Residual Effect of NPK 15-15-15 Fertilizer and Cassava Peel Compost on Soil Properties and Maize Grain Yield

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ABSTRACT

Residual effect of organic fertilizers promotes the carry-over benefits of the earlier applied fertilizers on soil and the succeeding crops. This trial examined residual effect of single as well as different combinations of NPK 15-15-15 and cassava peel composts (CPC) on soil physico-chemical properties, harvest index, biomass and grain yield of maize. Six treatments fitted into randomized complete block design (RCBD) and replicated three times were investigated. Six treatments composed of control, mineral fertilizer, cassava peel compost and their combinations. Analysis of variance (ANOVA) was used for all the data generated and the differences between treatment means were separated using Duncan multiple range test (DMRT) at $p \leq 0.05$. Regression and correlation analyzes were used to assessed the relationship between residual NPK fertilizer and cassava peel compost and the measured parameters. Plots that previously received combined application of 50 kg NPK ha^{-1} and 3.75 t CPC ha^{-1} improved soil physico-chemical properties better while plots with previous history of combined application of 100 kg NPK ha^{-1} and 2.5 t CPC ha^{-1} gave highest maize grain and biomass yield. The amendments had positive and significant correlation with clay percentage ($r^2 = 0.58$) while total organic matter ($r^2 = 0.41$) and total nitrogen content ($r^2 = 0.22$) were positively correlated with the applied soil amendments but not significant. Both grain and biological yields exhibited positive and significant relationship with amendments ($R^2 = 0.97$).

Keywords: Residual effect, NPK 15-15-15 fertilizer, cassava peel compost, soil physic-chemical properties, biomass yield

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INTRODUCTION

Maize is one of the core cereal crops grown in many parts of world and one of the most important cereal crops in Nigeria. It constitutes an important food security crop but its major production constraint is low soil fertility. A major physical challenge that characterized majority of the soil types in the tropics perhaps due to low organic carbon and nutrient status (Mohammed-Saleem (1986) and Gomiero (2016).

Fresh cassava peel is usually indiscriminately discarded as wastes on dumpsite thereby constituting environmental challenge in form of air pollution. Microbial decomposition of the deposited peels produces foul odour that results in air pollution (Ubalua, 2007). The IFAD annual reports of 2009 revealed that cassava peel consists of 85.5-94.5% dry matter, 89-93.9% organic matter, 10-31.8% fiber content, 42-65% protein content and 0.7-1% hydrogen (IFAD, 2009). Heuze et al. (2015) also reported that cassava peel represents 5-15% of the fibrous root and have higher protein content than the edible part which makes the peel a good source of plant protein for livestock feed.

The need to curtail the environmental menace caused by waste from cassava root peels informed the need for processing the peels and using them in agroproduction. Composting is one of the most suitable approaches for the disposals of putrescible solid wastes and for increasing the amount of organic matter content that can be used to restore and preserve the environment (Sangodoyin and Amori, 2013; Stentiford, 1987). It is also recognized as one of the plausible answers to future food safety and security (Morshedi et al., 2017; Ward and Reynolds, 2013). Application of compost perfectly helps in re-building soil humus and renews soil carbon and supplement stocks (Füleky and Benedek, 2010; Óscar et al., 2017) and also helps in moderating environmental conditions (Óscar et al., 2017; Zhang et al., 2014).

Kotschi (2013) reported the negative natural results and the threatening extents of mineral fertilizers utilization particularly nitrogen (N) fertilizers. Mineral fertilizers diminish the humus substance and biodiversity in soil (Eisenhauer et al., 2013), and causes soil fermentation and offers ascent to the formation of nitrous oxide, a powerful ozone-harming substance that causes environmental change, which ultimately destroys future food production (Eisenhauer et al., 2013). The intensification in soil acidity lessens phosphate allows by crops, raises the centralization of lethal particles in the soil and represses crop development. The use of nitrogen fertilizers destroy core fundamental principles of agricultural production and threatens future food security (Kotschi, 2013)

Place et al. (2003) reported that African soils exhibit a variety of constraints: physical soil forfeiture from erosion, nutrient deficiency, low organic matter, aluminum and iron toxicity, acidity, crusting and moisture stress. These limitations happen normally in tropical soils only and exacerbated by degradation processes that are related to land management. In Nigeria, nutrients depletion is exacerbated by little to no external addition of organic leading to soil impoverishment, soil fertility decline, soil degradation and significant yield losses (Yusuf and Yusuf, 2008). Most arable crop fields in Nigeria are cultivated without fertilizer application owing to its high cost or scarcity. Compost derived from cassava peels could be a cheap and readily available source of fertilizer for amending marginal soils. Hence, it is not unlikely that where such materials are used, there could be some nutrients left over that may be beneficial to the subsequent or succeeding crops. There is paucity of information on the residual effect of cassava peel composts and mineral fertilizer on soil properties and yield of maize. Thus, this trial examined the residual effects of sole and different combinations of NPK 15-15-15 and cassava peel compost (CPC) on soil physico-chemical properties, grain and biomass yield of maize.

MATERIALS AND METHODS

Description of Study Area

Field experiment were conducted at Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Southern Guinea Savannah of Nigeria (80° 10′ N and 40° 10′E; 700 asl). During the period of the experiment, the rainfall ranged from 8 mm to 271.5 mm with monthly average of 118.9 mm. The site had been under fallow and left uncultivated for two years; and dominated mostly by annual and biennial weeds before it was put into cultivation. The compost was made from a mixture of cassava peels and well cured poultry manure (3:1) following the procedure described by Adebayo et al. (2017). The residual trial was carried out on plots previously amended with compost and/or NPK fertilizer rates and cultivated with soybean. The earlier applied compost and or NPK 15-15-15 rates were: (i) control treatment where neither compost nor NPK fertilizer was applied (T1), (ii) 200 kg NPK ha^{-1} (T2,) (iii) 5 t ha^{-1}CPC (T3), (iv) 150 kg NPK ha^{-1}+ 1.25 t ha^{-1} CPC (T4), (v) 100 kg

NPK ha^{-1}+ 2.5 t ha^{-1} CPC (T5) and (vi) 50 kg NPK ha^{-1}+ 3.75 t ha^{-1} CPC (T6). Treatments were laid out in a randomized complete block design with three replicates. A block was further divided into 6 plots each of 4 m x 5 m to accommodate all treatments. Two meters gaps were maintained between blocks while 1 m gaps between plots.

NPK 15-15-15 is a complete fertilizer with 15-15-15 formulation of a water-soluble fertilizer contains a guaranteed analysis of 15 % N, 15% P_2O_5 and 15% K_2O.

Pre-planting soil samples (0-20 cm) obtained from the trial sited were analyzed for physical and chemical properties. Soil pH, organic matter, total nitrogen, available P and particle size analysis were carried out using standard procedures as described by IITA (1990). Exchangeable potassium was determined following 1M ammonium acetate extraction solution using flame photometer (Sparks 1996). The pH of sandy loam soil sample was 6.61 pH (in water), 0.2% organic carbon, 0.15% total nitrogen, 14.46 mg/kg available phosphorus and exchangeable K 0.68 Cmol/kg. Yellow–SWAN-1 maize variety obtained from a renowned allied seed center was sown. Light hoeing was carried out manually to remove the weeds on the plots where soybean had been previously cultivated during the last season. Seeds were sown at spacing of 0.75 m x 0.25 m.

Data collected included soil physico-chemical properties, and maize yield and yield components after harvesting. Biomass yield and harvest index were evaluated using the method of Andrade (1995) while Agronomy efficiency and interactive effect were estimated as described by Cassaman et al. (1998), Vanlauwe 2001 and Chieuage et al., (2011).

$$\text{Biomass yield} = \frac{\text{Oven dried subsample biomas weight (kg)}}{\text{fresh subsample biomass (kg)}}\ x\ \text{total biomass (kg) per harvested area}$$

$$\text{Harvest index} = \frac{\text{grain yield}}{\text{biomass yield}}\ x100$$

$$\text{Agronomy use efficiency} = \frac{Ytrt - Ycon\ (kg/ha)}{N\ rate\ \ kg\ N/ha}$$

Where Ytrt represents the yield for cassava peel compost, NPK fertilizer, cassava peel compost + NPK fertilizer treatments, Ycon represents the yield in the control treatment, and total N applied represents N rate in the cassava peel compost, NPK fertilizer or the combined treatment.

Interactive effect (kg ha^{-1})

$= Y_{com} - Y_{con} - (Y_{cpc} - Y_{con}) - (Y_{npk} - Y_{con})$

where Y_{con}, Y_{cpc} $Y_{npk,}$ Y_{comb} are mean grain yield(kg ha^{-1}) in the control, the sole NPK fertilizers, the sole cassava peel compost and the cassava peel compost + NPK fertilizers, respectively.

Analysis of variance (ANOVA) was used to analyze the data and means were separated using the Duncan multiple range test ($p \leq 0.05$). Correlation and regression analyses were also performed using Excel programming to assessing relationship between residual NPK fertilizer and cassava peel compost and the measured parameters.

RESULTS

Nutrients composition of the poultry manure, cassava peel, cassava peel compost and soil analyses

The selected nutrients composition of the poultry manure, cassava peel and the resulting compost as well as the pre-cropping soil is contained in Table 1. The results revealed that poultry manure had highest concentration of N and P which could be a better source of these nutrients than cassava peel which had the highest concentrations of K, and Ca. However, the compost had fairly higher levels of N (2.01 %), P (0.22%) and Mg (32.80 mg/kg) than the cassava peel. The content of Zn (43.14 mg/kg) and Cu (44.00 mg/kg) concentrations were highest in the compost than either poultry manure or cassava peel.

The results of pre-planting analysis done on the soil samples collected from the experimental site as shown in Table 2. The results revealed that the soil was sandy loam, slightly acidic, contained low organic carbon and total N. The soil had moderate available phosphorus and high potassium contents. The micronutrients contents in the soil ranged between normal to medium. Results of the residual effects of NPK fertilizer and CPC application on soil chemical properties are presented in (Table 3). Soil pH was not significantly affected by the residual effect of the previously applied NPK and CPC. The contents of soil organic carbon and total N was significantly high in the plots that previously received 50 kg NPK ha^{-1} + 3.75 t ha^{-1} CPC relative to other treatment. However, there was no significant difference in the total N content obtained in plots previously fertilized with 150 kg NPK ha^{-1} + 1.25 t ha^{-1} CPC and 100 kg NPK ha^{-1} + 2.5 t ha^{-1} CPC The available P content was highest (12.87 mgkg^{-1}) in the control plots, the observed value was comparable to the residual P content in

plots previously fertilized with 200 kg NPK ha^{-1}, 5.0 t ha^{-1} CPC and 50 kg NPK ha^{-1} + 3.75 t ha^{-1} although there was significant difference between the residue P content from the control and plots earlier supplied 100 kg NPK ha^{-1}+ 2.5 t ha^{-1} CPC plots. The observed soil exchangeable K content was significantly affected by the residual effect of the previously applied fertilizer with the highest value (0.66 mgkg^{-1}) obtained in plots previously fertilized with 50 kg NPK ha^{-1} + 3.75 t ha^{-1} CPC. This value was however statistically similar to the obtained values from unfertilized control and residual 200 kg N ha^{-1}.

The control plots had significantly highest copper content (16 mg/kg) while the least Cu content (10.00mg/kg) was obtained in the plots earlier supplied with 100 kg NPK ha^{-1}+ 2.5 t ha^{-1} CPC (Table 5). The highest residual Zn and Fe content were obtained in residual 50 kg NPK ha^{-1+} 3.75 t ha^{-1} CPC and the least values were obtained in plots previously amended with100 kg NPK ha^{-1+}2.5 t ha^{-1} CPC.

Residual effects of NPK fertilizer and cassava peel compost on maize yield and yield components

Residual effects of applied treatments had significant effect on maize grain and biomass yield (Fig. 1 and 2). The highest grain yield (2.28 t ha^{-1}) was obtained from plots previously supplied with100 kg NPK ha^{-1}+ 2.5 t ha^{-1} CPC, which significantly outperformed the other treatments while unfertilized plots produced the least grain yield (0.76 t ha^{-1}). Moreover, the yield obtained from 150 kg NPK ha^{-1}+ 1.25 t CPC ha^{-1} was 40% higher than in plots earlier supplied sole cassava peel compost but 32.6% lower than the grain yield obtained from 100 kg NPK ha^{-1}+ 2.5 t ha^{-1} CPC amended plots. Biomass yield was significantly affected by different nutrient sources and followed similar trend to grain yield (Fig. 1). Harvest index (HI) of maize was significantly influenced by the residual effects of the applied fertilizers. Although, HI of maize was not significantly influenced by the residual effect different rates of NPK or CPC but 200 kg NPK ha^{-1} increased the HI of maize significantly relative to the unfertilized plots (Fig. 3).

Agronomic use efficiency and yield interactive effect as influence by residual effect of NPK 15-15-15 fertilizer and cassava peel compost

The residual effect showed significant effect on agronomic use efficiency of maize. Highest agronomic use efficiency (0.004) was obtained in the plot previously fertilized with 200 kg NPK ha^{-1} **and was followed with plot**

supplied with 50% NPK 15-15-15 and 50% cassava peel compost. The least agronomy use efficiency was obtained (0.0002) with residual effect of 5 t ha^{-1} CPC which was not significantly different from 50 kg NPK ha^{-1} + 3.75 t ha^{-1} CPC (Fig 4). The plot formerly treated with 50 kg NPK ha^{-1} + 3.75 t ha^{-1} CPC had highest interactive effect (1.36 kg ha^{-1}) and residual effect of 50 kg NPK ha^{-1} + 3.75 t ha^{-1} CPC had lowest interactive effect (1.16 kg ha^{-1}) (Fig 5).

Correlation relationship between residual effect of NPK 15-15-15 fertilizer and cassava peel compost and soil physico-chemical properties

The amendments had positive and significant relationship with clay percentage (r^2 = 0.58) and the least positive and non – significant correlation with iron content (r^2 = 0.14) (Table 6). A negative and significant relationship was observed between amendments and silt percentage (r^2 = -0.54). The available phosphorus showed least negative and non-significant correlation with amendments (r^2= -0.16). There was no relationship between amendments and exchangeable potassium content (r^2 = 0.00). Soil pH (r^2 = -0.74) and zinc content (r^2 = -0.70) while other physico-chemical properties were not significantly correlated. The soil pH was positive and significantly correlated with all the soil chemical parameters. The total organic matter revealed positive and significant relationship with analyzed soil chemical properties. Although, there was no significant correlation between total organic matter, available phosphorus (r^2 = 0.42) and copper contents (r^2 = 0.06). The total nitrogen content followed the manner as total organic matter with the rest soil chemical properties. The available phosphorus content had positive and significant correlation with exchangeable potassium, copper, zinc and iron contents. The order of significant are potassium > copper> zinc>iron. The exchangeable potassium exhibited positive and significant relation with micronutrient contents. There was positive and statistical relationship between copper and zinc contents (r^2 = 0.57) while relationship between copper content and iron content (r^2= 0.27) were not significant. The relationship zinc and iron contents was significant (r^2 = 0.84).

Regression relationship between residual effect of NPK 15-15-15 fertilizer and cassava peel compost and grain yield and yield components

The result revealed that the optimum rates of residual NPK and cassava peel compost could be predicted up to 97% (Fig 6). Using the quadratic function $y = -0.0893x^2 + 0.8867x + 0.004$ the highest grain yield and biological yield of 2.28 t/ha t/ha and 7.87 t/ha were obtained at 100 kg NPK ha^{-1} + 2.5 t ha^{-1} CPC.

Similarly, relationship between amendments and harvest index might be estimated up of 70% (Fig 6). Using the quadratic function $y = -1.3329x^2 + 11.181x + 7.598$ the highest harvest (31.01%) index was recorded at residual effect of 200 kg NPK ha^{-1}.

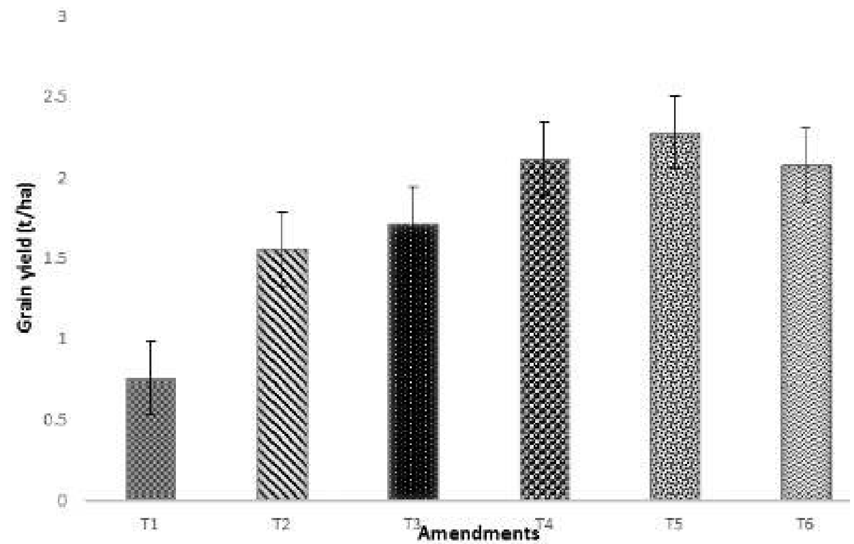

Fig 1:
Residual effect of NPK 15-15-15 and Cassava peel compost on grain yield of maize

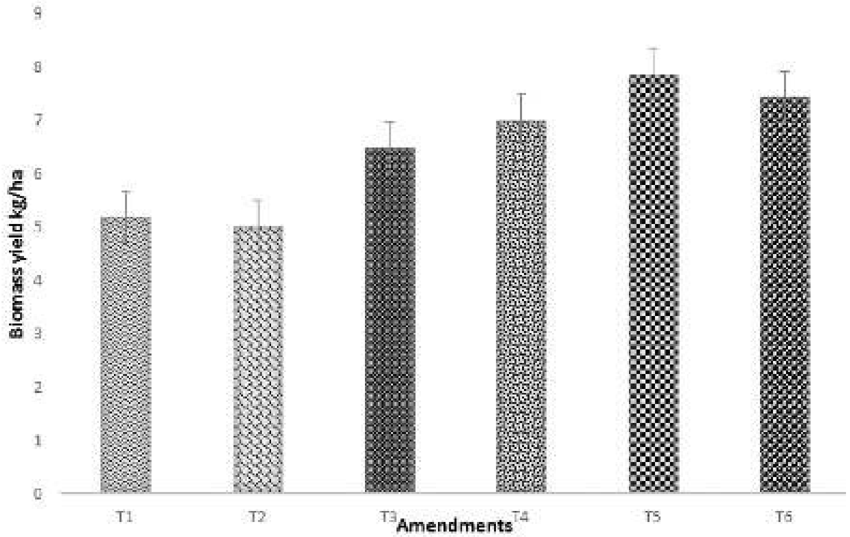

Fig 2:

Residual effect of NPK 15-15-15 and Cassava peel compost on biomass yield of maize

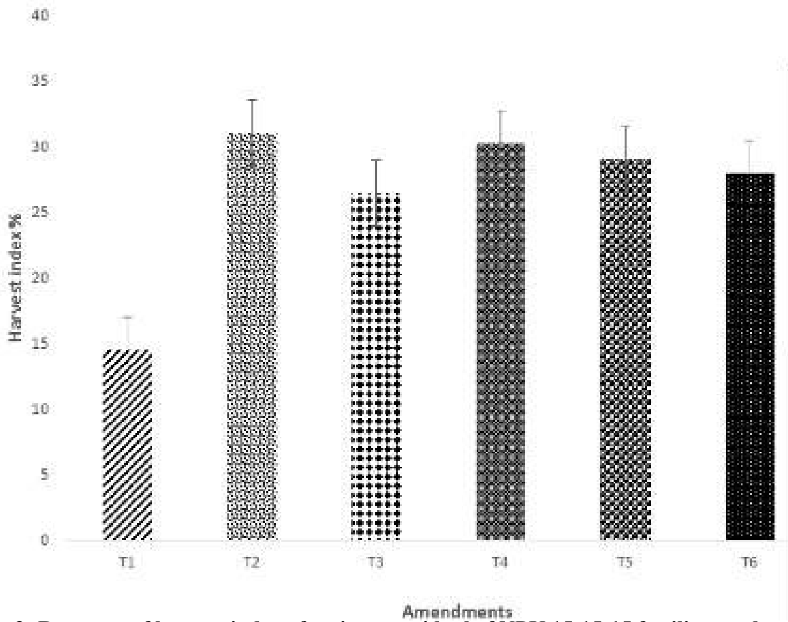

Fig 3: Response of harvest index of maize to residual of NPK 15-15-15 fertilizer and cassava peel compost

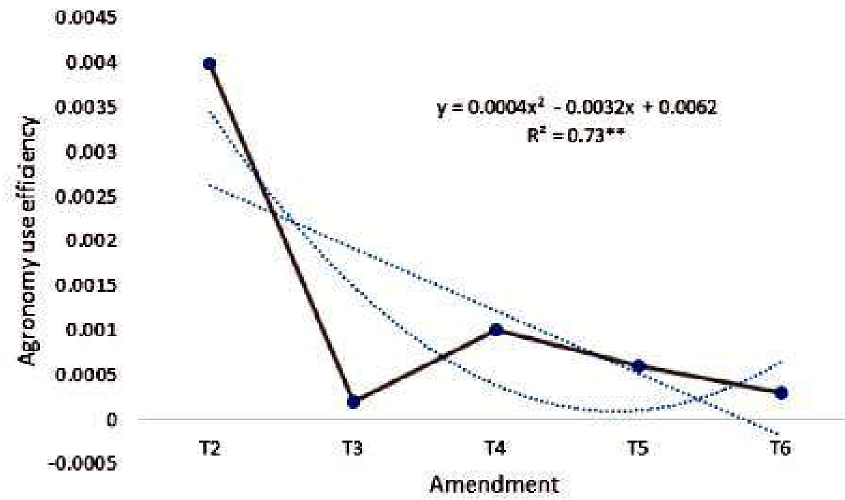

Fig 4: Residual effect of NPK 15-15-15 fertilizer and cassava peel compost on agronomy use efficiency

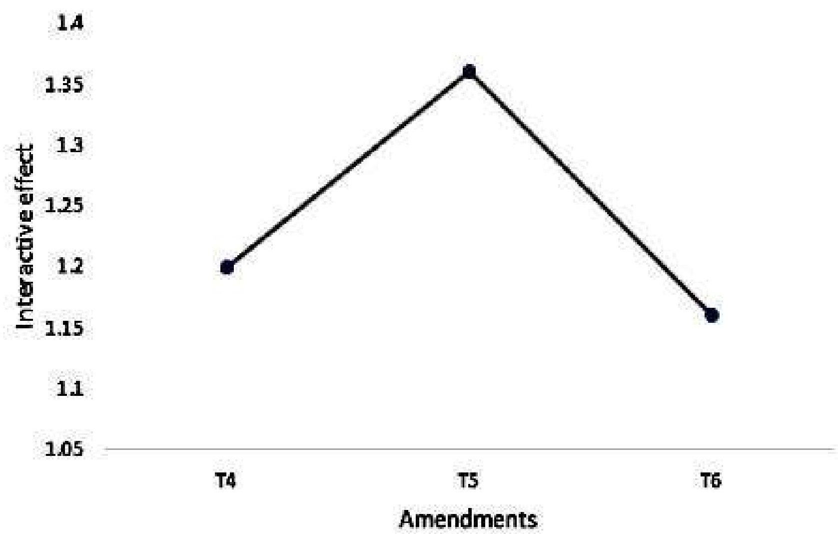

Fig 5: Interactive effect of NPK 15-15-15 fertilizer and cassava peel compost residual

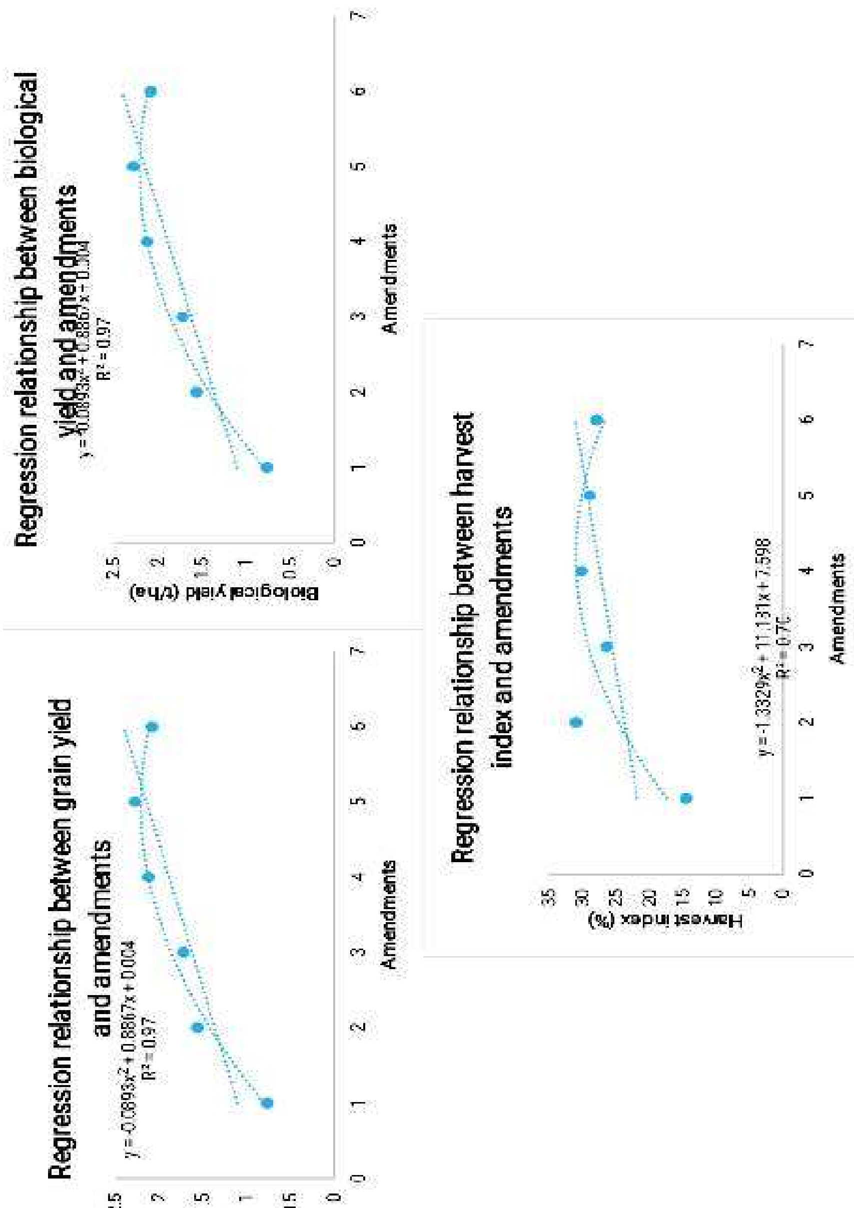

Fig 6:

Regression relationship between grain yield, biological yield, harvest index and amendments

Table 1: Nutrients composition of poultry manure, cassava p/eel and the cured compost before soybean cultivation

Nutrients	Poultry manure	Cassava peel	Cured compost[ǂ]
N (%)	6.24	1.60	2.01
P (%)	0.25	0.16	0.22
K (%)	0.82	1.14	0.51
Ca (%)	0.07	0.88	0.78
Mg (mg/kg)	25.49	31.27	32.80
Zn (mg/kg)	33.32	32.29	43.14
Cu (mg/kg)	31.88	39.22	44.00

[ǂ] Compost prepared from poultry manure and dry cassava peel in ratio 3:1 dry weight basis

Table 2: Pre-cropping physical and chemical characteristics of soil used for the study

Properties	Values	Rating (FAO 2001)
Sandy (%)	80.5	
Silt (%)	5	
Clay (%)	15	
Textural class	Sandy loam	
pH	6.61	Normal
Organic matter	0.20%	Very low
Total nitrogen	0.15%	Moderately low
Available P (mg/kg)	14.46	Moderate
K (cmol kg^{-1})	0.68	High
Cu (mg/kg)	1.22	Normal
Fe (mg/kg)	10.89	Medium

Table 4: Residual effect of NPK 15-15-15 fertilizer and cassava peel compost on physical properties of soil

Treatment	Sand (%c)	Clay (%)	Silt (%)
T1	65.0d	25.0b	10.0a
T2	69.0ab	25.0b	6.0d
T3	68.7b	26.8a	4.7e
T4	65.3c	26.7a	8.0c
T5	62.3d	27.7a	11.0b
T6	70.0a	26.0b	4.0e

All values with the same alphabets along the same column are not significantly ($p \leq 0.05$) different using DMRT, T1 = Control (unfertilized plots); T2 =200 kg NPK ha^{-1}; T3 = 5 t ha^{-1}CPC; T4 =150 kg NPK ha^{-1}+ 1.25 t ha^{-1} CPC T5 =100 kg NPK ha^{-1+} 2.5 t ha^{-1} CPC; T6 =50 kg NPK ha^{-1}+ 3.75 t ha^{-1} CPC

Table 5: Residual effects of NPK fertilizer and cassava peel compost application on soil pH, organic carbon and soil macronutrients contents

Treatments	P^{H}	Organic Carbon (%)	Total Nitrogen	Available Phosphorus (mg/kg)	Potassium (C mol/kg)
T1	6.6a	12.6e	0.12d	13.45a	0.63ab
T2	6.6a	17.15b	0.28b	12.72bb	0.62ab
T3	6.6a	16.40c	0.16c	12.50b	0.61bb
T4	6.5a	14.75d	0.13d	11.60c	0.59b
T5	6.5a	12.80e	0.13d	9.58d	0.50c
T6	6.63a	17.57a	0.36a	12.87bb	0.66b

All values with the same alphabets along the same column are not significantly ($p \leq 0.05$) different using DMRT, T1 = **Control (**unfertilized plots)**; T2** =200 kg NPK ha^{-1}**; T3** = 5 t ha^{-1}CPC**; T4** =150 kg NPK ha^{-1}+ 1.25 t ha^{-1} CPC **T5** =100 kg NPK ha^{-1+} 2.5 t ha^{-1} CPC**; T6** =50 kg NPK ha^{-1}+ 3.75 t ha^{-1} CPC

Table 6: Residual effects of NPK fertilizer and cassava peel compost on soil micronutrients

Treatment	Cu (mg/kg)	Zn (mg/kg)	Fe (mg/kg)
T1	16.0a	11.2c	14.3bc
T2	15.0b	12.0b	16.0a
T3	12.0c	11.4c	15.0b
T4	12.0c	11.4c	15.0b
T5	10.0d	10.0c	14.0c
T6	15.0a	15.0b	16.2a

All values with the same alphabets along the same column are not significantly ($p \leq 0.05$) different using DMRT, T1 = Control **(**unfertilized plots)**; T2** =200 kg NPK ha^{-1}**; T3** = 5 t ha^{-1}CPC**; T4** =150 kg NPK ha^{-1}+ 1.25 t ha^{-1} CPC **T5** =100 kg NPK ha^{-1+} 2.5 t ha^{-1} CPC**; T6** =50 kg NPK ha^{-1}+ 3.75 t ha^{-1} CPC

Table 7: Correlation relationship between residual effect of NPK 15-15-15 fertilizer and cassava peel compost and soil physico-chemical properties

	pH	TC	TN	P	K	Cu	Zn	Fe
Amendments								
PH	1.00							
TC	0.51*	1.00						
TN	0.52*	0.83**	1.00					
P	0.86**	0.42^{ns}	0.38^{ns}	1.00				
K	0.80**	0.60**	0.59**	0.95**	1.00			
Cu	0.64**	0.06^{ns}	0.28^{ns}	0.82**	0.80**	1.00		
Zn	0.52*	0.74**	0.89**	0.55**	0.77**	0.57**	1.00	
Fe	0.51*	0.94**	0.91**	0.51*	0.70**	0.24^{ns}	0.84**	1.00

PH = soil pH, TC = Total organic matter, TN = Total nitrogen, P = available phosphorus, K = Exchangeable potassium, Cu = Copper content, Zn = Zinc content and Fe = Iron content. ** significant $p \leq 0.01$, * significant $p \leq 0.05$ and ns= non- significant.

DISCUSSION

The residual effects of the applied materials significantly improved on soil chemical properties, maize grain and biomass yields. The residual effect extremely increased organic carbon. According, Ojuola, (2012) the soil of experimental site belongs to very low organic carbon classes (organic matter 0.20% which equivalent to 0.11 organic carbon) from pre- planting soil. This might be caused by compost and tested crop. Soybean is generally known as leguminous crop that can fix nitrogen into soil. However, compost contained a significant percentage of organic matter which improved soil organic matter. Similarly report was revealed by Oldfield et al., (2018) that compost contains both organic matter and plant nutrients whereas organic matter enhances soil physical properties and biological activity. High residual total soil N could have been triggered by 75% of cassava peel compost that enhanced soil organic matter from cassava peel compost. Many scholars reported that manufacture fertilizer organic residues mainly supplied nitrogen compared to other plant nutrients (Adugna, 2016; Amlinger et al., 2007). The soil pH was slightly acidic for all the treatments. These findings were similar to several works in the study area earlier reported by most researchers (Olabode et al., 2007, Babajide and Olla, 2014). The available phosphorus and exchangeable potassium contents were maintained as moderate and high levels. The result of total N, available P and K in the soil followed the same trend that was reported by Okesiji et al. (2014). The higher concentration of zinc and copper showed the effect of higher initial concentration of micronutrients in the compost composition. This is agreed with the report of (Senjobi et al., 2010, Akintoye and Olaniyan, 2012).

The result revealed that highest maize grain and biological yields under combined application of 50% mineral fertilizer and cassava peel compost may be as a result of complimentary effects of both fertilizer materials applied. It must have been that availability of N, P and K from the inorganic materials were influenced or increased by organic matters component of CPC. This is in agreement with studies conducted by various scholars which showed that the residual effect of organic fertilizers has positive effect on yield of some crops such as sorghum, corn and cabbage (Patidar and Mali, 2002; Silva et al., 2006). Shehzadi et al. (2014) reported that residual effect of organic and NPK fertilizer significantly increased yield of wheat. Residual effect of organic matter has been reported to improve plant height, dry-matter production of the crop at different growth stages; yield attributes and yield per hectare (Ramamurthy and Shivashankar, 1996; Silva et al., 2006). The value of harvest index reported in

the current study is similar to the ranged of 0.3-0.45 reported by Dowswell et al. (1996) and Moser (2004) in tropical and subtropical maize.

Chivenge et al. (2011) indicated agronomic use efficiency was higher when smaller quantities of nitrogen were applied in all soils compared to when only organic fertilizer or combined was applied. Nevertheless, combined application of cassava peel compost and NPK fertilizer showed greatest interactive effect especially when 50%NPK fertilizer and 50% cassava peel compost were applied. This indicated that addition of NPK fertilizer enhances mineralization of cassava peel compost.

The positive relationship between amendments, sand percentage, clay percentage, organic carbon, total nitrogen, zinc and iron. This showed that as amendment improves soil productivity. The compost richness in Ca^{2+}, Mg^{2+} and K^{2+} as well as organic carbon that greatly influenced the soil physico-chemical properties. Compost also serve as store house for micro- nutrients. Many researchers indicated that combined application of mineral fertilizers and organic fertilizers improve soil fertility in SSA (Chivenge et al. 2011; Adugna 2016). The correlation between sand and soil pH, total carbon and soil chemical properties implied that as sand percentage increases those properties were increased. This is in line with finding of Blanchart et al. (2005) who reported that decomposition of soil organic matter is highly rapid in tropical sandy soils that tropical clayey soils. Hien (2004) and Blanchart et al. (2005) found that sandy soil has an instant turn over and carries biological functions of C, N and P in a short period. There was strong relationship between organic carbon and other soil chemical properties. Organic carbon acts as a stockroom for other nutrients. This result agrees with the report of Roy et al. (2006) who revealed that soil organic matter performs a significant role on releases of nutrients into the solution and generates acids that influence the fixation and release of other nutrients. The relationship between total nitrogen and other soil nutrients, revealed the important of nitrogen in soil fertility. This is suggested that deficiency of nitrogen cause deficiency of others. Similarly, the relationship between available phosphorus, exchangeable potassium and other nutrients were similar to correlation between total nitrogen and the rest nutrients. Likewise, available copper significantly influence zinc availability in the soil. Similar result was obtained by Wang et al. (2014) and Rengel (2015) who find out that available copper and zinc had positive and significant relationship while available copper and iron relationship was negative and non-significant.

Available of zinc and iron had strong correlation which indicated that increase in available zinc, available iron also increased. Mousavi et al. (2014) and Regale and Rommel (2000) indicated that zinc deficiency leads to iron deficiency,

CONCLUSION

It is concluded that application of 100 kg NPK ha^{-1}+ 2.5 t CPC ha^{-1} had substantial residual effects on soil properties, maize grain yield and total biomass accumulation. This combined application was more beneficial and resulted in 50% and 52% higher than the control in terms of grain and biomass yield, respectively. This showed that combination of cassava peel compost and NPK 15-15-15 fertilizer drastically reduce amount of fertilizer required with increased in maize and biomass yields in an ecosystem friendly environment.

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