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Residual Effect of Compost, Compost Tea and Inorganic Fertilizer on Growth, Yield and Nutrient Composition of Maize (Zea mays L.)

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Abstract

The use of organic amendments has contributed immensely to crop yield and productivity due to their agronomic and environmental benefits. Among these benefits is the ability of organic amendments to stay longer in the soil unlike inorganic fertilizers. Greenhouse experiment was conducted to compare the residual effect of dry compost, compost tea and inorganic fertilizer on the growth, yield and nutrient uptake of maize (*Zea* mays *L.)* immediately after the first planting. The initial treatments consisted of dry compost (made from Mexican sunflower and poultry manure), compost tea (water extract from dry compost) and inorganic fertilizer (N.P.K 15:15: 15). Dry compost was applied at three levels (5, 10 and 15 t ha^{-1}), compost tea (200, 400 and $600m^3$ $ha^{-1)}$ and inorganic fertilizer at 100 and 150kg N ha^{-1}. These were arranged in Completely Randomized Design (CRD) with four replicates. Data were collected on growth and yield parameters, pre and post-planting soil nutrient compositions as well as plant nutrient analysis. Results showed that compost application generally enhanced the growth and dry matter accumulation of maize in the residual trial compared to compost tea and inorganic fertilizer. However, compost had significant effects on the growth and yield of the maize compared to compost tea and inorganic fertilizer with the highest mean values recorded in maize crop treated with dry compost at 15t/ha. This treatment increased the dry matter yield by 144% compared to control and inorganic fertilizer treatments. Plant tissue and post cropping soil nutrient analyses also revealed that application of organic amendments increased the residual concentration of phosphorus, potassium and calcium both in the soil and in the maize plant. Highest rate ($600m^3ha^{-1}$) of compost tea however increased growth and yield parameters compared to other rates in the residual trial. In conclusion, residual effect of compost is more pronounced on growth, yield and nutrient uptake of maize compared to compost tea and inorganic fertilizer.

Keywords: Compost; Yield; Mexican sunflower; Compost tea

Introduction

Increase in human population had resulted to intensive cultivation without adequately replenishing soil nutrients. However, one major constraint affecting agricultural productivity in Africa has been identified as low soil fertility. The effect of soil fertility decline is reduction in food production. In order to sustain soil and crop productivity, it is necessary to explore alternative soil fertility replenishment strategies which are effective and affordable to farmers and the major way to improve soil fertility is to replenish soil nutrient, this may therefore be accomplished through the application of organic and inorganic fertilizer. Long term application of inorganic fertilizer has resulted in soil degradation, loss of organic matter, change in soil microbial biomass as well as health and environmental hazard (Pimentel, 1996). Also, excessive application of inorganic fertilizer has created risk of soil degradation and environmental pollution (Lachance and Rouleau 2004). Overreliance on use of inorganic fertilizers has been associated with decline in crop yield and soil properties over time (Hepperly *et al.* 2009) and significant land problems, such as soil degradation due to over exploitation of land and soil pollution caused by high application rates of fertilizers (Singh, 2000). Meanwhile, the use of organic fertilizer for soil fertility management is now being preferred to the conventional method due to its benefits which include: environmental friendliness, cost effectiveness, improves soil microbial population, increase soil nutrient, and most especially, its long term effect on the succeeding crop unlike the conventional methods of farming. Residual effect of organic fertilizer added to the soil has a carry-over benefit on the succeeding crop (Kihanda *et al.* 2006). Organic fertilizer nutrients are not fully available to the crops in the season of its application (Eghball, 2002), therefore, enough nutrients will be available for the succeeding crop.

Organic fertilizer in form of compost is now preferred to inorganic fertilizer because it is considered as a traditional way of returning organic matter to the soil. Compost is said to be rich in organic compound and its application to the soil has been found to improve soil fertility (Togun *et al.* 2003). It is believed (Ginting *et al.* 2003) that adding considerable quantities of compost to agricultural land, improves soil organic matter thereby leaves a significant residual effect on soil for several years after its application ceases.

In modern agriculture, the use of compost tea for crop production has been utilized as a good source of organic matter in soil amendments. Compost tea is derived when a known quality of composted material soaked in water for fermentation to occur (Litterick *et al.* 2004). Sometimes, it's being preferred to dried compost due to its soluble nutrients and most especially, compost tea suppresses plant diseases and pathogen (Abbasi *et al.* 2002). It Improves crop production by decreasing disease incidence, improving plant nutrient status and generally promoting plant growth (Arancon *et al.* 2007; Hargreaves *et al.* 2008). Some researchers defined compost tea as fermented watery extracts of composted materials that are used for their beneficial effects on plants, including antimicrobial activities (Dionne *et al.* 2012; Deschêne, 2007; Ghorbani *et al.* 2006.). However, regular addition of organic manure to the soil improves soil fertility, hence improves crop production.

The research work being reported here compared the residual effectiveness of compost, compost tea and inorganic fertilizer (NPK) on the growth, yield and nutrient uptake of maize (*Zea mays L.)* under pot condition.

Materials and Methods

In order to access the residual effect of compost, compost tea and inorganic fertilizer on maize yield and nutrient uptake, an experiment was conducted at the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria ($7^0$24'N, $3^0$54'E) between June-August, 2012 and August-October, 2012 respectively, where the mean rainfall ranges from 1,000–2,000mm and annual mean temperature ranges from 21^0C and 28^0C.

Compost and Compost Tea Preparation

Compost was prepared from *Tithonia diversifolia (*Mexican sunflower*)* and poultry manure which was prepared four months before planting at the ratio 3:1 by weight. *Tithonia* was chopped, weighed and mixed with poultry manure using Partially Aerated Composting Technique (PACT-2) by Adediran *et al.* (2001).

Compost tea was obtained by water extraction from dried compost. The extraction procedure was adapted from the one proposed by Denschene, (2007). From a mixture of 1:4 compost/tap water W(g)/V (L). 500g of dried compost soaked with 2litres of water, covered inside a perforated plastic bucket for two weeks.

Greenhouse Experiment

The soil was sieved and 5kg soil was weighed into 5kg capacity experimental pots. The pots were arranged to fit in a complete randomized design (Steel &Torrie, 1980) and were replicated four times. The treatments included three levels of dry compost (5, 10 and 15t/ha), three levels of compost tea (200, 400 and $600m^3ha^{-1}$) and two levels of inorganic fertilizer (100 and 150kg Nha^{-1}). The compost and compost tea were applied two weeks before planting. The inorganic fertilizer was applied two weeks after planting. The variety of maize used was SUWAN-1SR which was obtained from the Institute of Agricultural Research and Training, Ibadan, Oyo state.

Four seeds per pot were planted and then thinned to two plants per pot three days after germination. Data were collected on Plant height, Leaf area, number of leave/plant and dry matter accumulation. For dry matter accumulation, maize plants were harvested eight weeks after planting. Each pot contained two maize plants. The roots of the harvested maize plants were washed inside water and the washing continues until all the soil particles were removed. The maize plant was partitioned into root and shoot (containing the leaves and the stem). The yield components harvested were the root and the shoot of the maize plant. They were oven-dried at a temperature of 60ºc for 48 hours and their weights recorded as total dry matter per pot.

Shortly after harvest, residual trial experiment was carried out. The treatments and the experimental design were the same with first trial. The same data collected for first planting were also collected for the residual experiment.

Soil Analysis

Soil samples were taken at random from the pots and were mixed together for homogeneity, prior to setting of the experiment. Samples were air dried, ground and sieved (2mm) and was taken for physico-chemical analysis such as $pH(H_20)$, exchangeable bases, total nitrogen, zinc (Zn) as well as organic carbon. The total nitrogen of the soil was determined by the macro kjedahl techniques using selenium tablets and boric acid as an indicator while phosphorus was determined by colorimetric method, potassium and sodium by flame photometry while calcium, zinc, iron and magnesium concentrations were determined using AAS as described by IITA (1982) after digestion with 0.1NHCl. Soil pH determination was by a pH meter (Electrometric Method), Organic carbon and Organic matter were determined by Walkley-black method as described by Nelson and Sommers (1982).

Data were analysed statistically for the Analysis of Variance and the mean of the treatment were separated by Duncan's multiple range test using Duncan D.B (1955). The software used was statistical Analysis System (SAS) version 9.

Results

The result for the pre cropping soil analyses shows that soil used was slightly acidic with a pH (H_20) of 6.37, the soil total N, 0.18%; phosphorus and potassium 18.00mg/kg and 0.27cmol/kg are low. The soil was also low in organic carbon (1.33%). The concentration of calcium, magnesium and sodium, are 0.50, 0.68 and 0.17cmol/kg. This is an indication that the soil was low in some essential elements.

Response of maize growth to residual effect of compost, compost tea and NPK fertilizer at different rates

At the first trial, application of inorganic fertilizer performed better when compared to compost and compost tea although it was not statistically different from compost amendment at 15t ha^{-1}(Fig 1). At the residual trial, it was observed that soil amendment with compost treatments increased the maize plant height from 122.60, 135.02 and 147.27cm to 132.60, 143.72 and 154.57cm respectively, with compost at 15t ha^{-1} having the highest plant height mean value (Figure 1). There was a significant reduction in plant height with the application of compost tea at the three rates and the synthetic fertilizer applied as well as the control plant (Figure 1).

An increase in leaf area development was observed with the addition of all fertilizer types used. As observed in plant height, similar observation was also recorded for leaf area development. An increase in leaf area production was recorded for plant treated with NPK fertilizer at 150kg N ha^{-1} followed by 100kgN ha^{-1} at the first trial. Whereas at the residual trial, reduction in leaf area development was recorded in plant treated with mineral fertilizer and an increased in leaf area development was recorded for plants treated with compost fertilizer. A significant increase in the leaf area was however recorded in plant treated with compost at 15t ha^{-1} followed by that of 10t/ha and they differed significantly from other treatments. The control plant recorded the lowest leaf area when compared to other treatments (Figure 2).

The residual effect of fertilizer on leaf number production was more pronounced in plants amended at compost 15t ha^{-1}. There was an increase in the leaf number produced with soil amended with 15t ha^{-1} dry compost. It increased from 11.00 which was the initial mean value to 11.75 and it differs significantly compared to other fertilizer source applied. A decreased in leaf number was recorded in plant treated with NPK mineral fertilizer at both rates; it reduces from 11.00 and 11.50 to 9.00 and 9.75 respectively. Furthermore, at the second trial, a decrease in leaf number production was also observed in plant treated with compost tea. Although, application of compost tea increased leaf number production compared to the control with the maize plant having the lowest leaf number both at first trial and at the second trial. For all the fertilizer applied, higher rates performed better than their lower rates (Figure 3).

For the residual experiment, a decrease in growth parameters was observed with all fertilizer applied expect for higher rates of dry compost treatments (10 and 15t ha^{-1}).

Table 1: Physio-chemical properties of soil and chemical composition of compost.

Parameters	Soil	Dried compost	compost tea
pH(H_2O)	6.37	5.80	5.83
Organic carbon (%)	1.33	16.7	-
Total Nitrogen (%)	0.18	1.92	1.89
Phosphorus (mg/kg)	18.00	29.48	23.51
Exchangeable base (cmol/kg)			
Potassium	0.27	6.80	4.27
Calcium	0.50	0.43	1.50
Magnesium	0.68	11.87	10.60
Sodium	0.17	14.30	10.17
Extractable micronutrient (mg/kg)			
Iron	2.3	9.73	6.77
Zinc	88	2.05	0.75
Copper	44.5	75.00	79.50
Manganese	88.5	16.00	12.75
Particle size Distribution			
sand	84.5	-	-
Silt	7.4	-	-
Clay	8	-	-

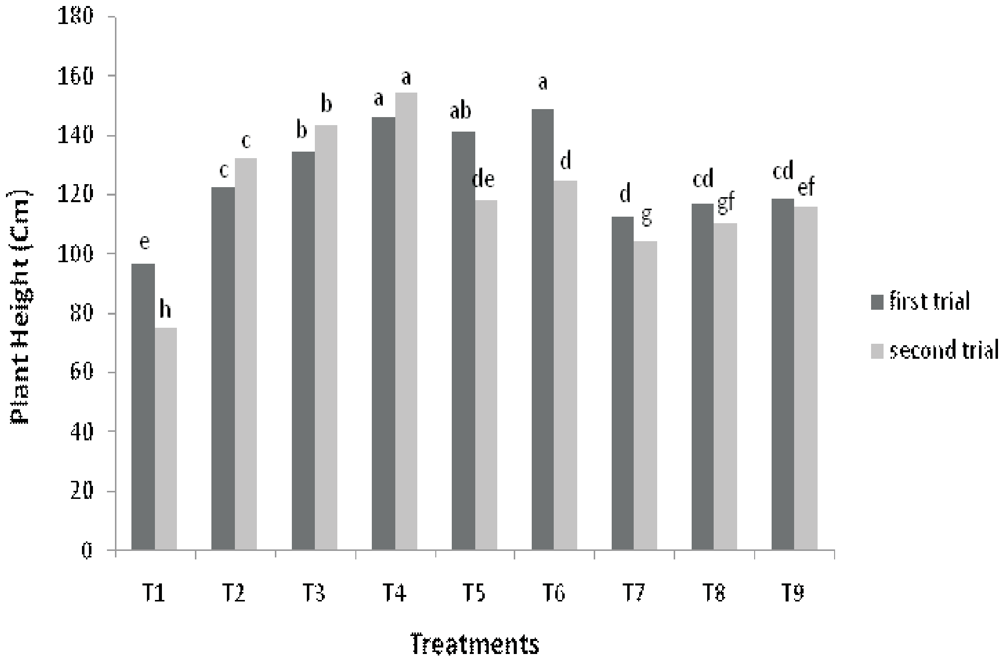

Figure 1: Residual Effect of Treatments on Plant Height of SWAN 1 Maize Variety at Maturity (8weeks after planting).

T_1=No fertilizer, T_2= 5tha^{-1}compost, T_3= 10t ha^{-1} compost, T_4=15t ha^{-1}compost. T_5=100KgN ha^{-1}Inorganic fertilizer, T_6= 150KgN ha^{-1}Inorganic fertilizer, T_7= 200m^3 ha^{-1}compost tea, T_8= 400m^3 ha^{-1}Compost tea, T_9= 600m^{3}ha^{-1}Compost tea.

Means followed by the same letter in the bar chat are not significantly different from each other at $P \leq 0.05$ by DMRT.

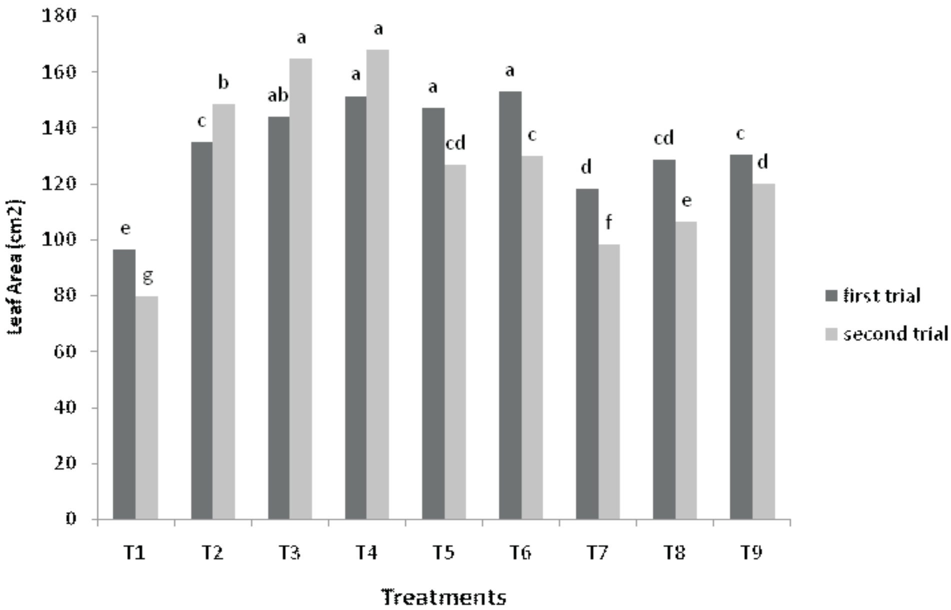

Figure 2: Residual Effect of Treatments on Leaf Area of SWAN 1 Maize Variety at Maturity (8 weeks after planting).

T_1=No fertilizer, T_2= 5tha^{-1}Dried compost, T_3= 10t ha^{-1}Dried compost, T_4=15t ha^{-1}Dried compost. T_5=100KgN ha^{-1}Inorganic fertilizer, T_6= 150KgN ha^{-1}Inorganic fertilizer, T_7= 200m^3 ha^{-1}compost tea, T_8= 400m^3 ha^{-1}Compost tea, T_9= 600m^3 ha^{-1}Compost tea.

Means followed by the same letter in the bar chat are not significantly different from each other at $P \leq 0.05$ by DMRT.

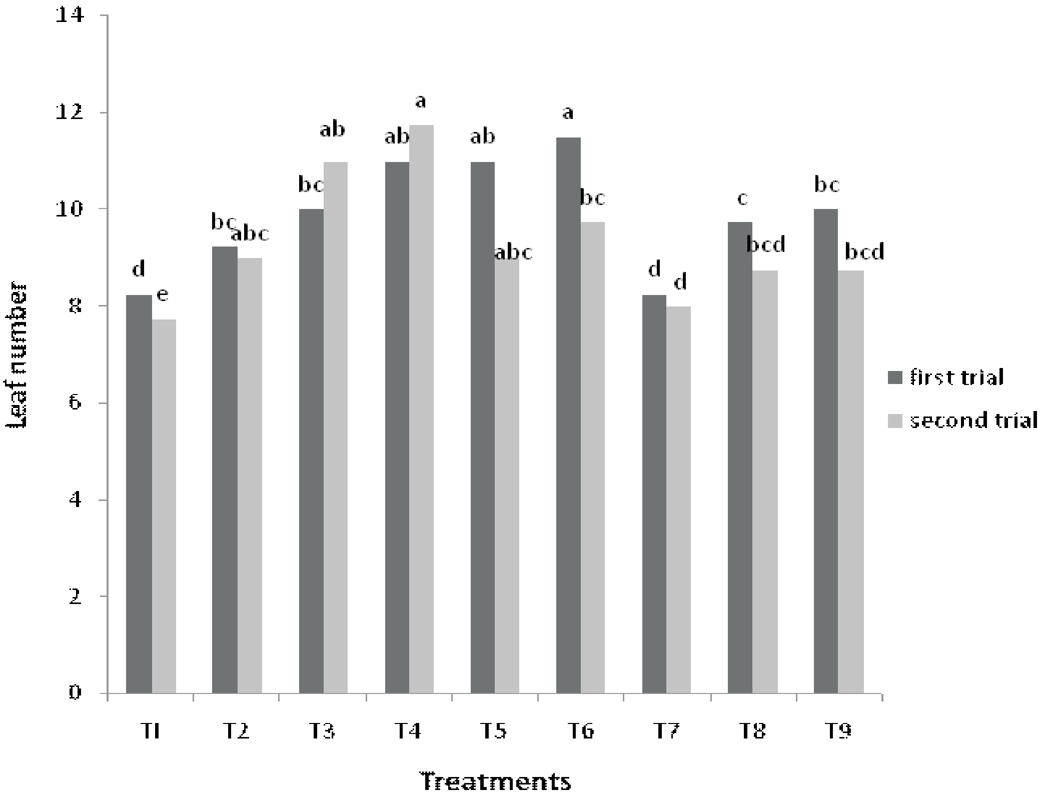

Figure 3: Residual Effect of Treatments on Leaf Number of SWAN 1 Maize Variety at Maturity (8 weeks after planting).

T_1=No fertilizer, T_2= 5tha^{-1}compost, T_3= 10t ha^{-1}compost, T_4=15t ha^{-1}compost T_5=100KgN ha^{-1}Inorganic fertilizer, T_6= 150KgN ha^{-1}Inorganic fertilizer, T_7= 200m^3 ha^{-1}compost tea, T_8= 400m^3 ha^{-1}Compost tea, T_9= 600m^3 ha^{-1}Compost tea.

Means followed by the same letter in the bar chat are not significantly different from each other at $P \leq 0.05$ by DMRT.

Residual effect of compost, compost tea and NPK fertilizer on dry matter accumulation

Application of compost significantly increased the dry matter production, but the highest rate performed better at both trials. Similarly, higher rate of compost tea and synthetic fertilizer (600m^3 ha^{-1} and 150kgN ha^{-1}) gave significant increases in dry matter accumulation when compared to their lower rates, even at both trials. The control plants produced the least dry matter weight both at the first and residual trial (Table 2).

At the residual trial, an increase in shoot fresh and dry matter accumulation was observed with the initial application of compost and compost tea. Their mean values increased from 92.43, 139.00 and 189.74g to 153.24, 191.19 and 210.38g respectively. Dry matter accumulation was reduced with initial application of inorganic fertilizer and compost tea. (Table 2).

Residual effect of compost, compost tea and N.P.K fertilizer on post cropping soil compositions.

In the first trial, it was observed that nitrogen, phosphorus and potassium content was high in soil treated with inorganic fertilizer more than other treatments applied (compost and compost tea). A remarkable reduction in N, P and K content was observed with the application of inorganic fertilizer at the second trial. The reduction was mostly observed in the soil treated with compost tea and inorganic fertilizer. The nitrogen content reduced from 1.63

Table 2: Residual effect of Compost, Compost tea and N.P.K fertilizer on Dry Matter Accumulation of Maize (SUWAN 1).

	DRY MATTER ACCUMULATION(g)			
	First trial		**Residual trial**	
Treatments	**S.F.W**	**S.D.W**	**S.F.W**	**S.D.W**
T1	68.95^{e}	9.95^{f}	50.41^{g}	6.11^{h}
T2	92.43^{d}	17.21^{cd}	153.24^{c}	21.68^{c}
T3	139.00^{ab}	20.13^{bc}	191.19^{b}	27.70^{b}
T4	189.74^{a}	36.91^{a}	210.38^{a}	39.84^{a}
T5	118.28^{ab}	21.09^{bc}	110.37^{d}	15.25^{d}
T6	181.63^{a}	22.75^{ab}	147.53^{d}	15.99^{d}
T7	77.28^{e}	12.81^{e}	75.48^{f}	8.86^{g}
T8	97.74^{cd}	14.37^{dc}	92.59^{e}	10.74^{f}
T9	107.07^{bc}	15.65^{bc}	100.86^{e}	12.99^{e}

Means followed by the same letter in a column are not significantly different from each other at P=0.05 by DMRT.

- SFW: Shoot Fresh weight
- SDW: Shoot Dry weight

and 1.94% to 0.68 and 0.57% respectively in soil fertilized with inorganic fertilizer rates. For the P and K content also, there was a reduction of these elements in soil treated with inorganic fertilizer. Whereas, an increase in phosphorus, potassium, calcium and organic carbon was observed in soil treated with compost, however, compost amended at 15t ha^{-1} recorded the highest mean values of 0.79, 8.24, 13.00 and 2.20% respectively. Reduction in nutrient status was observed in unfertilized soil (control) in all elements analysed (Table 3).

Residual Effect of Compost, Compost Tea and N.P.K Fertilizer on Plant Tissue Nutrient Compositions.

As observed for the post cropping soil nutrient composition, where inorganic fertilizer had the highest nitrogen, phosphorus and potassium content at the first trial, similar trend was also noticed for the plant tissue. Application of inorganic fertilizer recorded the highest mean value for nitrogen, phosphorus and potassium content.

At the second trial, reduction in nitrogen content was observed in all fertilizer types used. However, an increment in phosphorus content was observed in the plant amended with compost and compost tea. A significant reduction was observed with the application of compost tea for all the plant tissue nutrients analysed except for phosphorus content. Compost increased the concentration of other essential macronutrients like Ca and Mg more than inorganic fertilizer and compost tea (Table 4).

Table 3: Residual effect of compost, compost tea and N.P.K fertilizer on post cropping soil nutrient compositions.

Treatments	first trial	Residual trial	first trial	Residual trial	First trial	Residual trial	first trial	Residual trial	First trial	Residual trial
	N%		P(%)		k(%)		ca(%)		org C %	
T1	0.36^{c}	0.19^{c}	0.30^{c}	0.29^{b}	0.43^{a}	0.30^{d}	0.43^{b}	0.40^{e}	1.31^{a}	0.23^{e}
T2	0.53^{b}	0.27^{bc}	0.46^{b}	0.59^{a}	3.87^{abc}	3.56^{abc}	8.45^{ab}	11.20^{ab}	1.54^{a}	1.58^{b}
T3	1.00^{ab}	0.35^{bc}	0.64^{ab}	0.70^{a}	3.98^{abc}	6.84^{a}	8.45^{ab}	11.29^{ab}	1.64^{a}	1.69^{b}
T4	1.09^{ab}	0.39^{bc}	0.77^{ab}	0.79^{a}	4.02^{b}	8.24^{a}	11.75^{a}	13.00^{a}	1.80^{a}	2.20^{a}
T5	1.63^{a}	0.68^{a}	1.61^{a}	0.80^{a}	8.11^{a}	4.63^{abc}	7.29^{ab}	6.10^{cd}	1.50^{a}	0.80^{d}
T6	1.94^{a}	0.57^{ab}	1.98^{a}	0.85^{a}	6.12^{a}	4.60^{abc}	7.44^{ab}	9.90^{bc}	1.52^{a}	0.82^{d}
T7	0.45^{b}	0.30^{bc}	0.44^{b}	0.40^{b}	2.59^{cd}	1.18^{cd}	6.00^{ab}	3.50^{d}	1.53^{a}	1.39^{c}
T8	0.49^{b}	0.32^{bc}	0.49^{b}	0.44^{b}	2.58^{bcd}	2.18^{bcd}	7.44^{ab}	4.07^{d}	1.59^{a}	1.40^{c}
T9	0.50^{b}	0.46^{a}	0.50^{b}	0.46^{b}	2.60^{abc}	2.20^{bcd}	7.60^{ab}	6.00^{d}	1.54^{a}	1.40^{c}

T_1=No fertilizer, T_2= 5tha^{-1}Dried compost, T_3= 10t ha^{-1}Dried compost, T_4=15t ha^{-1}Dried compost, T_5=100KgN ha^{-1}Inorganic fertilizer, T_6= 150KgN ha^{-1}Inorganic fertilizer, T_7= 200m^3 ha^{-1}compost tea, T_8= 400m^3 ha^{-1}Compost tea, T_9= 600m^3 ha^{-1}Compost tea.
Means followed by the same letter in a column are not significantly different from each other at P=0.05 by DMRT.

Table 4: Residual effect of compost, compost tea and N.P.K fertilizer on post cropping plant tissue nutrient compositions.

Treatments	First trial	Residual trial	First trial	Residual trial	First trial	Residual trial	First trial	Residual trial	first trail	residual trial
	N%		P%		K%		Ca%		Mg%	
T1	0.26^{c}	0.20^{c}	0.10^{b}	0.09^{d}	0.43c	0.30^{c}	0.18^{c}	0.10^{b}	0.27^{b}	0.20^{b}
T2	1.09^{b}	0.43^{ab}	0.14^{b}	0.27^{ab}	1.22c	2.52^{bc}	0.28^{bc}	0.29^{ab}	0.32^{b}	0.38^{b}
T3	1.98^{b}	0.46^{ab}	0.18^{b}	0.32^{ab}	1.81^{c}	3.21^{abc}	0.35^{ab}	0.37^{ab}	0.43^{b}	0.50^{b}
T4	4.60^{b}	0.50^{a}	0.60^{a}	0.69^{a}	3.75^{ab}	5.07^{a}	0.40^{a}	0.46^{a}	0.54^{a}	0.60^{a}
T5	8.06^{a}	0.67^{a}	0.85^{a}	0.50^{abc}	4.00^{a}	3.95^{ab}	0.32^{ab}	0.25^{ab}	0.37^{b}	0.30^{b}
T6	6.78^{a}	0.56^{a}	0.84^{a}	0.38^{abc}	3.90^{a}	3.99^{ab}	0.32^{ab}	0.30^{ab}	0.40^{b}	0.34^{b}
T7	0.68^{b}	0.44^{ab}	0.11^{b}	0.15^{c}	1.03^{c}	0.32^{c}	0.16^{bc}	0.15^{b}	0.30^{b}	0.26^{b}
T8	0.70^{b}	0.45^{ab}	0.18^{b}	0.19^{c}	1.98^{bc}	0.35^{c}	0.20^{bc}	0.16^{b}	0.39^{b}	0.33^{b}
T9	0.71^{b}	0.46^{ab}	0.20^{b}	0.25^{bc}	1.98^{bc}	0.37^{c}	0.20^{bc}	0.16^{b}	0.40^{b}	0.35^{b}

T_1=No fertilizer, T_2= 5tha^{-1}Dried compost, T_3= 10t ha^{-1}Dried compost, T_4=15t ha^{-1}Dried compost, T_5=100KgN ha^{-1}Inorganic fertilizer, T_6= 150KgN ha^{-1}Inorganic fertilizer, T_7= 200m^3 ha^{-1}compost tea, T_8= 400m^3 ha^{-1}Compost tea, T_9= 600m^3 ha^{-1}Compost tea.
Means followed by the same letter in a column are not significantly different from each other at P=0.05 by DMRT

Discussion

In this study it was found out that the application of compost improved the growth and yield parameters at the residual trials. A reduction in plant height, leaf area and number of leaves was observed with the application of inorganic fertilizer and compost tea. Amelioration of soil with compost proved effective at the second trial when compared with the first trial in all growth parameters observed. This shows that the applied compost released nutrients slowly to plant such that all its nutrients were not available at the first year of application but became more stable and available for plant uptake at subsequent planting. This could be as a result of slow rate of mineralization associated with the use of organic manure, thus, improving the soil fertility and quality and this result was also similar to the findings of Wakene *et.al* .(2001). Similarly, Ramanurthy and Shivashankar (1996) reported that nutrients present in organic manure are not fully available to the crop in the season of its application. . The result is in agreement with those reported by El-Shinawy *et al.* (1999), who found that fresh mass of lettuce was influenced positively by organic manure.

Furthermore, plant growth was slower in plant amended with compost at the first trial but with the help of microbes present in compost which contain significant amount of plant growth regulators such as natural hormones (auxin, gibberllin and cytokinnis) vitamin B and organic acids which are important for photosynthetic activity (Quilty and Cattle 2011), plant grows better and resulted in higher yield at the later stage of development. This finding is also similar to result of Levy and Taylor (2003).

High dry matter accumulation was recorded with the application of compost at the first and second trial. Similar explanation was given by Ojeniyi and Adejobi (2000) who obtained an increase in maize dry matter accumulation in response to organic fertilizer. The significant increase in dry matter on pot augmented with compost at 15t ha^{-1} is an indication that compost can serve as an alternative to inorganic fertilizer. This is in line with the observation reported by Myint *et al.* (2010). High shoot fresh and dry weight for the first and second trial obtained with the application of compost proves that compost supplies adequate nutrient necessary for plant such that plant is able to produce good plant canopy in oder to tap sufficient sunlight which will help plant to produce enough assimilate for plant growth and development. Similar view has been reported by Echarteet *et al.* (2001).

High dry matter gotten with the use of Mexican sunflower in this study confirms the finding of Malana (2001) who reported the effectiveness of Mexican sunflower compost in soil fertility improvement. Reduction in growth parameters as well as the dry matter accumulation with the use of inorganic fertilizer at the second trial may be due to the fact that inorganic fertilizer are water soluble such that pre-ceeding crop used all the available nutrient, thus left little or no nutrient in the soil for succeeding crop utilization

Incorporation of organic material in form of manure has beneficial effect on soil chemical and physical properties. Reduction in nitrogen content due to the application of the treatments may be attributed to leaching and uptake by crop at the first trial causing insufficient nitrogen to the succeeding crops.

An increment in potassium content as observed with application of compost is the fact that potassium plays an important role in water relation in plant such that it is responsible for transport of water in the xylem and photosynthates in the phloem. This could have been the reason for high leaf area observed which might have led to increase in dry matter accumulation recorded in compost treated plants. Also, an increase in potassium content at the residual trial is because potassium cannot be leach out easily with the application of organic matter such as compost. Organic manure usually has large cation exchange capacity which can retain potassium effectively (Singh and Trechan, 1998)

Residual benefits of compost has been able to sustain crop yield for some years since small portion of the important nutrients are available for plant uptake in the first year after application. This same result was also observed by Eghabll and Power (1999) that 20% of compost Nitrogen becomes available for the succeeding crops. Also, according to Ginting *et al.* (2003), the residual effect of organic manure in soil can contribute to improvement in soil quality for several years after application ceases.

The fact that higher fertilizer treatments gave the highest growth and yield parameters measured is an indication that abundant nutrient supply is directly corresponding to growth whereas reduction in growth, yield and nutrient uptake in control plant could be linked to the low fertility status of the soil used for the study. This affirms the fact that inadequate nutrient availability and poor soil nutrient management would constitute constraints to maize production. This observation supports the assertion of Bationo *et al.* (2006) that poor crop-soil management practices contributed to reduced crop yield in tropical Africa.

Conclusion

The residual increase in growth, yield and nutrient parameters with the application of Mexican sunflower (Tithonia) compost in this study is an indication that sunflower compost are able to retain nutrient for very long period of time when compared to the inorganic fertilizer and compost tea applied. Therefore, the use of compost can be used to improve crop yield and promote sustainable food production.

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