Evaluation of organo-mineral fertilizer on the growth and mineral composition of tomato

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ABSTRACT

Tomato is one of the most important vegetable consumed worldwide. It contributes greatly to a healthy and well balanced diet. The aim of this trial was to evaluate the effects of organo-mineral fertilizer on the growth and mineral composition of tomato (Roma VF). The treatments were three levels of organo-mineral fertilizer at the rates of (0, 2.5, 5t/ha). The experiment was laid out in a randomized complete block design (RCBD) replicated three times. The results showed no significant difference in the plant height and number of leaf at different concentrations of organo-mineral fertilizers. Similar trend was observed in yield except in the number of fruits and flower that were significantly difference at different rates of organo-minerals. Proximate analysis of the tomato from treated and untreated soil was also not significantly different (P>0.05). The result of this study has shown that the organo-mineral has little effect on the growth and nutritional value of tomato.

Key words: Organo-mineral fertilizer, growth, mineral composition, tomato.

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INTRODUCTION

Tomato, *Solanum lycopersicum*, belongs to the family Solanaceae, is one of the three important fruit vegetables of the tropical region which originated in South and Central America (Julel, 2001). The tomato, *Solanum lycopersicum*, is a short- lived perennial plant, grown as an annual plant, typically growing to 1-3 m tall, with a weakly woody stem that usually scrambles over other plants (Qasem, and Judah, 2015). Tomato is one of the most widely cultivated crops in the world. It is an important cash crop for small- holders and medium-scale commercial farmers (Shankara, 2013). Tomato is sensitive to quite a number of environmental stresses, especially extreme temperature, drought, salinity and inadequate moisture stresses (Kalloo, 2012). It is one of the popular and most consumed vegetable in the world. It is tasty and easily digestible and its bright colour stimulates appetite. Like other vegetable, tomato plays a very important role in human diets; because it supplies some of the nutrient deficient in other food materials (Biwasi, 1999).

It is a good source of Fe and vitamin A, B and C. Tomatoes have been reported to be an important source of nutrient antioxidant such as lycopene and vitamin C in human diet. Lycopene, the most important antioxidant has been linked with reduction of prostrate and other forms of cancer as well as heart diseases (Barber and Bryson, 2006). The antioxidant components of tomatoes have been reported to be influenced by the cultivars, growing conditions and seasons, harvesting stage and ripening on and off-vine (Toor *et al.,* 2005). However, there is limited information on the effects of different forms of fertilizer on the antioxidant component of tomatoes. This may be because the mineral composition of crops depends on the amount and type of nutrients taken from the growth medium, such as soil, it is necessary that adequate amount of nutrients should be available for the production and nutrient content of tomatoes (Barker and Bryson, 2006). Fertilizers have been established to be important in *Solanum* species cultivation (Olaniyan and Nwachukwu, 2003). While nitrogen is important in vegetative development; phosphorus is needed to stimulate flowering and fruit formation while potassium is for seed setting. NPK fertilizer is therefore needed for good crop yield in *Solanum* species (Ojo and Olufolaji, 1999).

Tomato thrives well in the forest zone only with the late rains probably because of the incidence of white flies (*Bemisia tabaci)*, this is the vector of the common yellow patch disease. However, before nutrients in the soil can be taken by plants, the soil physical properties must be in good condition to enhance free flow of water and nutrients in the soil. In contemporary agriculture, soil must be resistance to various forms of degrading factors and soil properties must meet the requirement of sustainability and input – saving crop cultivation technologies (Balesdent *et al*., 2000).

These days because of high population densities, continuous farming is replacing bush fallowing which used to add a lot of nutrients and organic matter to the soil. The bush fallowing improves not only the nutrient content but also the hydro-physical properties of the soil. The improvement of the chemical and hydro-physical properties by the bush fallow system is due to the addition of organic matter to the soil.

It is therefore important to know the right amendment that may improve physical properties of the soil so as to improve growth and yield of crops (Palojarvi and Nuutinen, 2002). Also soil physical properties are being destroyed due to continuous farming and excessive use of fertilizer with no added organic matter. In order to obtain high yield of tomatoes there is the need to increase the nutrient status of the soil to meet the crop's requirement and thereby maintaining the fertility status of the soil.

One of the ways of increasing the nutrient status is by boosting the soil nutrient content either with the use of organic materials such as poultry manure (PM), other animal waste, or with the use of compost with or without inorganic fertilizers (Dauda et al., 2008; Akintokun *et al. 2*015). However, there are limitations to the replacement of mineral fertilizer N with manure N. The concentration and availability of N in manure is variable (Sims and Wolf 1994). It is also frequently difficult to apply manure uniformly at controlled rates (Laguë *et al.* 1994), and to use existing fertilizer application equipment for organic nutrient sources. Production of pelletized organo-mineral fertilizer products from excess manure is one possible solution to these limitations. Addition of mineral fertilizer nutrients to the manure during production of organo-mineral fertilizer products increases nutrient concentrations, requiring lower field application rates. Such additions also improve the uniformity in the concentrations and availability of nutrients within the finished product. Use of organic or organo-mineral nutrient sources has the added advantage of supplying a range of macro-nutrients and micro-nutrients and organic matter. Application of manures and organic materials improves crop yield capacity and soil physical and chemical properties (Eghball and Power 1994; Akintokun *et al.* 2015). Hence, this work is designed to evaluate the effects of organo-minerals on the growth and nutritive value of tomato.

MATERIALS AND METHODS

Description of the Experimental Site

The experiment was conducted on the Teaching and Research Farm of the Directorate of University Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta, in the forest savanna- transition agro ecological zone situated at latitudes $7^0 15^1$N and longitude $3^0 25^1$E, altitude 144m above the sea level. The rainfall distribution pattern for Abeokuta is bimodal. The annual rainfall ranges from 1145 to 1270 mm.

Collection of materials:

The variety of tomato seeds (ROMA VF) were purchased from Agbeloba Agro services shop in the state ministry of Agriculture while organo-mineral fertilizers was purchase from department of Agronomy University of Ibadan. The rice husk was collected from the Ofada rice milling stations in Lafenwa market Abeokuta Ogun State.

Experimental Design and Treatments

The experiment was done at Federal University of Agriculture Abeokuta during 2017 farming seasons. The experimental design was a complete randomized block with three replicates and plot size of 3 m x 3 m. Organo-mineral fertilizer was applied two weeks after transplanting at the rate of 0, 2.5 and 5 t/ha.

The physio-chemical Analyses of Soil

Soil samples were collected using soil auger at a depth of 0 -20 cm at the experimental site for physico-chemical analyses, prior to the planting, The following analyses were carried out: pH, exchangeable bases, Na (cmol/kg), k(cmol/kg), Ca (cmol/kg), H+ (cmol/kg), CEC (cmol/kg), Available P (cmol/kg), Organic carbon (%), Organic matter (%), % N, % of silt, % of clay and % of sand using the method described by Association of Official Analytical Chemist (AOAC.,2005).

Plant material and planting

Tomatoes seedlings were raised in the nursery before being transplanted to the field at DUFARMS, FUNAAB. Two seedbeds were made for the different varieties and the seed were planted on the beds. The tomato seedlings were transplanted to the field after 28days of planting in the nursery. Organo mineral fertilizer was applied 2Weeks After Planting (WAP) using broadcasting method. Weeding was done once in every two weeks

Data Collection

The yield parameters such as number of flowers, Number of fruits, Fruit weight per plant, Total fruit yield per hectares of tomato varieties were noted.

Proximate Analysis: The constituents of Organo-minerals and tomatoes were analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist (A.O.A.C., 2005).

Data analysis: The data collected was subjected to Analysis of variance (ANOVA) using GENSTAT and means were separated using Duncan multiple range test.

RESULT

The physico-chemical properties

The physico-chemical properties of the soil are presented in Table 1. It showed that the pH of the soil is slightly acidic and textural class of the soil is sand. The percentage sand, silt and clay are 84.40, 5.60 and 10%, respectively. The soil is low in nitrogen (0.11cmo/kg) and potassium (0.34cmo/kg) but the available phosphorous (10.04mg/kg) was relatively moderate.

Table 1: Physico-chemical properties of soil before transplanting.

Parameter	Value
Sand (%)g/kg	84.40
Silt (%)g/kg	5.60
Clay (%)g/kg	10
Textural Class	loamy sand
Soil pH (1: 1 H_20) soil to water	6.33
Exchangeable Ca ($cmolkg^{-1}$)	17.26
Exchangeable. Mg ($cmolkg^{-1}$)	1.03
Exchangeable Na ($cmolgk^{-1}$)	0.71
Exchangeable K ($cmolkg^{-1}$)	0.37
H^+	0.05
CEC ($cmolkg^{-1}$)	19.42
N (%)	0.11
Org C (%)	0.78
Organic matter	1.35
Av.P ($mgkg^{-1}$)	10.04
Fe ($mgkg^{-1}$)	5.04
Cu ($mgkg^{-1}$)	0.84
Zn ($mgkg^{-1}$)	6.

Nutrient analysis of organo-minerals

The nutritive value of the organo-minerals was also evaluated. The result showed that the percentage sodium, calcium, magnesium and potassium to be 1.06, 1.66, 1.26, 5.36%, respectively while that of Organic carbon, organic matter, nitrogen and phosphorus were 17.21, 29.44, 1.95 and 6.14%, respectively (Table 2).

Table 2: The nutrient analysis of organo_mineral.

NUTRIENTS	VALUES
pH	8.40
%Na	1.06
%Ca	1.66
%Mg	1.26
%K	5.36
%O.C	17.21
%O.M	29.44
%N	1.95
%P	6.14

Effects of organo-minerals on the Plant height and leaf area of tomato

The results of the effects of organo-minerals on the plant height were presented in Fig 1. The results showed no significant difference ($P \leq 0.05$) in the height of plant at different concentrations of organo-minerals. At three weeks after transplanting (3WAT), highest plant height was recorded by the control (23.55cm) and least on the soil treated with 2.5t/ha (20.62cm) while at 6, 9 and 12WAT, the soil treated with 5t/ha showed higher growth and least by the control. Similar trend was observed in the leaf area of the plants treated with different concentration of organo-minerals. There was no significant difference ($P \leq 0.05$) in the leaf area at different concentration and time. The result of the effects of organo-minerals on the leaf area of tomato is presented in Fig.2.

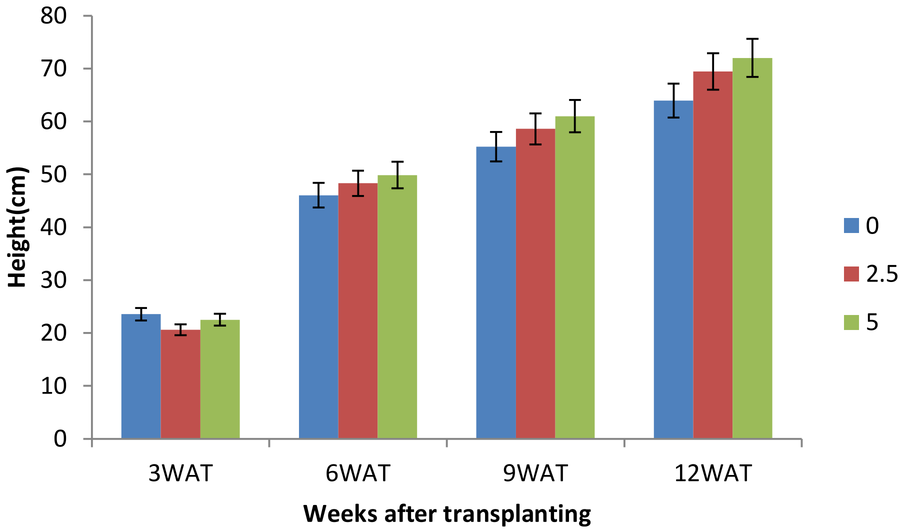

Fig 1: Effects of Organo-minerals on the height of tomato

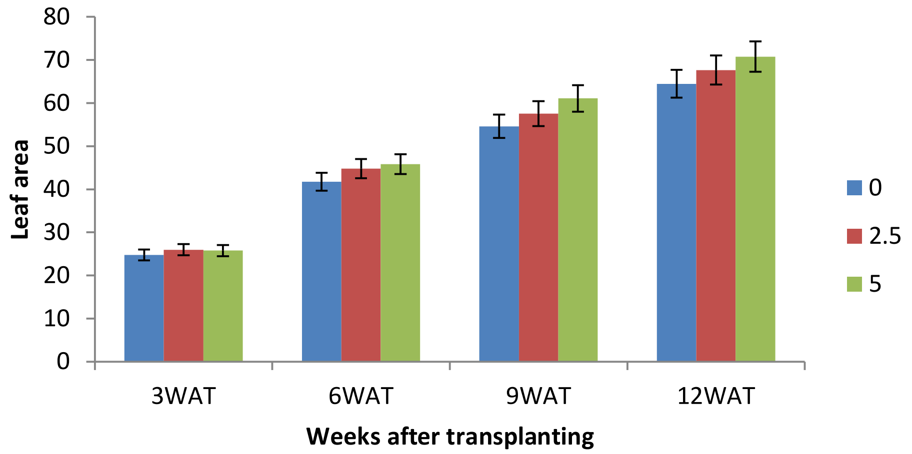

Fig 2: Effects of Organo-minerals on the leaf area of tomato

Table 3: Effects of organo-minerals on the plant girth

ORGANOMINERAL (t/ha)	3WAT	6WAT	9WAT	12WAT
0	0.24	0.68	1.04	1.17
2.5	0.27	0.70	1.12	1.27
5	0.25	0.75	1.13	1.31
LSD 5%	0.02	0.04	0.03	0.09

Table 3 showed the effects of organo-minerals on plant girth. The plant girth at different concentrations and weeks after transplant were significantly different ($P \leq 0.05$). Highest girth was recorded at the concentration of 5t/ha at 12 weeks after transplanting (1.31cm) and least was recorded by the control (1.17cm).

Effect of organo-mineral on the yield of tomato

Table 4 showed the effects of organo-mineral on the yield of tomato. The fruit weight (g) per plant at different organo-mineral concentration of 0, 2.5 and 5t/ha was 108.9, 109 and 107.9, respectively while the mean number of fruits was 5.72, 5.84 and 5.78, respectively. There was no significant difference ($P \leq 0.05$) in fruit weight at different levels of organo-minerals. The results of number of flowers and total yield per hectare were significantly different at different levels of organo-mineral application.

Table 4: Effect of organo-mineral on the yield of tomato

Treatment	Fruit weight (g)/ per plant	Number of fruits	Number of flowers	Total yield (ha)
0	108.9	5.72	9.017	0.74
2.5	109	5.84	10.62	0.70
5	107.9	5.78	9.97	0.72
LSD (0.05)	5.53(NS)	0.43(NS)	0.47**	0.03*

*=significant, **=Highly significant, NS=not significant

Proximate analysis of the tomato seed (Roma VF)

The proximate analysis of the tomato showed percentage crude protein of 11.76, 12.28 and 11.97%, at the concentrations of 0, 2.5 and 5t/ha, respectively while the % crude fat was 6.78, 7.23 and 6.94%, respectively. The % crude fibre and ash were not significantly different(P≤0.05) at different concentrations of organo-mineral. The same trend was observed in the percentage moisture content and dry matter. The moisture content and dry matter at the concentrations of 0, 2.5 and 5t/h were 8.29, 8.21, 8.35 and 91.71, 91.79, 91.65%, respectively. The results of the proximate analysis of the tomato are presented in Table 5.

Table 5: Proximate analysis of the tomato seed (Roma VF)

Treatment(t/ha)	%CP	%CFAT	%CFIBRE	%ASH	%M	%DM
0	11.76	6.78	3.71	4.59	8.29	91.71
2.5	12.28	7.23	3.65	4.43	8.21	91.79
5.0	11.97	6.94	3.76	4.67	8.35	91.65

Key: CP= crude protein, CFAT=crude fat, CFIBRE=crude fiber, M= moisture, DM = Dry matter

DISCUSSION

The focus of research in recent years has shifted towards the application of organic nutrient sources to reverse the negative nutrient balances in cropping system in agriculture in Africa (Vanlauwe*et al.,* 2001: Akintokun *et al.*2015). The addition of the mineral fertilizer to improve crop yield, by increasing the nutrient supply at the initial stages of net immobilization, resulting from application of the plant materials (Palm *et al.,* 1997; Giller, 2001).

In this study, the application of 5 t ha^{-1} of organo-mineral fertilizer produced the tallest plant followed by application of 2.5 t ha^{-1} while the application of 0 t ha^{-1} produced the shortest plant at week 12. This was in conformity with the findings of Egbuchua and Enujeke, (2013); It also agrees with the findings of Ojeniyi *et al.* (2012) who reported that increasing the rate of organo-mineral fertilizer increased the plant height of maize. Ipimoroti *et al.* (2015) also reported that plant height and leaf area of tea was increased with increased rates of organo-mineral fertilizer application. The result was also in consonance with the findings of Olaniyi *et al.* (2012) who opined that the application of organo-mineral fertilizer significantly increased plant height of okra. Similar trend was observed in the leaf area which was also higher at 5t/h of organo-minerals. This is also in line with the findings of Ojeniyi *et al.*(2009) that reported an increase in number of leaf due to corresponding increase in organo-mineral applied. Ande *et al.*(2010) also reported better performance of maize and other cereals when treated with organic manure. The higher plant height, leaf area and other parameters obtained with organomineral fertilizer over the control could be attributed to the improvement of soil physical properties such as nutrient retention, structural stability and continual availability of major nutrients especially solubilized phosphorus coupled with possible chelation of micro nutrients by organic constituents of the organo-mineral fertilizer. Effects on total leaf area showed that there was a slight influence of treatments at various rates up to the 12^{th} week after transplanting where the widest leaf area of 70.8cm^2 at 5 t ha^{-1} rate of treatment application was obtained. The control experiment produced the least leaf area of 64.46cm^2. The significant ($P < 0.05$) different of plants that received treatments over control confirmed the work of Schippers (2000) who reported that organo-mineral fertilizer are very useful in promoting plant height and vegetative growth of plant by producing large leaf areas. These results also coincided with the findings of El Noeman*et al.* (2013), Filatov and Afonin (2014) and Sayed (2012). They stated that nitrogen from organo-mineral fertilizers significantly increased leaf area through effect on elongation of leaves.

The significant increase in number of leaves, stem girth and plant height observed with applied organo-mineral fertilizer rates as compared with the control might also probably be due to increased inorganic content which help to burst the growth of the plant at the initial stage and the organic content which help the crop growth at the latter stage. This confirmed the report of Ipinmoroti *et al.* (2002) that quick mineralization of inorganic component and the slow nutrient release of the organic constituents must have sustained the continuous better performance of *Acruentus* than their separate applications. The yield of the tomato was not significantly different when the yield from tomato treated with organo-minerals was compared with the control. This disagrees with the findings of Randy (2012) who reported an increase in growth and yield of tomato as a result of organo-mineral application. Adeniyan and Ojeniyi (2003) have also reported that balanced plant nutrition and enhanced crop production are ensured with the use of organo-mineral fertilizer. The increase in fruit yield due to application of organo-mineral fertilizer at different levels was mainly due to better and adequate utilization of nutrient supply.

The results obtained in this research work indicated that organo-mineral fertilizer produce vegetative growth better than the control of tomato plants on the sandy loam soil. This may be because organo-mineral fertilizer contains essential elements necessary for growth like nitrogen, phosphorus, calcium, magnesium and potassium as the essential elements. This agrees with the report of Obi and Ebo (1995) that poultry manure as organic matter improves the chemical and biological qualities of the soil which increases crop productivity. The results of this work showed an increase in growth of tomato treated with organo-minerals but no significant effect on the yield of tomato.

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