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Research Paper

Chemical and Microbiological Characteristics of Composts

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This study was carried out in Bauchi state northern guinea savanna agro-ecological zone of Nigeria to determine the chemical and microbiological characteristics composts. The composts materials consisted of three plant residues and two animal manures. The treatments were factorially combined to give four treatments. The method of composting adopted was the pit methods using 1.5 m × 1.5 m × 1 m length, breadth and depth, respectively. Total microbial count was determined by serial dilution of the sample using nutrient agar. The colony counted and data collected were subjected to statistical analysis using genstat statistical package. The result showed variations among the treatments in all the parameters tested. Treatment one (T_1) presented the highest microbial counts (11cfu/g for bacteria) and (59 cfu/g for fungi), while the treatment T_2 produced the lowest counts (4 cfu/g for bacteria) and (11 cfu for) fungi). Treatment T_4 had the highest organic carbon (26.63 mg/kg and available P (33.66%), while Treatment T_3 had the highest pH (8.21) but it was similar to that of T_1.The highest water holding capacity (WHC) (51%) was observed in T_1.Total N was highest in T_3 (1.25 gkg^{-1}).

Key words: Compost, plant residues, animal manure, bacterial counts and fungal counts.

INTRODUCTION

The existence of man has been very much dependent on the cultivation of crops on soil which generally depletes soil nutrients. In the primitive ages, the sustenance of crop cultivation on soil was done by moving from one piece of land to the other after exhausting the nutrients of the former in what is referred to as shifting cultivation. The previously cultivated soil is left to gradually replenish its natural nutrients.

Civilization and population explosion are two main factors that have changed the primitive way of cultivation. The coming of civilization means that people have to more or less settle in one place permanently. Population explosion has resulted into more people scrambling for the same amount of land that was available to the few. In order to feed the increased population and also ensure that land resources go round, crop production moved away gradually from shifting cultivation to using same piece of land over several years, replenishing the soil nutrients by synthetic nutrient sources.

According to Adenawoola and Adejoro (2005), the extent to which farmers use inorganic fertilizer for sustainable crop production constrained by inadequate supply of the right type of fertilizers at the right time, high cost of the material (especially now that governments have virtually removed subsidy) and lack of technical knowhow.

Considering these constraints in the use of inorganic fertilizer, interest and researches have intensified on the use of organic sources of nutrients to produce crops. Several studies have shown positive effects of organic waste on soil productivity and crop yield (Brady and Weil, 2002; Waizah *et al.,* 2011; Lal and Kang, 1982). They have also been shown to improve the physico-chemical properties of soils compared with mineral fertilizers. Organic wastes are however, required in large quantities in order to make any meaningful impact in nutrient supply. The bulky nature of these materials has sometimes necessitated their use in combination with the less bulky synthetic mineral fertilizer (Ayeni, 2010).

Organic fertilizers are also known to improve the biological conditions of soils. Soil structure is improved and mineral nutrients are released to the soil as the population and activity of soil organism are increased as a result of adding organic fertilizers (Havlin *et al*., 2003).

Organic fertilizers include both plants and animal residues (Brady and Weil, 2002). The plant cover is influenced in Nigeria by the rainfall pattern, favoring more plant cover southwards because of higher rainfall. Northwards, the plant cover is scanty while at the same time the livestock population that feeds on plants is more due to the conducive weather for their production. There is therefore competition for plant material between livestock and fertilization using the farm by-products. Similarly some of the farms by- products are used as domestic fuel and for fencing and roofing. A rationalization of the by- products to meet both needs will be irreparable considering the fact that neglecting any of the aforesaid uses could create other problems to the farmers. The leguminous residues can be completely consumed by livestock but the maize residues are not always completely consumed by the animals resulting to a situation where farmers burn off the remaining or use it as fuel wood.

Animal wastes have been used for a long time as source of fertilizer by farmers. The potentials of crop residues as fertilizers are also documented (Havlin *et al*., 2003), but it takes longer time to decompose and release nutrients for plants to use. It therefore, becomes necessary to device means that will increase the rate of decomposition and nutrient release which is the main reason for this study and this can be achieved through composting. This study was therefore conducted to investigate the chemical and microbial (Bacteria and Fungi) composition of the composted materials.

MATERIALS AND METHODS

Location and climate

This study was carried out in Bauchi, Bauchi state, northern guinea savanna agro ecological zone of Nigeria. Bauchi state lies within latitude 10° 17′ N and longitude 9° 49′ E at approximately 600m above sea level. The climate of the area is characterized by two distinct seasons – the rainy season lasting May to September and the dry season lasting October to April. The annual rainfall ranges from 600mm in the extreme northern parts to 1300 mm in the southwestern parts of the State. The temperature regime shows that the mean daily maximum temperature for July and August (29.2°C), December and January 24.7°C and 37.6°C in April and May. The sunshine hours ranges from about 5.1 h in July to about 8.9 h in May and the relative humidity ranges between 12% in February and 68% around August.

Treatments and experimental design

The Experiment was 2×2 factorial in a completely randomized designed with two factors. Factor A had two plant residues groundnut and cowpea haulms (each with maize residue) and factor B had two animal manures, cow dung and poultry dropping (each with maize residue). The compost material was combined to give four treatment combinations as follows:

Maize + cow dung + groundnut haulm – treatment one (T_1)
Maize + cow dung + cowpea haulm – treatment one (T_2)
Maize + poultry dropping + groundnut haulm – treatment one (T_3)
Maize + poultry dropping + cowpea haulm – treatment one (T_4)

The treatments combinations were replicated three times in a completely randomized design.

Composting

The composting was done between February – April and the method adopted was the pit method; using dimensions of 1.5 m × 1.5 m × 1 m length, breadth and depth respectively. The materials were mixed in a ratio of 2:2:2:1 maize straw, animal manure, legumes residue and soil, respectively. Maize residue at the rate of 10 kg was first laid followed by 10 kg of either cow dung or poultry manure then 10 kg of either groundnut or cowpea haulms and then finally 5kg of soil. The procedure was repeated to lay the 2nd and 3rd layers at the interval of one week each. Watering was done regularly to keep the pile at the recommended moisture level of between 50 to 60 %. A week after the third layer was laid, curing which involved turning started and this was carried out at weekly intervals until the compost was 12 weeks. After curing the composts were sampled for laboratory analysis.

Laboratory analysis

The samples for physico-chemical properties were air dried and used for the following determinations: Soil pH was determined at a soil to water ratio of 1:1 using a glass electrode pH meter. Organic carbon- This was determined using the wet oxidation method described by (Jaiswal, 2003). Total nitrogen- was determined by the micro-Kjeldhal method as described by (Jaiswal, 2003).

Available phosphorus was extracted using the Bray-1 method as described by (Bray and Kurtz, 1995). Exchangeable bases were extracted with 1N ammonium acetate solution as described by (Jaiswal, 2003), potassium and sodium read on the flame photometer, while calcium and magnesium were read on the atomic absorption spectrophotometer. The samples for biological analysis were taken to the laboratory and the following procedures were adopted:

The total bacterial and fungal count were determined by serial dilution of the sample and was collected on the surface plate of nutrient agar and incubated in sterile condition at 37^{o}C in the incubator for 24 h and the colonies were counted using colony counter as described by (Isirimah *et al.,* 2006).

Statistical analysis

The data collected were subjected to Analysis of Variance (ANOVA) and significant mean were separated using Duncan multiple range test.

RESULTS AND DISCUSSION

Chemical properties of the compost manures

pH

The result indicated that T_1 and T_3 with the mean values of 8.12 and 8.21 for compost manures which had groundnut haulms had significantly higher pH (P=0.5%) values than the T_2 and T_4 with the mean values of 7.7 and 7.5 compost manures which had cowpea haulms although all the pH values were in the alkaline range (Table 1). Poultry litter which is known to contain high amount of ammonium compounds which could have contributed in lowering the pH of the compost, apparently appeared that the groundnut haulm present may be responsible for the increased pH values in T_1 and T_3. Similarly the cowpea haulm may be responsible for the reduce pH values in T_2 and T_4.

Total Nitrogen

The total nitrogen content of the compost manure from the different treatment combinations was significantly different from each other as shown in (Table 1) T_3 had significantly highest total N (2.29) than all the other treatments, while T_2 (0.75) had the lowest value at 5% level of significance.

The treatment combinations having poultry droppings had significantly higher total N than the treatments with cow dung. Maerere *et al.* (2001) reported that poultry droppings contain more ammonium compounds than cow dung. The breakdown of the ammonium compound during decomposition obviously increases the N content of the compost more than the content in the compost containing cow dung. It also appeared that the legume materials in the compost had effect on the total N content of the finished products. The compost with groundnut haulm and poultry droppings (T_3) had higher total N in the organic content than their counterparts with cowpea haulm. It probably may be that the cowpea haulm contains more recalcitrant organic N in the organic N pool. According to Igbesias-Jimenez and Alverez (1993), as the more labile organic N disappears, the most recalcitrant organic N (the N that is resistant to microbial degradation) predominates in the organic N pool, and the mineralization rate slows. The total N content also seems to have been affected by the C.N ratio of the materials. The C:N ratios of maize stalk, cow dung and poultry manure were 60:73, 11:30 and 3:10 respectively (Adeniyan and Ojeniyi, 2005). But the recommended C:N ratio for quality compost that is fully mature is 25:1 to 40:1. According to them, C: N ratios that are outside their range generally results in immature, incompletely digested compost, this result agree with Ayeni, (2008).

Organic Carbon

The organic carbon content of the compost produced from different agricultural waste is shown in (Table 1). There was no significant difference in the organic carbon content of the compost manures. For a good compost the C: N ratio is recommended to be between 25:1 and 40:1 (Adeniyan and Ojeniyi, 2005). Much of the carbon in the compost manures comes from the same source-maize stalk; therefore, the no significant difference is not surprising, this result concur with what was reported by Agboola and Ray (1991).

Available Phosphorus

The available P content of the compost manures is also shown in (Table 1). The compost from the T_3 combination had significantly high P content than the T_1 and T_4 combinations which were equally significantly higher than T_2 combination. The higher P content in the T_3 combination can be explained by the presence of poultry litter and groundnut haulm in the mixture. According to

Table 1. Chemical properties of the compost

Treatments	$pH(H_20)$	Total N g/kg	Org. carbon mg/kg	Avail. P (%)	WHC	Exchangeable Bases (cmol/kg)			
						Ca	Mg	K	Na
T_1	8.12a	1.25c	20.52a	27.44b	51.10a	3.54a	0.57c	0.11c	0.17c
T_2	7.70b	0.75d	19.81b	13.65c	40.67b	2.09b	0.41d	0.25b	0.09d
T_3	8.21a	2.29a	19.66b	70.59a	50.13b	4.38a	1.28a	0.35a	0.37a
T_4	7.59b	1.67b	20.63a	33.66b	41.17b	3.59a	1.09b	0.25b	0.27b
SE±	0.08	0.17	0.20	6.4	1.77	0.26	0.11	0.03	0.03

T_1 = treatment one, T_2 = treatment, T_3 = treatment and T_4

Table 2. Total bacterial and fungal counts in the compost manures.

Treatments	Bacterial Count (cfu/g)	Fungal Count (cfu/g)
T_1	11.00a	59.00a
T_2	4.00d	11.00c
T_3	9.00c	51.00b
T_4	10.00b	49.00b
SE±	0.87	5.62

Waizah *et al.* (2011), poultry litter normally contain higher amount of N P and organic carbon. Groundnut plants also appear to absorb and utilize more P than cowpea resulting into high P in the groundnut haulm than in the cowpea haulm. This is also reflected in the non significant difference between the T_1 and T_4 combinations. Although the T_4 combination had poultry litter which contains high amount of P, it contains cowpea haulm while the T_1 combination with cow dung having lower P content contains groundnut haulm which contains higher P content than the cowpea haulm, this concurs with Adediran *et al.* (2003).

Exchangeable bases

The exchangeable bases content of the different compost manure is presented in (Table 2). The exchangeable calcium (Ca) content was significantly different among the treatment combinations. The T_1, T_3 and T_4 combinations had significantly higher Ca than the T_2 combination. This can probably be inferred that cow dung contains less amount of calcium than the poultry manure. Cowpea may also be a “poor” harvester of Ca compared to groundnuts which seems to be a heavy feeder. According to Adeniyan and Ojeniyi (2005), groundnut requires plenty calcium as its deficiency retards movement of the nutrients through the peg causing a dark plumule or poppy peanuts (unfilled shells and reduced yields). Anchor *et al.* (2013) also stated that groundnut seems to have considerable ability to utilizing residual manure and this does influence the fertilizer use in their production and that the crop require calcium for its pod production.

The contents of the exchangeable Magnesium (Mg), Potassium (K) and Sodium (Na) in the treatment combinations followed similar pattern. They were significantly higher in T_3 combination than in T_4 combination which was also significantly higher in content than T_2 combination except for K which had the same content with the T_4 combination. This result suggests that poultry manure and groundnut haulms contain more nutrients that can easily be released when decomposed. Poultry manure is from feeds that are compounded and therefore contains deficiency quantities of nutrients unlike the cow dung. Similarly, groundnut plants seem to be heavy feeder on these nutrients than cowpea plants.

Groundnut plants have the advantage of extracting soil nutrients by both the roots and the pegs (Adenawoola and Adejoro, 2005). This probably enables the plant residues to contain more nutrients than the cowpea plant. It is well known that when organic materials are undergoing decomposition, the microorganism multiply thus requiring more nutrients especially nitrogen. Therefore, it is logical to conclude that the treatment combinations that had higher nitrogen contents had higher population of microorganism enabling a more complete breakdown and release of nutrients such as Mg, K and Na.

Water holding capacity

There was significant difference (P=0.05) in the water holding capacity of the different compost manures as shown in Table 1. The T_1 and T_3 combinations had significantly higher water holding capacity than the T_2 and T_4 treatment combinations.

The presence of groundnut haulms appeared to have brought about the higher water holding capacity of the T_1 and T_3 combinations. The effect of cow dung and poultry manure were probably similar because the cow dung was broken down into smaller pieces before addition which obviously increased it surface area, an advantage poultry manure would have had over it (Olayinka, 2001).

Microbiological content

The bacterial and fungal counts in the composts produced from combinations of agricultural by-products are presented in Table 2.

The bacterial count indicated that T_1 (11.00) combination had significantly higher bacterial number than the T_4 (10.00) combination which also had significant higher number than T_3 (9.00) which similarly had significant number than the T_2 (4.00) combination.

The fungal count also indicated that the T_1 (59.00) combination had significant higher fungal count than the T_3 (51.00) and T_4 (49.00) combinations which similarly had higher fungal count than the T_2 (11.00) combination. This trend in the occurrence of organic matter decomposers indicates that the groundnut residue probably contained more nutrients which enabled the microbes initially present to multiply more rapidly than the cowpea residue. Also the cow dung component appear to be harder to digest than the poultry manure hence the higher total number of microbes in the T_1 (59.00) combination and least in the T_2 (11.00) which contains cow dung the legume component was cowpea, (Olayinka, 1990).

Conclusion

In conclusion, treatment containing maize + poultry dropping + groundnut haulms shows higher potential to improve soil fertility better than all the other treatments as its pH, total N, available P, and all the exchangeable bases are significantly higher than the other treatments.

AUTHORS` DECLARATION

We declare that this study is an original research by our research team and we agree to publish it in the Journal.

REFERENCES

Adediran JA, Akande MO, Akanbi WB (2003). Effects of organic root plus (biostimulant) on nutrient content, growth and yield of tomato. Nig. J. Soil Sci. 15:26-33.

Adenawoola AR, Adejoro SA (2005). Effect of poultry manure, NPK fertilizer residues on soil nutrient and performance of jute (corchorus olitorius). Nig. J. soil sci. 15:133-135.

Adeniyan ON, Ojeniyi SO (2005). Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. J. soil sci. 15:34-41.

Agboola AA, Ray PA (1991). Maintenance of soil fertility under traditional farming system in organic fertilizer in the Nigeria Agriculture; present and future. A seminar organized by federal ministry of Agriculture and Natural Resources Kaduna Nigeira March 26-27-1991.

Anchor OI, Ayuba SA, Ali A (2013). Effect of groundnut residues on soil chemical properties in the sub-humid southern guinea savanna zone of Nigeria. Nig. J. Soil Sci. 23(2):76-80.

Ayeni LS (2008). International cocoa pod, ash, poultry manure and NPK 20:10:10 for soil fertility management – incubation study. Continental J Agron. 2:25 – 30.

Ayeni LS (2010). Effect of combined cocoa pod ash and NPK on soil properties, nutrient uptake and yield of maize *(Zea mays L.*). J. Am. Sci. 6(3): 79-84.

Brady NC, Weil RR (2002). The Nature and Properties of soils.13th edition. Pearson education. India.

Bray RH, Kurtz LT (1995). Determination of total organic and available forms of phosphorus in soil. Soil sci. 59: 39-45.

Havlin SL, Nelson WL, Beaton JD, Tisdale JL (2003).Soil fertility and fertilizers.5th edition.Prentice-Hall of India.

Igbesias-Jimenez E, Alverez CE (1993). Apparent availability of nitrogen in compacted municipal refuge. Biology and Fertility of Soils 16:313-318.

Isirimah NO, Igwe C, Ogbonna DN (2006). Soil microbial population as ecological indicator of changes resulting from different land use and management in Rivers State of Nigeria. Nig. J. Soil Sci. 16:164-169.

Jaiswal PC (2003). Soil, Plant and Water Analysis. Kalyani Publishers, Ludhiana, New Delhi, NordaHyderabab, India.Pp.1-399.

Lal R, Kang BT (1982). Management of Organic Matter in Soils of the Tropics and Subtropics.International Soil Science Society (ISSS). Proceedings, 3:152 –178.

Maerere AP, Kimbi GG, Nonga DL (2001). Comparative effectiveness of Animal manure on Soil chemical properties, yield and root growth of Amaranthus. Afr. J.Sci. Techn. Vol 1(4).

Olayinka A (1990). Effects of poultry mature, corn straw and Sawdust on plant growth and soil chemical properties. *Journal of Agriculture* 12 (1): 36-44.

Olayinka, A. (2001). Effects of co-applied cowdung and organic nitrogen on microbial respiration in soil under laboratory conditions. Communications in Soil Science and Plant Analysis 32 (19 & 20):3229 – 3242.

Waizah Y, Anegbeh PO, Orimoloye JR, Eguavoen IO, Idoko SO, Izevbigie FC (2011).The efficacy of poultry manure and inorganic fertilizers in improving soil fertility and growth of rubber seedlings in Iyanomo Southern Nigeria. J. Agric. Prod. Tech. 1(2):66-74.