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Comparative Study of the Effects of Corn Wastes and Poultry Dropping Composts with Inorganic Fertilizer on Soil N and P Mineralization, PH and Microbial Activities under Laboratory Conditions.

[1]Ogunrewo O. M., [2]Olayinka A., [3]Taiwo L. B.

[1]*Department of Agricultural Sciences, Wesley University, Ondo (WUO), Ondo State, Nigeria.*

[2]*Department of Soil Science and Land Resources Management, Obafemi Awolowo University (O.A.U), Ile-Ife, Nigeria.*

[3]*Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan, Nigeria.*

**Corresponding author: bolabusuyi@yahoo.com, 08068657224.*

Abstract
The comparative effects of corn waste and poultry droppings composts with inorganic fertilizer on N and P mineralization, pH and microbial activities in soil were assessed in a laboratory incubation study with a view of studying the effectiveness of corn waste compost as amendment for a degraded soil. The study was conducted in the Soil Microbiology Laboratory, Department of Soil Science and Land Resources Management, Obafemi Awolowo University, Ile-Ife, Nigeria. The experiment was arranged in a Completely Randomized Design (CRD) with 3 replicates. The treatments were: control, three corn waste composts (corn waste boiled with salt, corn wastes boiled with water alone, corn waste not boiled all), poultry droppings compost and inorganic fertilizer (N.P.K. 20:10:10). The composts were added at the rate of 5t/ha while the NPK was added at the rate of 25 kg N/ha. Mineralized N and P as well as CO_2 evolution were assessed in the incubated soil fortnightly over a period of 16 weeks. Soil pH was also evaluated at the end of the incubation period. Corn wastes and poultry dropping composts increased N and P contents over the control throughout the period of incubation, with the highest values obtained in the unboiled corn waste compost, with values of 2.53 and 151.56 mg/kg, respectively. Corn wastes and poultry droppings composts improved soil pH and increased microbial activities in the soil over the control throughout the period of incubation with the highest values observed in corn waste compost that was not boiled (F_3) which gave 71.1 mg C/100g. Application of unboiled corn waste compost (F_3) giving the highest content for N and P nutrients is therefore recommended.. It also recommended as it gave the highest pH though all the composts had liming effects as against inorganic fertilizer that showed acidifying capacity. Microbial activities was highest at 4th week of incubation as maximum CO_2 evolution was observed at that time for all the compost incubation. Application of corn waste composts without any major heat treatment could therefore be recommended for soil fertility parameters improvement rather than leaving them on the farm to constitute environmental hazard.

Keywords: Nitrogen, Phosphorus, Compost, mineralization, pH.

Introduction
The continuous depletion of soil fertility in the tropics continues to be a common experience by farmers, resulting in low crop yields and poor economy in the area (Ovie *et al.,* 2013). This is because more pressure is being put on the soil being cultivated yearly in order to feed the ever-increasing global population (Owino *et al.,* 2006). The use of inorganic fertilizer has been a major method employed by local farmers worldwide to improve soil fertility. However, this practice has not been sustainable due to a number of

shortcomings associated with its use especially in this part of the world. These include unavailability of the fertilizers, economic constraints when available and adverse effects on soil physical and chemical properties (Isherwood, 2008) among several others. These have forced farmers to search for alternative sources of replenishing soil nutrients. One of such solutions is the use of organic fertilizers which include materials such as rice bran, cow dung, livestock wastes, composts, farmyard manure and crop residues among several others. The use of these waste materials not only provide nutrients for plant growth but also serve as a means of their disposal from their point of generation where they are usually found to be constituting environmental and health hazards (Taiwo *et al.,* 2008). They also have the advantage of making the nutrients plant-available gradually over time on a consistent basis unlike in inorganic fertilizers, where the nutrients are supplied in a boom-and- burst pattern **(**Onweremadu *et al.,* 2010**)**. In an ecosystem, compost can be useful for erosion control as well as land and stream reclamation. Placing of compost materials on steep slopes, tops and bottoms of slopes and other land areas susceptible to erosion helps to slow down the velocity of water while at the same time nutrients are being added to the soil in such areas (Ogunrewo, 2015).

The use of compost is, however, not without disadvantages. The space used in composting can be in use for a whole year, thus making such unavailable for planting activities. Some nutrients might also be leached due to exposure to rainfall if the compost materials are not properly covered or kept in the process of composting. Another constraint in the use of composts is that they are usually needed in large quantities for application. This makes it difficult to use when a large area of land is to be cultivated as a high cost of transportation and labour will be involved. Moreover, in compost use, disease-producing organisms and insects may not be adequately controlled, thus causing the prevalence of some disease pathogens. This occurs especially when the compost is not allowed to properly cure before application to the soil, making it attractive to pests and disease pathogens, and also causing weed proliferation (Zia *et al.,* 2003). Improperly cured composts usually have wide C:N ratios that make nutrients like N to be immobilized and unavailable to plants (Olayinka, and Adebayo, 1989; Olowoake and Adeoye, 2012). Emission of foul odour is another disadvantage attached to compost utilization. This is due to the production of gases such as H_2S, amines and sulphamines during the composting process. Other gases such as methane and phosphine produced in the process can also be inflammable which on continuous accumulation can self ignite. Hence, care and caution must be applied in the process of compost making (Odeyemi, 1983; Ogunrewo, 2015).

Plant nutrients in soil can either be needed in large or small quantities with nitrogen and phosphorus being example of such needed in large quantities. Nitrogen (N) is important as a constituent of various cell structures, involved in various cell and tissue processes, useful in nitrogen fixation, enzyme formation and enzyme activities. Phosphorus (P) on the other hand is important for root development, plant growth, nodulation in plant roots and symbiotic nitrogen fixation in legumes (Daramola and Taiwo, 1997). Phosphorus is also important in the formation of energy constituents in the cell such as ATP and ADP. The interplay of N and P has profound effects on soil fertility, plant health and productivity (Kuma and Rao, 1991); hence an optimum amount of both is very essential for effective agricultural practices.

One major attribute of a soil that affects productivity is the soil reaction (soil pH) which refers to the degree of acidity or alkalinity of a soil. This is caused by the relative concentration of H^+ or OH^- ions present in such soil. The pH of a soil will often determine whether or not certain plants can be grown successfully on it. This is most important characteristics of a soil solution that affects nutrient form, nutrient availability, microbial survival, rate of microbial activities, plant growth and ultimately crop yield (Onyewkere, 2005; Onwuka *et al.,* 2010). A soil with low pH can however, be managed by the addition of calcium and magnesium compounds through a process known as liming (Olayinka, 1990a).

This experiment was therefore carried out to compare the effects of amending a degraded soil with composts with inorganic fertilizer on N and P mineralization, microbial activities (using microbial respiration as an index) as well as soil pH under laboratory incubation conditions.

Materials and methods

Experimental site

The experiment was carried out in the Microbiology Laboratory of the Department of Soil Science and Land Resources Management, Obafemi Awolowo University, Ile-Ife, South West Nigeria at ambient temperature (25-27^{0}C). Corn wastes (comprised of sheath and cobs) were collected and subjected to different treatments (as stated below); depicting the various forms in which these corn wastes can be found in our environment. While the corn wastes were composted, the inorganic fertilizer (NPK 20:10:10) was purchased from a farmer's store.

Compost Preparation

Corn wastes (comprised of corn cobs and sheaths) were collected from maize cobs initially boiled with table salts were collected and air dried. The table salt (NaCl) was used to boil maize at the rate of 22g /Kg maize. Corn wastes were also collected from maize that was boiled with ordinary water and those not boiled at all. The corn wastes were chopped and broken into small pieces after air drying. The air dried corn wastes were loaded with poultry manure into big black pots at a ratio of corn waste to poultry manure of 3:1 and wetted. Big plastic pipes were inserted into the pots to facilitate aeration and allow for emission of gases in the course of the composting. Another pot was also set up for composting poultry manure alone. The materials were left to compost for 14 weeks after which samples were taken from the different composts and analysed for their respective nutrient contents. The composts were kept in air tight, big, black cellophane bags prior to use in the laboratory.

The treatments involved in the experiment were as follows:

1. Control (soil only) - (F_0)
2. Soil + 5 t/ha compost of corn wastes boiled with wate and NaCl salt - (F_1)

3. Soil + 5 t/ha compost of corn wastes boiled with water only - (F_2)
4. Soil + 5 t/ha compost of un-boiled corn wastes - (F_3)
5. Soil + 5 t/ha compost of poultry droppings - (F_4)
6. Soil + 25 Kg N / ha NPK 20-10-10 fertilizer - (F_5)

Nitrogen and Phosphorus mineralization

One hundred gramme (100g) portions of soil, on dry weight basis (dwb), were amended with 0.21 g of the composts above at the rate of 5 t/ha and 0.005g of NPK 20-10-10 was added at the rate of 25Kg N/ha. The soil and amendments were thoroughly mixed by hand and returned into 500 ml glass jars. The treatments were set up in triplicates and wetted with distilled water to 70% of the field moisture capacity (FMC). The jars were arranged in a Completely Randomized Design (CRD) and incubated at ambient temperatures (25^0C – 27^0C) for 16 weeks. 2g samples were taken fortnightly from each glass jar to determine N and P mineralized. Available P was determined using the modified Bray-1 technique (Kuo, 1996) while the mineralized N was determined with the steam distillation method of Bremner and Keeney (1966).

pH and microbial activities

Another 100g of soil was amended and set up as described above. Vials containing 10ml of 1M NaOH were lowered into each glass jar and tightly capped. Every fortnight, the CO_2 evolved was determined using the double acid titration method of Anderson (1982).

For pH determination, 10g of soil was further sub-sampled from each jar and glass electrode was used to read the pH both under distilled water and under $CaCl_2$. The experiment was terminated at the end of 16 weeks.

Statistical analysis:

Statistical analyses of all data collected were carried out using ANOVA at 0.05 level of significance. Separation of means were done using the Duncan's New Multiple Range Test (DNMRT) with SAS (SAS, 9.1 version 2002-2003).

Results and Discussion

Physical and Chemical Properties of the Soils Used for the Experiments

The physical and chemical properties of the soil used for the laboratory incubation are presented in Table 1. The soil contained 4.6, 2.6 and 2.8 percentage sand, silt and clay respectively, showing a textural class of Sandy clay loam. The pH values were 5.4 and 4.9 in water and 0.01M $CaCl_2$, respectively, both signifying acidic reaction. This is typical of continuously cropped tropical soils. The organic matter and organic C contents of 10.3 g/kg and 6.0 g/kg, respectively were low while available P content (13.4 mg/kg) was just medium. Total N content was 0.5 g/Kg and this is typical of tropical soils which are usually low in N content. The exchangeable Ca^{2+}, Mg^{2+}, K^+ and Na^+ contents were 3.76, 1.64, 0.43 and 0.09 cmol/kg, respectively also signifying low fertility status (Table 1).

Table 1: Physical and Chemical Properties of the Soil Used for the Laboratory Incubation Experiments.

Particle Size Analysis (g / kg)	
Sand	460
Silt	260
Clay	280
Textural Class	Sandy Clay Loam
Bray-1 P (mg / kg)	13.4
pH (H_2O) 1:1	5.4
pH ($CaCl_2$) 1:2	4.9
Organic matter (g / kg)	10.3
Organic C (g / kg)	6.0
Total N (g / kg)	0.5
C:N ratio	12
Exchangeable cations (cmol$^{(+)}$/kg)	
Ca^{2+}	3.76
Mg^{2+}	1.64
K^{+}	0.43
Na^{+}	0.09

Chemical Properties of the Corn Waste Materials Prior to Composting.

The un-boiled corn wastes (F_3i) had the highest organic carbon content (81.0 g/kg) while corn wastes boiled with water and NaCl salt (F_1i) and corn wastes boiled with water alone (F_2i) had similar contents of 76.7 and 72.3 g/kg respectively (Table 2). This amounts to 5.3% and 10.7% reductions, respectively when compared to the unboiled. The lower organic carbon (OC) contents of the boiled corn wastes may be due to the removal of the soluble C by heat during the boiling treatment. This is in line with the findings of Miko (1995) that observed that an increase of in soil temperature could lead to a loss of over of organic carbon both in temperate and tropical regions. The total N contents for corn waste boiled with NaCl salt (F_1i) and corn waste boiled with water only (F_2i) were similar with values of 9.0 and 9.1 g/kg, respectively, while that of unboiled corn waste (F_3) was double (18.1 g/Kg) (Table 2). Boiling the first two amendments with NaCl salt and water respectively may possibly be responsible for their lower total N contents as nitrogen is soluble in water and volatile under high temperatures (Battino *et al.,* 1994; Olayinka, 2003).

For total P contents, corn wastes boiled with water only (F_2i) had the lowest value (1.0 g/kg), while corn wastes boiled with NaCl salt (F_1i) and the unboiled corn wastes (F_3i) had 4.0 and 3.7 g/kg, respectively. More of P was probably solubilized in the water-only boiled compost. The unboiled

Table 2: Chemical properties of the corn waste materials used for the organic fertilizers prior to composting.

Materials	Organic C	Total N	P	K	Ca	Mg	Na	C:N
	←			g / kg			→	
F_1i	76.7	9.0	4.0	2.6	2.3	0.7	8.3	9
F_2i	72.3	9.1	1.0	3.0	2.6	0.9	3.0	8
F_3i	81.0	18.1	3.7	4.7	3.3	1.0	3.0	5

Where, F_1i = Corn wastes boiled with water and NaCl salt
F_2i = Corn wastes boiled with water only
F_3i = Un-boiled corn wastes

corn wastes (F_3i) had the highest values for K, Ca and Mg which were 4.7, 3.3 and 1.0 g/kg respectively. These high cation values can be attributed to the nutrients in the wastes not reduced through boiling or heat application. However, the corn wastes boiled with NaCl salt (F_1i) had the highest Na value (8.3 g/kg) compared with that boiled with water only (F_2i) and the unboiled corn wastes (F_3i) whose Na values for both were about one third of the corn wastes boiled with salt (F_1i). This is expected as the first treatment was boiled with NaCl salt. The C: N ratios of the corn waste materials which were: 9, 8 and 5 respectively for corn wastes boiled with NaCl salt, corn wastes boiled with water only and the un-boiled corn wastes (F_1i, F_2i and F_3i) respectively were within levels that are appropriate for good crop cultivation (Table 2). The amendments made of un-boiled corn wastes (F_3i) had the lowest C:N ratio probably because more N than C may have been lost in F_1i and F_2i through boiling.

Chemical Properties of the Composts Used for the Experiments

The pH values of compost of corn wastes boiled with salted water (F_1); boiled with water only (F_2); un-boiled corn wastes (F_3) and poultry droppings (F_4) were 8.1, 7.8, 7.9 and 8.0, respectively (Table 3). These pH values being slightly alkaline were expected to improve the reaction of the incubated soil which was initially acidic. Total N contents of the composts were higher than that of the soil used for this experiment with the N values for Composted corn wastes boiled with NaCl salt (F_1), composted corn wastes boiled with water (F_2) and composted unboiled corn wastes (F_3) being 3.2, 3.5 and 2.9 g/kg, respectively, and composted poultry droppings (F_4) having the highest value of 12.6 g/kg. Hence, these composts are expected to enhance the soil N contents and improve the soil properties in the course of the experiment.

Total P contents for F_1, F_2 and F_3 were very high with values of 1.1, 1.0 and 1.6 g/kg, respectively. The P value of composted poultry droppings (2.4 g/kg) was higher than those of composted corn wastes boiled with NaCl salt (F_1) and composted corn waste boiled with water only (F_2) by about 100%. The C:N ratios of the four composts were moderate and within the range appropriate for proper plant growth as composted corn wastes boiled with salt (F_1), the compost of corn wastes boiled with water only (F_2), the compost of un-boiled corn wastes (F_3) and the compost of poultry droppings (F_4) had values of 16, 17, 17 and 12 respectively. The C: N values of the three corn waste composts (F_1, F_2 and F_3) were higher compared to that of the composted poultry droppings (F_4). This might be due to the carbonaceous nature of the corn wastes used in preparing the composts F_1, F_2 and F_3, making more C available. Total K and Na contents were highest from compost of unboiled corn wastes (27.6 and 24.3 g/kg, respectively) while Ca and organic C contents was highest in compost of poultry manure (135.5 and 152.8 g/kg, respectively). The cations which are generally high in the different composts would ultimately make more nutrients available for the plants cropped on the soil

Table 3: Chemical properties of the organic fertilizers produced from corn wastes and used as amendments.

Organic Fertilizers	pH (water)	Organic C	N	P	K	Ca	Mg	Na	C:N
		Total (g / kg)							
F_1	8.1	51.0	3.2	1.1	22.8	46.5	9.1	30.8	16
F_2	7.8	61.0	3.5	1.0	21.4	65.6	1.4	23.5	17
F_3	7.9	50.0	2.9	1.6	27.6	54.4	9.4	24.3	17
F_4	8.0	152.8	12.6	2.4	14.8	135.5	12.3	17.2	12

Where, F_1 = Composted corn wastes boiled with water and NaCl salt
F_2 = Composted corn wastes boiled with water only
F_3 = Composted un-boiled corn wastes
F_4 = Composted poultry droppings

(Olayinka *et al.,* 1998) after application.

Effects of Corn Wastes and Poultry Droppings Composts compared with Inorganic Fertilizer on Mineralized N (%) Over a 16 Weeks Period of Incubation in the Laboratory.

The amounts of mineralized N in the control were significantly ($p < 0.05$) lower than that of the other treatments throughout the 16 weeks of incubation (Fig 1). Thus, the treatments had significant ($p < 0.05$) effects on N mineralized. At weeks 2 and 4, Inorganic fertilizer (F_5) had the highest N mineralization and was significantly ($p < 0.05$) higher than the remaining treatments while compost of un-boiled corn wastes (F_3) had significantly ($p < 0.05$) higher N contents than the other treatments from week 6 till the end of the incubation period. The higher values of mineralized N in the inorganic fertilizer treatment at the initial stage of incubation (2-4 weeks) might be attributed to the immediate release of nutrients commonly associated with inorganic fertilizer use. This is in line with the findings of several workers (Adekunle *et al.,* 2004; Akanni and Ojeniyi (2011). The lower values observed in the mineralized N after the 4th week from inorganic fertilizer could be attributed to immobilization of N by soil microorganisms or nutrient loss to soil structural degradation commonly associated with inorganic fertilizer use (Makinde and Ayoola, 2009; Lawal *et al.,* 2010). The higher level of mineralized N observed in the compost of unboiled corn wastes (F_3) from week 6 till the end of the incubation period could be as a result of high release of the nutrients due to decomposition or mineralization of the said compost.

There were no significant ($p < 0.05$) differences in the composted corn wastes boiled with salt (F_1), composted corn wastes boiled with water only (F_2) and composted poultry manure (F_4) from Week 6 till the end of the incubation process (Fig 1). This shows that the rates of N mineralization in these different composts were similar at this point and that most of the N nutrient had been mineralized by that time. For the un-boiled corn wastes compost (F_3), an initial period of immobilization was observed to be followed by a phase of N mineralization (Fig 1). This confirms that the nutrient (N) from the composted un-boiled corn wastes (F_3) was being released gradually over time unlike what was observed in the inorganic fertilizers, where the nutrients are often being made available in a 'boom and burst" pattern (Babadele and Ojeniyi, 2013a).

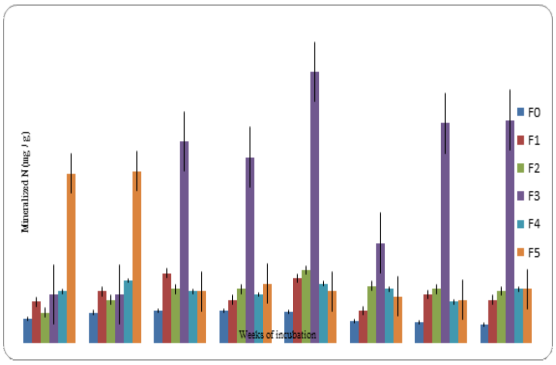

Figure 1: Mineralized N (mg / g) of soil amended with composted corn wastes and poultry droppings over a period of 16 weeks of incubation in the laboratory.
Where F_0 = Control (soil only) F_1= Soil + 5 t/ha composted corn wastes boiled with water and NaCl salt
F_2 = Soil + 5 t/ha composted corn wastes boiled with water only F_3 = Soil + 5 t/ha composted un-boiled corn wastes F_4 = Soil + 5 t/ha poultry droppings composted
F_5 = Soil + 25 Kg N /ha NPK 20-10-10 fertilizer

Effects of Corn Wastes and Poultry Droppings Composts and Inorganic Fertilizer on Mineralized P (mg / kg) over a 16-week Period of Incubation in the Laboratory.

The mineralized P increased weekly up to the end of Week 10 and thereafter declined till the end of the incubation for all the treatments (Fig 2). The control was however lower than most of the other treatments depicting the significance of the experiment. A sharp decline was observed at week 12 of the incubation signifying that most of the P had been mineralized by the 12th week. At Weeks 4, 8 and 12, there were no significant ($p < 0.05$) differences in the P mineralized by the control and the inorganic fertilizer (F_5) treatments (Fig 2). This similarity might be due to the acid-producing effect of inorganic fertilizer on soils after a while which usually results in Al and Fe toxicity. These Al and Fe ion produced can fix P, thereby reducing the amount mineralized or detected of P in the incubation process (Senjobi *et al.,* 2013).

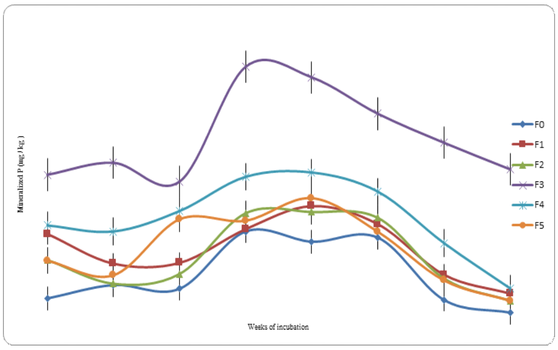

Figure 2: Mineralized P (mg / kg) in soil amended with corn wastes and poultry droppings composts over a period of 16 weeks of incubation in the laboratory.
Where: F_0 = Control (soil only; F_1= Soil + 5 t/ha composted corn wastes boiled with water and NaCl salt; F_2 = Soil + 5 t/ha composted corn wastes boiled with water only F_3 = Soil + 5 t/ha composted un-boiled corn wastes; F_4 = Soil + 5 t/ha poultry droppings composted; F_5 = Soil + 25 Kg N /ha NPK 20-10-10 fertilizer

All through the incubation period, the mineralized P in the composted un-boiled corn wastes (F_3) was significantly ($p < 0.05$) higher than that in the other treatments. This high value was followed by that of composted poultry droppings (F_4) (Fig 2).

This trend can be attributed to the fact that P contents in F_3 and F_4 was higher than in the other composts initially (Table 3).

Amount of P mineralized from the inorganic fertilizer treatment (F_5) was not significantly ($p < 0.05$) different from that of the control (F_0) at the end of weeks 4, 8 and 12 and was even lower at the end of Week 6. This could be due to the fact that the inorganic fertilizer had acidic effects that facilitated the process of P immobilization (Olayinka, 1990b). There were no significant ($p < 0.05$) differences in the mineralized P from the compost of corn wastes boiled with salt (F_1) and compost of corn wastes boiled with water only (F_2) over the 16 weeks of incubation except at the end of Week 2 where the compost of corn waste boiled with water only (F_2) gave a significantly ($p < 0.05$) lower value. Boiling the corn wastes with table salt or with water alone, thus, gave a similar effect on mineralized P in the laboratory incubated soil (Fig 2).The low P levels could be as a result of heat treatment on the corn wastes for both composts.

The pH of the Soil Amended with Corn Wastes and Poultry Droppings Composts and Inorganic Fertilizer at the End of a 16-week Incubation Period in the Laboratory.

The pH of the control (F_1) was lower than that of all the other treatments except for that of the inorganic fertilizer (F_5) (Table 4). The pH observed after application of inorganic fertilizer depicted an acid reaction at the end of the 16 weeks of incubation. This confirms that the application of inorganic fertilizer to a soil may likely give an acidic effect over a period of time. This is in line with the work of several workers that shows that inorganic fertilizers after a period of time begin to have acidifying effects and can have detrimental effects on the soil to which it is applied and its structure (Lawal *et al.,* 2010; Ojeniyi, 2012). The low trend observed in the control might therefore be due to the depletion of nutrients especially the exchangeable cations leaving majorly H ions behind on the exchange complex.

Table 4: The pH of the soil amended with corn wastes and poultry droppings composts and inorganic fertilizer at the end of a 16-week incubation period in the laboratory.

	pH	
Treatments	**H_2O**	**$CaCl_2$**
F_0	4.5	3.6
F_1	7.9	6.8
F_2	8.1	7.2
F_3	9.6	8.2
F_4	10.1	8.8
F_5	4.7	3.1

Where, F_0 = Control (soil only)
F_1= Soil + 5 t/ha compost of corn wastes boiled with water and NaCl salt
F_2 = Soil + 5 t/ha compost of corn wastes boiled with water only
F_3 = Soil + 5 t/ha compos of un-boiled corn wastes
F_4 = Soil + 5 t/ha poultry droppings composted
F_5 = Soil + 25 Kg N /ha NPK 20-10-10 fertilizer

All the composts (F_1, F_2, F_3 and F_4) gave pH values in the alkaline range with compost of poultry droppings (F_4) giving the highest value of 8.8 (Table 4).This emphasizes the fact that composts have liming properties as they contained exchangeable cations like Ca, Mg and K (Olayinka, 1990a; Ojeniyi and Adeniyan, 1999) and thus were capable of increasing the soil pH which was initially acid in nature as observed in Table 1.

Carbon dioxide (mg C/100 g soil) Evolution from Soil Amended with Corn Wastes plus Poultry Droppings Composts and Inorganic Fertilizer over 16 Weeks of Incubation in the Laboratory.

The amounts of CO_2 (mg C/100g soil) evolved from the soil amended with corn wastes and poultry droppings compost and inorganic fertilizer over a 16-week period

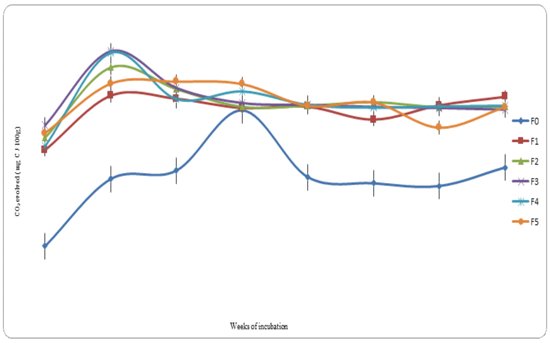

Figure 3: Carbon dioxide (mg C / 100 g) evolution from soil amended with corn wastes and poultry droppings composts and inorganic fertilizer over a period of 16 weeks of incubation in the laboratory.

Where, F_0 = Control (soil only)

F_1 = Soil + 5 t/ha composted corn wastes boiled with water and NaCl salt

F_2 = Soil + 5 t/ha composted corn wastes boiled with water only

F_3 = Soil + 5 t/ha composted un-boiled corn wastes

F_4 = Soil + 5 t/ha poultry droppings composted

of incubation at ambient temperatures (25^{o}C- 27^{o}C) are shown in Figure 3. There was a flush of CO_2 evolution between the 2nd and 4th weeks followed by a plateau in the CO_2 evolution and then a decline as the incubation process proceeded. This trend of 4-week flush was in line with the observations of several workers (Olayinka and Adebayo 1984; Ogunbusuyi, 2008). These workers suggested that the flush might be due to high availability of nutrients for microbial respiration at that phase. They further suggested that once the composts are highly carbonaceous, there will be high release of CO_2 at this time as the microbes gets more material to feed on thus becoming more active. The CO_2 evolution in the control was significantly ($p < 0.05$) lower than the amounts evolved in all the other treatments across the weeks. This was in line with the observations of Olayinka and Ailenhubi (2003) where the applications of organic amendments significantly ($p < 0.05$) increased CO_2 evolution over the control. This they suggested may be due to the stability of the indigenous soil humus in the control. No significant ($p < 0.05$) difference was, however, observed in the CO_2 evolution of the treatments F_1, F_2, F_3 and F_4 from Week 6 till the end of the incubation process. This may mean that for these treatments, the more recalcitrant organic fractions had accumulated after the 4th week and were still being attacked by the microorganisms (Fig 3).

Conclusion

The laboratory incubation results showed that the corn wastes and poultry droppings composts increased N as well as P contents in the soil after incubation in the laboratory over a period of 16 weeks. It can also be concluded from the research that most of the N and P nutrient had been mineralized by the 6th week with the unboiled corn waste compost (F_3) showing the highest value at this time. The amendment of the soil with organic composts under laboratory incubation experiments also revealed that the CO_2 increased to a certain level precisely about the 4th week for all the compost treatments, plateau and then decline towards the end of the incubation period. This emphasizes that 4th week connotes time of maximum CO_2 evolution. The unboiled corn waste compost (F_3) however gave the hugest value of CO_2 value.

While the pH level was increased by all the organic amendments in this experiment, the reverse was the case with the inorganic fertilizer and the control. This confirms that composts have liming capacity as against inorganic fertilizers that enhances soil acidity.

It would therefore be recommended that rather than allow farm residues and wastes such as corn wastes and poultry manure to be a source of environmental pollution, they can be effectively used in amending depleted soils by composting them before application to the soil. Soil fertility index such as N and P contents, soil pH and microbial activities can be improved by applying these composts and left in the soil for a while before cropping as against inorganic fertilizer application. This will ultimately enhance crop yield and result in more money for our farmers at a very little cost of production.

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