an important addition, it is absolutely crucial. It is a material created by nature (San Mateo County magazine, 2007).

Healthy compost adds nitrogen, phosphorus, potassium and sulfur to soils. It can also help the soil retain moisture and give structure and support for its inhabitants (Ogunbanjo, 2007). Not only can compost stimulate plant growth, it can carry the necessary bacteria to resist dangerous pathogens and toxins in the soil. Compost can help create soil out of every kind of soil, silt, clay, or sandy dirt. The two things sick soils lack are microorganisms and organic matter. By adding nutrients to soil, vegetation becomes healthier and micro and macro organisms are attracted to the ecosystem. The most beneficial organism is the earthworm, but there are many others. Once this ecosystem becomes balanced in the natural intended, every aspect of the system works to create a good environment for vegetation (Tyler, 2004).

Composting of organic wastes is a bio-oxidative process involving the mineralization and partial humification of the organic matter, leading to a stabilized final product, free of phytotoxicity and pathogens and with certain humic properties (Zucconi and de Bertoldi, 1987). It is the spontaneous biological decomposition process of organic materials in a predominantly aerobic and anaerobic environment (Yvette, 2000). The composting process has received much attention in recent years because of pollution concerns and the search for environmentally sound methods for treating waste. Composting has been used as a means of recycling organic matter back into the soil to improve soil structure and fertility (Ojeniyi, 2012).

Phosphocompost is a form of compost that has been fortified with a phosphorus source. Phosphorus source that could be used includes phosphate rock, pyrite and bio solids such as bone meal. Advanced preparation of phosphocompost can be done by making use of phosphate solubilizing microorganisms such as *Aspergillus awamori, Pseudomonas straita, Bacillus megateriu* (Pazhanivelan *et al.*, 2006). Phosphate is the key ingredient that helps in high yield, it is also called building block as it is the major constituent of RNA and DNA found in cells. Availability of phosphate energizes the plant and influences fruit size of the plant.

In agricultural systems, P is needed for the accumulation and the release of energy associated with cellular metabolism, seed and root formation, maturation of crops (especially cereals), quality and strength of straw in cereals. In the natural (i.e. non-agricultural) systems, P is recycled back into the soil via litter, plant residues and animal remains (Brogan *et al.*, 2001). Although, a high level of phosphorus in the soil is an environmental concern because it may be washed into streams and lakes by run-off or soil erosion and cause eutrophication (Sharpley *et al.*, 1997). Phosphocompost will not only reduce P deficiencies, improve P uptake and grain yield of crops but also enhance recycling of agro-waste into useful soil amendment (Oyeyiola *et al* 2016). To increase the soil fertility in a sustainable manner and enhance plant growth and safety, the use of phosphocompost as fertilizer is appropriate. Usage of phosphocompost on acidic nutrient degraded soils will go a long way to reduce high application rates of chemical fertilizers on these fragile soils (Oyeyiola *et al* 2016). Therefore the work aimed to prepare phosphocompost from different organic material and assess its nutrient quality.

MATERIALS AND METHODS

EXPERIMENTAL SITE DESCRIPTION

The work was carried out at the compost shed of the Faculty of Agricultural Sciences Ladoke Akintola University of Technology Ogbomoso, Oyo State South Western Nigeria between May and September, 2015. The shed was roofed with Aluminum roofing sheet coated with green color.

EXPERIMENTAL SITE PREPARATION

The compost shed used was cleared of stones and other debris and was well swept. The door leading into the shed and the windows were measured and covered up with sac-like material in order to enable uniform ambient temperature in the room, and to prevent rain droplets from gaining access into the room.

COMPOST PREPARATION AND FORTIFICATION

Four piles of compost were prepared. The carbon sources: Rice bran (RB) and Sawdust (SD) were mixed with the nitrogen source: Poultry Manure (PM) in ratio 1:3, The carbon source Rice bran (RB) was collected from rice mill at Arada area Ogbomosho and sawdust (SD) from saw mill at Pakiotan area Ogbomosho, Nitrogen source which is poultry manure (PM) was collected from onigbinde farms Ogbomosho, Oyo state, *Gliricidia sepium* leaves and flexible stem was collected fresh from Teaching and Research Farm Ladoke Akintola University of

Technology Ogbomosho, Oyo State, and bone meal was collected and grinded before use. Turning was done every three days during the first two weeks of composting and subsequently every five days till compost maturity after 84 days of composting.

Fortification was done to make the compost readily available. Bone meal was used as the phosphorus fortifier. Two methods were used for the fortification which is the co-composting and post composting method.

Co-Composting Method: This method involves the mixing of Sawdust (SD) , Poultry Manure (PM), Bone Meal (BM) and *glyricidia sepium* (GL), all to give a mix tagged SD+PM+BM+GL. These forms a pile of about 255 g (SD 60 g + PM 180 g + BM 7.5 g + GL 7.5 g). The above process was repeated again substituting RB as the carbon source to give a mix tagged RB +PM +BM +GL.

POST COMPOSTING METHOD

Phosphorus fortifier (BM) in this method would be added when the compost is matured. Therefore we have a mix tagged SD+PM+GL and RB +PM +GL. Throughout the mixing, there was subsequent addition of ordinary water to the upcoming pile and we ensured uniform mixing. A thick nylon material was at the base of each pile in order to avoid any form of reaction with the ground. Each pile was covered with nylon in order to boost the heat buildup and to also avoid any form of unwanted reaction. While turning the compost, water was sprinkled on any pile noticed to be dry.

GERMINATION TEST

After 84 days of composting, the compost is assumed to be stabilized and samples from the cured compost were taken for seed germination test. The aim of this test is to get the germination percentage, root elongation percentage and the germination index. Two compost types; SD+PM+GL (Post compost) and RB+PM+GL (Post compost) were prepared by adding 1g of BM to 4g of already cured compost types; SD+PM+GL and RB+PM+GL. The addition of compost types SD+PM+GL (pc) and RB+PM+GL (pc) makes the number of compost types increase to 6 compost types altogether.

Five (5) g of the 6 compost types were poured in a 120ml bottle and 50ml of water was added. The mixture was shaken at a uniform rate for 1 hour and the germination media was prepared using cotton wool and petri dish, 0.8g of cotton wool was placed in each of the petri dish to be used. After an hour of shaking, the mixture was filtered into a clean 120ml bottle to get a filtrate of the compost types.

The seeds to be used (maize seed) were carefully picked and disinfected using 70% ethanol. Ten (10) ml of distilled water was sprinkled on the cotton wool and the seeds were carefully placed (distilled water was used as control experiment). For the 6 compost types, the above process was carried out for 100% concentration of the compost filtrate and also 50% (5 ml compost filtrate + 5 ml distilled water). Each petri dish was sealed with foil paper to regulate the effects of exogenous factors and also to prevent water loss thereby retaining oxygen. Each sample was replicated once and all measurement in terms of weight and volume were carried out using the sensitive weighing scale and measuring cylinder respectively.

DATA COLLECTION

Ambient and compost temperature were taken daily throughout the 84 days of composting. Samples were taken from each pile every two weeks, air dry and then take to the laboratory to get the pH value and electrical conductivity value. This is done using 1:4 and 1:2 i.e. compost: distilled water. Five (5) g of each sample was measured (using sensitive weighing balance) and poured inside a 120ml bottle then 20mls of distilled water was added to the 1:4 samples and 10 mls was added to the 1:2 samples. Bottles were labeled accurately to avoid any mistake. There were replicates for each sample. The samples were placed in the mechanical shaker and shook for 40 minutes. After achieving a uniform mix, the samples were poured inside pH cups and the pH meter and Electrical conductivity meter were inserted one at a time to get the values.

All petri dishes were kept in a cool dry place and after 4 days, data in terms of number of germinated seeds (%), root elongation (cm) and weight (g) gained by the root. Germination index was calculated to assess compost phytotoxicity.

$$\text{Germination index} = \frac{\text{Relative germination \%} \times \text{Relative root length \%}}{100}$$

$$\text{Relative germination\%} = \frac{\text{no of seeds germinated in compost extract}}{\text{No of seeds germinated in control}} \times 100$$

$$\text{Relative root length\%} = \frac{\text{mean root length in compost extract}}{\text{mean root length in control}} \times 100$$

RESULTS

Table 1 reveals the different stages involved in composting. Day 1 to 5 indicated the mesophilic stage where we have excessive increase of temperature. Day 6 to 22 indicated the thermophilic stage where microbial activities of decomposition were active. Day 23 to 64 indicated the cooling stage and day 65 to 84 marks the maturation stage. Temperature evolution is an indicator of microbial activity during the composting process.

Figure 1 showed the amount of N, P, K and Ca present in matured compost. SD+PM+GL+BM and SD+PM+GL had the highest amount of N (0.68), while RB+PM+GL (post) had the least amount (0.52). SD+PM+GL (post) had the highest amount of phosphorus (3.90) followed by RB+PM+GL (post) 2.56. The other treatments showed no significant difference while RB+PM+GL had the least amount (1.07). SD+PM+GL+BM had the highest amount of potassium (1.47) followed by RB+PM+GL+BM (1.42) while SD+PM+GL (post) and RB+PM+GL (post) had the least amount of 1.28, giving null significant difference between the two treatments. SD+PM+GL (post) and RB+PM+GL (post) had relatively higher amount of calcium of values 14.49 and 13.17 respectively, while RB+PM+GL+BM gave the least amount of value 5.52.

From table 2, SD+PM+GL (post) had the highest amount of C and Zn while SD+PM+GL had the least. SD+PM+GL+BM had the highest amount of Na and Fe while RB+PM+GL (post) had the least. RB+PM+GL (post) had the highest amount of Mg followed by SD+PM+GL (post) while SD+PM+GL+BM gave the least amount. RB+PM+GL+BM had the highest amount of Mn while SD+PM+GL (post) had the least amount. SD+PM+GL+BM had the highest amount of Cu while SD+PM+GL and RB+PM+GL had no significant difference and both gave the least amount,

TABLE 1: Comparison between ambient and compost combination temperatures.

Days	Ambient	Compost A	Compost B	Compost C	Compost D
	……………………………°C…………………………………………………				
1	25	32	32	32	32
8	31	47	56	54	57
15	30	45	47	44	48
22	27	45	46	46	47
29	28	43	46	40	43
36	27.5	47	38	38	44
43	30	40	43	34	45
50	30	37	42	33	45
57	30	35	43	35	43
64	27	30	38	30	35

71	28	33	37	30	35
78	25	32	34	30	34
84	27	32	32	30	31

Where Compost A = RB+PM+GL+BM, Compost B = SD+PM+GL+BM, Compost C = RB+PM+GL, Compost D = SD+PM+GL, SD = Sawdust, RB = Rice bran, GL= *Glyricidia sepium* and BM = Bone meal.

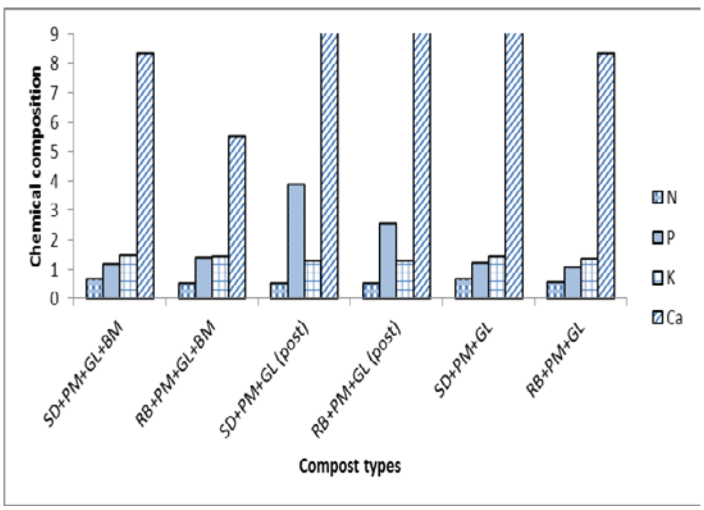

fig 1: SELECTED CHEMICAL COMPOSITION OF EACH COMPOST PILE.
Where SD = Sawdust, RB = Rice bran, GL= *Glyricidia sepium* and BM = Bone meal.

TABLE 2: CHEMICAL COMPOSITION OF EACH PILE

	C	Mg	Na	Mn	Fe	Cu	Zn
	...........%...........		……………………..ppm…………………………..				
SD+PM+GL+BM	24.71	0.33	79.39	310.49	277.33	8.10	88.00

RB+PM+GL+BM	24.62	0.36	76.09	331.78	233.70	7.79	89.03
SD+PM+GL (post)	25.74	0.38	11.54	239.01	131.43	6.98	96.03
RB+PM+GL (post)	22.52	0.40	9.47	265.10	73.78	7.23	93.48
SD+PM+GL	24.32	0.36	77.73	269.92	210.66	6.39	90.24
RB+PM+GL	25.18	0.37	78.27	297.63	102.33	6.39	93.46

Where SD = Sawdust, RB = Rice bran, GL= *Glyricidia sepium*, and BM = Bone meal.

DISCUSSION

The difference in the curing days is as a result of the sawdust being far more lignified than rice bran; therefore it will take the microorganism longer time to decompose sawdust based compost. Tom Richard (1996) confirmed this in his report that plant cell material is composed of 3 important components: cellulose, lignin and hemicellulose, and lignin being the most difficult to biodegrade.

Looking at the curing trend, rice bran based compost that was fortified with bone meal after maturation cured first and this can be explained in comparison to previous researches that has been done on compost that the microorganisms inside the rice bran based pile doesn't really require the extra energy given (the BM), the extra energy slowed down the decomposing rate (Carreiro, 2000). Hence the Rice bran-based unfortified cured faster than the fortified one. On the other hand, the microbes in the SD based compost requires extra energy to breakdown the sawdust faster, therefore the Sawdust-based fortified cured faster than non-fortified one. Cornwell (2008) reported this also when he conducted a research on litter decomposition rate within biomass.

It was observed when the actual concentration of the compost extract was used for germination test that where bone meal was used to fortify the compost had better germination than where bone meal was not added and where bone meal was added after composting. This may be due to the fact that addition of bone meal supplied enough phosphorus during composting, this made it cure better and promote good germination process, while addition of bone meal at the point of use did not have significant difference compared to when bone meal was not supplied at all. (Andreas baumgarten., 2004).

CONCLUSION

From the experiments carried out, results obtained showed that activities of microorganisms in compost have a great influence on temperature which is an important factor in composting. It is eminent from the experiment that composting can take place within 84 days when the average ambient temperature is around 28°C in this region. The time of the year to compost should be put into consideration before composting.

Conclusively, in compost production, where rice bran is the carbon source, fortification is not necessarily needed for speedy maturation but it is needed to increase growth factors. Where sawdust is the carbon source, fortification is highly recommended; it promotes plant growth and ensures speedy maturation. Considering the availability of the two carbon sources, sawdust is recommended to be used because it is easy to acquire. To promote plant growth with the use of compost, it is recommended that the compost should be fortified at the onset of composting.

REFERENCES

1. Bernal M . P., Alburquerque J . A., and Moral R. (2007). Composting of animal manures and chemical criteria of compost maturity assessment. A review. *Bioresource Technology*. 100:5444–5453.

2. Brogan J., Crowe M. and Carty G. (2001). Developing a National Phosphorus Balance for Agriculture in Ireland. *Environmental Protection Agency*, Wexford, Ireland.

3. Ogunbanjo O.R., Omueti J.A.I., Jayeoba O.J., Omolaiye J.A., Abiola I.O. and Uzokwe N.E. (2007). Yield response of maize to animal manures and bulking agents in fortified compost, ASSET Series A 7 (1): 87-98.

4. Ojeniyi S . O., Adejoro S . A., Ikotun O. and Amusa O. (2012). Soil and plant nutrient composition, growth and yield of cassava as influenced by integrated application of NPK fertilizer and poultry manure. *New York Science Journal*, vol.5 (9): pp 62-68.

5. Oyeyiola YB, Omueti JAI (2016). Phosphorus Uptake and Use Efficiency by Cowpea in Phosphocompost and Chemical Fertilizer Treated Nutrient Degraded Acid Soils. Agri Res & Tech: Open Access Journal.

6. Oyeyiola YB, Omueti JAI, Kolawole GO (2015) Effects of phosphocompost on acidity indices in an acidic soil in Ilesha, south-western Nigeria. In: Rahmann G, et al. (Eds.), Proceeding of the 3rd African Organic Conference. Achieving Social and Economic Development through Ecological and Organic Agriculture Alternatives, Lagos, Nigeria, Africa.

7. Pazhanivelan S., Amanullah M., Vaiyapuri K., Rahale C. S., Sathyamoorthi K. and Alagesan A. (2006).Effect of rockphosphate incubated with FYM on nutrient uptake and yield of lowland rice. *Resource Journal of Agriculture Biological Sciences*. 2(6): 365-368.

8. San mateo county magazine (2007), Management of household wastes.

9. Tyler K . B. and Lorenz O. A. (2004). Diagnosing nutrient needs of melons through plant tissue analysis. *Horticultural Sciences*. 85: 393-398.

10. Yvette B.. Guanzon Robert J. and Holmer (2000). Composting of Organic Wastes: *A Main Component for Successful Integrated Solid Waste Management in Philippine Cities.*

11. Zucconi F. and de Bertoldi M. (1987). Compost specification for the production and characterization of compost from municipal solid waste. Compost: production, quality and use. Elsevier, Barking, pp. 30–50.