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OUTCOME OF COMPOST MADE FROM TITHONIA DIVERSIFOLIA, POULTRY MANURE AND COW DUNG ON GROWTH AND FRUIT YIELD OF OKRA (ABELMOSCHUS ESCULENTUS L. MOENCH)

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ABSTRACT

Compost quality depends on the kind and worth of raw materials used in producing it which in turn influences its effect on plants. During rainy season, in year 2011 and 2013 field experiments were carried out at the Federal University of Agriculture, Abeokuta to ascertain the effects of Tithonia divers folia + poultry manure compost and T. divers folia + cow dung compost on the growth and yield of Okra. Fertilizers were T. divers folia + poultry manure compost at 10, 20 and 30 t ha-1 (PMC 10, PMC 20 and PMC 30, respectively) and T. divers folia + cow dung compost at 10, 20 and 30 t ha-1 (CDC 10, CDC 20 and CDC 30, respectively), ordinary poultry manure at 10 t ha-1 (PM 10), ordinary T. divers folia at 10 t ha-1 (T 10), ordinary cow dung at 15 t ha-1 (CD 15) and a control (unfertilized plot). The fertilizers were arranged in a Randomized Complete Block Design which was replicated three times. Data were collected on the plant height, number of leaves, stem girth, number of days to 50% flowering, number of fruits and pod weight. Data collected were subjected to analysis of variance and the significant means were separated using Duncan Multiple Range Test ($p<0.05$). Results showed that plants fertilized with PMC 30 had increased plant height of 36.13 cm in 2011 while plants treated with PMC 30 had highest height of 30.72 cm in 2013. Highest numbers of leaves were observed on plants treated with PMC 20 and PMC 30 (14.00 and 14.00) in 2011 and 2013, respectively. Application of PMC 10 increased okra stem girth in both years to 4.39 cm and 4.14 cm in 2011 and 2013 respectively, while plants treated with PMC 20 flowered earlier than unfertilized plants (29 days in both years). Application of CDC 30 and PMC 30 resulted in highest percentage increase (46.64 %, 30.89 %) in number of okra fruits compared to control in 2011 and 2013 respectively. In 2011 and 2013, okra plants treated with CDC 20 and PMC 30 had a significantly increased ($p<0.05$) pod yield than the untreated okra. It is concluded that T. divers folia + poultry manure compost applied at 30 t ha-1 enhanced okra growth and yield and the treatment is consequently recommended to okra farmers for improved plant and optimum yield.

Keywords: Fruit, Growth, Okra, Pod, Yield.

INTRODUCTION

Diminution of soil productiveness in the tropics is a major reason for decrease in growth and yield of crops most especially okra plant (Cardoso and Kuypor, 2006; Sanchez *et al.,* 2003). In recent past, methods like bush fallowing system and shifting cultivation had been adopted to allow soil regain back its nutrient naturally but because of the fast growing and ever increasing population of the world in general and Nigeria in particular, these methods are no longer feasible as there is much demand on land (Miguel, 2008). This calls for an alternative in which addition of organic material such as plant materials e.g. *Tithonia diversifolia,* animal manure such as poultry manure, cow dung and compost (plant and animal materials combination) which could help support continuous crop production without reduction in quality and quantity of yield (Escobar *et al*., 2008). Okra (*Abelmoschus esculentus* L. Moench), is an inexpensively essential vegetable crop planted in the tropical and sub-tropical parts of the world (Saifullah and Rabbani, 2009). It is grown for its fibrous fruits or pods containing round, white seeds and harvested when immature and eaten as a vegetable (Abidi *et al*., 2018). It is a source of nutritional fiber, minerals and vitamins; usually recommended for cholesterol control and weight reduction. Compost is natural substance that has been decaying and recycled as a nourishment and soil improvement. Compost consists of the moderately steady natural resources resulting from the hastened organic breakdown of natural substance under restricted, aerobic condition (Storey *et al.,* 1995; Epstein, 1997). Addition of compost to marketable vegetable crops in Nigeria has gained small awareness, though it has been reported to enhanced yield. Examples of plant materials that could be used for fertilizer are *Tithonia diversifolia,* maize stalk, *Chromoleana odorata*, *Panicum maximum* while those of animals are poultry manure, cow dung, swine waste, and goat manure (Kolawole *et al*., 2014). Each of these could be applied to the soil solely or in combination and they could also be composted (Mohammed *et al*., 2004). Plant and animal materials differ in chemical composition and physical characteristics and therefore will affect their efficiency when applied as sole materials or as compost (Irshad *et al*., 2013). It is therefore necessary to determine the effectiveness of some of these materials when applied solely and as compost on growth and yield of crops The use of compost for soil fertility and crop production has always been on single type. Information on the usage of more than one compost type for the purpose of comparism is scarce. So there is need to research into comparing more than one compost type on the production of crops. The purpose of this research is to examine the outcome of *Tithonia diversifolia* + poultry manure, *Tithonia diversifolia* + cow dung, ordinary *Tithonia diversifolia*, ordinary poultry manure and ordinary cow dung on and their compost on okra plant growth and fruit yield.

MATERIALS AND METHODS

Description of Research Site: The research was carried out at the Organic Farm of the Federal University of Agriculture, Abeokuta which is the derived Savanna Ecological Zone of Nigeria (7.13° N and 3.28° E).

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Preparation of Compost: Materials used for composting were poultry manure, *Tithonia diversifolia* and cow dung. poultry manure was obtained from Isolu poultry farm opposite Federal University of agriculture, Abeokuta (FUNAAB) first gate., *Tithonia diversifolia* was sourced behind Federal University of Agriculture International School, Abeokuta (FUNIS) hostel, while cow dung was collected from cattle section of FUNAAB College of Animal Science (COLANIM) farm. Materials were composted at ratio 3:1 (Misra and Roy, 2002) i.e. 3kg of chopped *Tithonia diversifolia* at vegetative stage with 1kg of poultry manure. The same was done for cow dung. Organic materials were covered with black polythene nylon so as to prevent excessive moisture and also generate heat. Materials were turned over regularly and adequately watered and it was left for twelve (12) weeks.

Field Experiment: The experimental site was manually cleared and leveled with cutlass and hoes respectively. Plots with 3 m x 4 m were partitioned with 1 m spacing between the row. Soil samples (0 – 15cm layer) were collected at random using soil auger at different point on the site before treatments application which were bulked and sub-sampled for routine analysis.

Treatment Application and Experimental Design: Treatments such as *Tithonia diversifolia* + poultry manure compost at 10, 20, and 30 tonnes / hectare, *Tithonia diversifolia* + cow dung compost at 10, 20 and 30 tonnes / hectare, Sole poultry manure at 10 tonnes / hectare, Sole *Tithonia diversifolia* at 10 tonnes / hectare, Sole cow dung at 15 tonnes / hectare and control (no treatment) were laid out in a Randomized Complete Block Design (RCBD), applied two (2) weeks before planting and replicated three (3) times.

Okra Seeds Variety and Planting: Okra seeds variety (NHAe47-4) was obtained from National Institute of Horticultural Research (NIHORT) Ibadan, Nigeria and planted at two (2) seeds per hole with using 60 cm x 30 cm spacing which were later thinned to one (1) seedling per hole a week after planting.

Weed Control: Weeding was done with cutlass or hoes at four (4) weeks interval.

Data Collection: At the middle row of each plot, ten (10) plants were selected and tagged for plant height, number of leaves and stem girth determination. These parameters were taken at two (2) to eight (8) weeks after planting. Number of days to 50 % flowering was also determined by counting from planting date till when 50% of the plant population flowered. Mature okra fruits were harvested at three days interval, counted, weighed and recorded.

Treatment Analysis: Oven dried *Tithonia diversifolia,* air dried poultry manure, cow dung and composts were analyzed for nitrogen, phosphorus, potassium, sodium, calcium and magnesium. Nitrogen was determined by modified micro Kjeldahl method (Jackson, 1964). Phosphorus was determined by using Vanado-molybdate method (Aduayi and Gatitu, 1973). Potassium and sodium were determined by Flame Photometry while calcium and magnesium were determined by Atomic Absorption Spectrophotometer.

Data Analysis: Data obtained were analyzed using Statistical Analysis System (SAS, 2002). Significant means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability.

RESULT

Chemical Properties of the Materials used for the Experiment:

This is shown in Table 1, highest nitrogen content was given by *Tithonia diversifolia* (T), this was followed by poultry manure (PM) and cow dung (CD). Also, nitrogen content of composts is lower than sole organic materials. The Phosphorus content of organic materials was observed to be highest in cow dung, followed by *Tithonia diversifolia* + cow dung compost (CDC), followed by poultry manure (PM), followed by *Tithonia diversifolia* + poultry manure compost (PMC), followed by *Tithonia diversifolia* (T) which had the least phosphorus content. The Potassium content of the organic materials followed this order CD > PM > T > CDC > PMC (Table 1). The sodium contents of the organic materials showed that PMC had the highest followed by CDC followed by T followed by PM followed by CD. The calcium content of the organic materials also followed this order CDC > PMC > CD > PM > T. The magnesium content of the organic materials showed that PM had the highest followed by CD followed by CDC followed by PMC followed by T. The C/N ratio of the treatments showed that T had the least followed by PM followed by CD followed by CDC followed by PMC.

Chemical and Physical Properties of the Soil Used: The physico-chemical properties of the soil used for the study are shown in Table 2. It was observed that the soil was slightly acid. The organic matter and the total nitrogen contents were low. The phosphorus content was medium. Potassium and sodium content were moderate. The result showed that the soil had very low calcium and magnesium contents and the soil was sandy loam in texture.

Table 1: Chemical Properties of poultry manure, poultry manure + Tithonia diversifolia compost, cow dung, cow dung + Tithonia diversifolia compost and Tithonia diversifolia.

Properties	TN (%)	P (mg kg^{-1})	K (g kg^{-1})	Na (g kg^{-1})	Ca (g kg^{-1})	Mg (g kg^{-1})	C/N Ratio
PM	0.62	4.8	7.78	3.10	3.62	7.69	19.3
PMC	0.41	4.2	2.98	6.17	4.48	1.96	44.31
CD	0.59	6.8	9.82	2.25	4.27	7.37	25.36
CDC	0.36	5.2	3.49	6.04	6.53	3.09	37.14
Tithonia diversifolia	1.58	0.79	3.89	5.26	3.05	3.00	4.29

KEY:

PM: Poultry Manure
PMC: *Tithonia diversifolia* **+** poultry manure compost
CD: Cowdung
CDC: *Tithonia diversifolia* + cowdung compost.

Effect of sole Tithonia diversifolia, poultry manure, Cow dung and their Compost on Plant Height of Okra in year 2011 and 2013: In the year 2011, at 2 weeks after planting to 8 WAP, okra plants treated with Tithonia diversifolia at 10 t ha^{-1} (T10) gave significantly ($P < 0.05$) highest plant height while those fertilized with poultry manure at 10 t ha^{-1} (PM 10) took over at 8 WAP (Figure 1). Control (untreated) plants had the least plant height. Whereas, in year 2013 it was observed at 2 WAP to 4 WAP that plants treated with PMC 10 gave highest plant height while, plants treated with PMC 30 had highest plant height from 6 WAP to 8WAP. Control (untreated) plants had the least plant height (Figure 1).

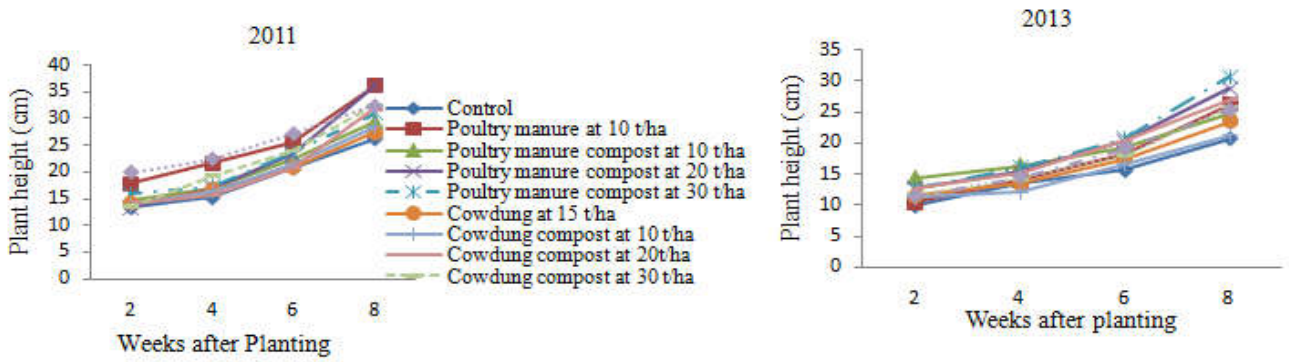

FIGURE 1: Effect of sole *Tithonia diversifolia*, poultry manure, cow 3dung and their composts on plant height of okra (cm) in year 2011 and 2013.

Table 2: Physico-chemical properties of the soil used for the experiment

Soil Properties	
pH (H_20)	6.5
pH (KCl)	6.2
O.C (%)	0.68
O.M (%)	1.17
TN (%)	0.13
Av.P (mg kg^{-1})	19.88
Na (cmol kg^{-1})	0.45
K (cmol kg^{-1})	0.50
Ca (cmol kg^{-1})	0.08
Mg (cmol kg^{-1})	0.11
Sand (g kg^{-1})	814
Clay (g kg^{-1})	154
Silt (g kg^{-1})	32
Textural class	Sandy Loam

Effect of sole *Tithonia diversifolia*, poultry manure, Cow dung and their Compost on Number of Leaves of Okra in year 2011 and 2013: Figure 2 shows the number of leaves of okra as influenced by the application *Tithonia diversifolia*, poultry manure, cow dung and their composts. In year 2011, that at 2 weeks after planting, it was revealed that okra plants treated with CDC 30 gave significantly higher number of leaves than the number of leaves of okra plants treated with T 10 and control. At 4 WAP, plants treated with PMC 20 had highest number of leaves which was significantly higher than the number of leaves of those fertilized with CD 15 and control. Also, at 6 WAP, plants treated with PM 10 and T 10 gave highest okra number of leaves, control was observed to have the least. Meanwhile, at 8 WAP, plants treated with PMC 20 gave the highest number of leaves while those fertilized with CDC 30 and control had the least. In year 2013, at 2 WAP, plants treated with PM 10 gave the highest number of leaves. Control was observed to have the least. At 4 WAP and 6 WAP, plants treated with T 10 had highest number of leaves while control had the least. At 8 WAP, plants treated with PMC 30 gave significantly highest number of leaves while control had the least (Figure 2).

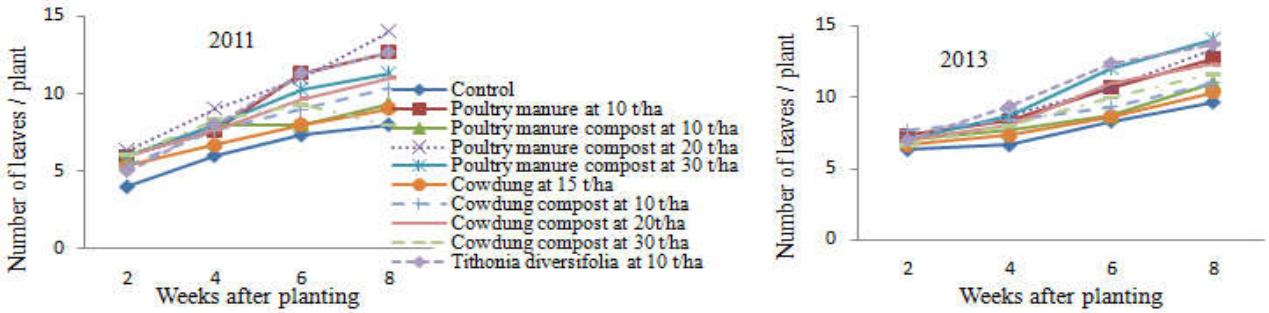

FIGURE 2: Effect of sole Tithonia diversifolia, poultry manure, cow dung and their composts on number of leaves of okra in year 2011 and 2013.

Effect of sole *Tithonia diversifolia*, poultry manure, Cow dung and their Compost on Stem Girth of Okra in year 2011 and 2013: Figure 3 showed the effect of *Tithonia diversifolia*, poultry, and cow dung and their composts on the stem girth of okra plant in the year 2011 and 2013. It was observed that okra plants treated with PMC 10 gave broadest stem girth from 2 WAP to 8WAP. Control (untreated) plants had the least stem girth (Figure 3).

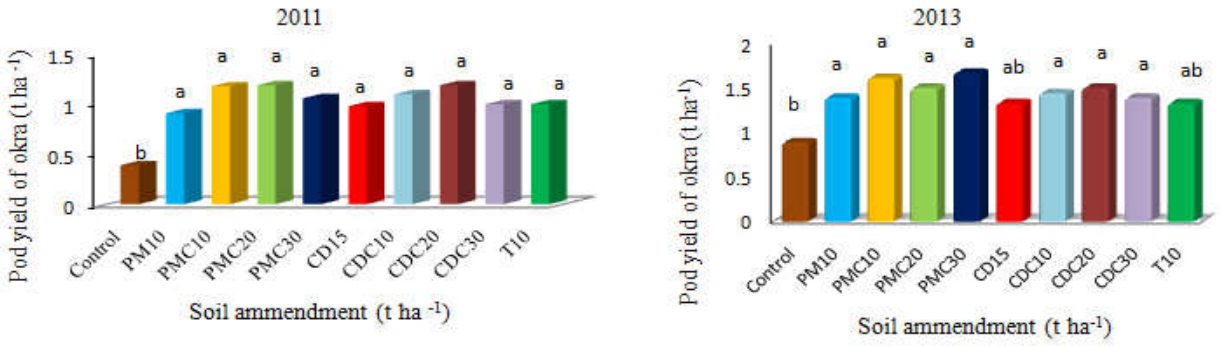

FIGURE 3: Effect of sole *Tithonia diversifolia*, poultry manure, cow dung and their composts on stem girth of Okra (cm) in year 2011 and 2013.

Effect of sole Tithonia diversifolia, poultry manure, Cow dung and their Compost on Number of Fruits of Okra in year 2011 and 2013: The highest values were observed on plants fertilized with Tithonia diversifolia + cow dung compost at 30 t ha^{-1} (CDC 30) and Tithonia diversifolia + poultry manure compost at 30 t ha^{-1} (PMC 30) in 2011 and 2013 respectively. Increase in number of okra fruits relative to fertilizer application followed this order: CDC 30 > PMC 30 > Tithonia diversifolia + cow dung compost at 20 t ha^{-1} (CDC 20) > Tithonia diversifolia + poultry manure compost at 20 t ha^{-1} (PMC 20) > cow dung at 15 t ha^{-1} (CD 15) > Tithonia diversifolia + poultry manure compost at 10 t ha^{-1} (PMC 10 > Tithonia diversifolia + cow dung at 10 t ha^{-1} (CDC 10) > Tithonia diversifolia at 10 t ha^{-1} (T 10) > poultry manure at 10 t ha^{-1} (PM 10) > control, PMC 30 > PMC 10 > CDC 20 > PMC 20 > CDC 10 > CDC 30 > PM 10 > T 10 > CD 15 > control in 2011 and 2013 respectively (Table 3).

Table 3: Effect of sole Tithonia diversifolia, poultry manure, cow dung and their composts on number of fruits of okra in year 2011 and 2013.

Treatment / ha	Number of fruits / plant	
	2011	**2013**
Control	11.93c	12.30b
PM 10	12.83c	15.13ab
PMC 10	13.90c	17.63a
PMC 20	14.90bc	16.30ab
PMC30	20.30ab	17.80a
CD15	14.40c	14.33ab
CDC10	13.70c	15.50ab
CDC20	16.96abc	16.48ab
CDC30	22.36a	15.16ab
T10	13.33c	14.43ab

Means with the same letter(s) in a column are not significantly different from each other at P < 0.05.

KEY:

PM: Poultry Manure PMC: Tithonia diversifolia + poultry manure compost CD: Cowdung
CDC: Tithonia diversifolia + cowdung compost T: Tithonia diversifolia

Effect of sole *Tithonia diversifolia*, poultry manure, Cow dung and their Compost on Pod Yield of Okra in year 2011 and 2013: In year 2011, the pod yield of all fertilized plants increased above the control plants (Figure 4). Okra plants treated with CDC 20 had highest pod yield which was only significantly higher than the control (untreated) plants (Figure 4). Also, in the year 2013, fertilizer application significantly influenced pod yield of okra as all okra plants treated had increased okra pod yield than the control plants. Although, plants treated with PMC 30 had highest pod yield which was significantly higher than untreated (control) plants (Figure 4).

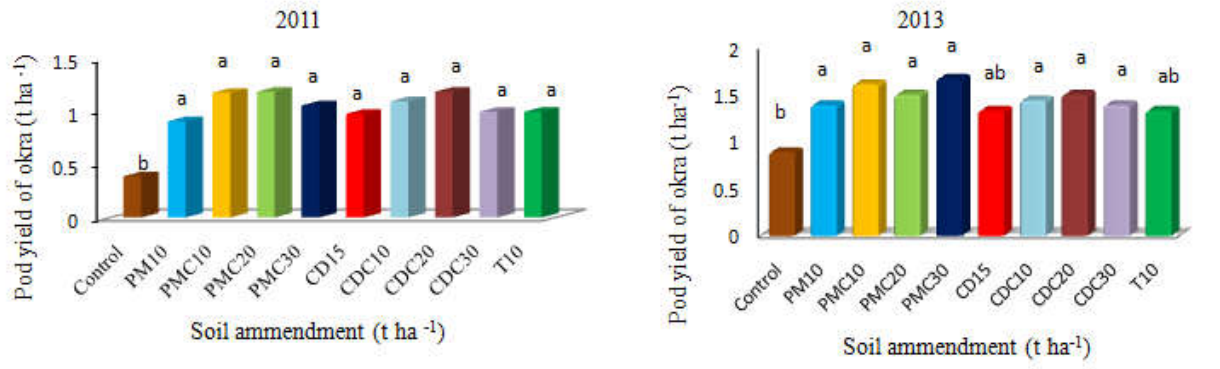

FIGURE 4: Effect of sole Tithonia diversifolia, poultry manure, cow dung and their composts on the pod yield of okra in 2011 and 2013.

DISCUSSION

The soil used for the experiment had been classified as an Alfisol (Ojeniyi, 1990). It was observed that the sandy loam nature of the soil with high sand particles and low nutrient (Total nitrogen, organic carbon, magnesium) makes it suitable for the study. It was observed that the nitrogen content of sole organic materials were higher than in compost, this could be due to the volatilization of ammonia (NH_3) during composting (Steiner *et al*., 2010). The composted materials had increased C/N ratio than sole materials probably because of reduced nitrogen content in the compost since there was a decrease in the total nitrogen of the composted materials. Also C/N ratio dictates the decomposition and mineralization rate and release of nutrient. The highest okra height observed from T 10 amended plants at 2 weeks after planting in 2011 was due to nutrients being released early from *Tithonia diversifolia* as a result of lower C/N ratio. (Flavel and Murphy, 2006) reported that the nature of organic materials affects the rate of mineralization. The above observation could be because of increased nitrogen content in *Tithonia diversifolia*. Nitrogen was reported by Vos and Biemond (1992) to promote the number of leaves of potato. Shokalu *et al.,* 2011 also reported a significant higher number of leaves of *celosia argentea* L. due to the application of *Tithonia diversifolia*. Highest okra agronomic parameters observed as a result of *Tithonia diversifolia* + poultry manure compost application could be because of high pH and organic carbon content which when decomposed would have assisted in the release of plant nutrient necessary in promoting the agronomic parameters (Chan, 2008). PMC has the highest C/N ratio, this could have delayed nutrient release particularly phosphorus which enhances flower development (Makinde *et al*., 2011) till the flowering period, when more nutrients would be released and therefore enhance the flowering of okra. Compost application generally increased the number of okra fruits to the maximum in both years, the C/N ratio and pH of both composts are higher than the sole organic materials. The former would have assisted in the release of nutrients towards the fruiting period of okra and thereby lead to increase in the number of fruits while the former would have increased nutrient availability in the soil (Sanwal *et. al*., 2007).

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