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Effect of Different Levels of Poultry Manure on Soil Physical Properties, Nutrients Status, Growth and Yield of Tomato (*Lycopersicon esculentum*)

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Abstract: The relative effect of different levels (0, 10, 20, 40, 50 t ha^{-1}) of poultry manure on selected soil physical properties, nutrient status, growth and fruit yield of tomato (*Lycopersicon esculentum*) was studied in field experiments conducted at FECA and FUTA sites, Akure, in Southwest Nigeria. Soil bulk density and temperature reduced with level of poultry manure, while moisture content, height, number of branches, leaf area and taproot length increased. However the 20 t ha^{-1} poultry manure gave highest value of number and weight of fruits. The mean values of fruit weight recorded for 0, 10, 20, 40 and 50 t ha^{-1} manure were 17.6, 27.9, 35.6, 24.4 and 23.0 t ha^{-1}, respectively.

Key words: Correlations, growth, nutrient, soil physical, tomato, yield

INTRODUCTION

Low soil fertility and physical limitations affect tomato (*Lycopersicon esculentum*) production especially in Nigeria where often have constraints of compaction, shallow depth, supraptimal temperature and nutrient deficiency. Ojeniyi and Adekiya (2002) had shown that high soil bulk density due to zero tillage adversely affected growth, yield and nutrient status of tomato in Southwest Nigeria. The soil limitations can be tackled by adequate application of poultry manure, which is easily available. Infact disposal of poultry manure is a problem of increasing importance in Nigeria and other developing countries. Whereas the use of chemical fertilizers by farmers has not been sustainable due to its scarcity, high cost, nutrient imbalance and degradation of soil physical properties.

Field experiments conducted in tropical and temperate countries ascertained that poultry manure improved availability of macro and micro nutrient in soil (Ojeniyi and Adeniyan, 1999; 2003) nutrient uptake by maize (Adeniyian and Ojeniyi, 2001) yield of tomato, amaranthus (Macrere *et al*., 2001) and Conola (*Brassica napens*). However, there is scarcity of research information on effect of different levels of poultry manure on soil physical properties, growth and nutrient status of tomato. Aluko and Oyedele (2005) noted very little information on effects of organic waste incorporation on soil strength and physical properties. In their study conducted at Ile-Ife, Southwest Nigeria they observed that poultry manure had no significant effect on soil dry density and porosity. Hence, this work carried out at Akure in the rain forest zone of Southwest Nigeria investigated effect of different levels of poultry manure on selected soil physical properties, growth, macronutrient status and yield of tomato.

MATERIALS AND METHODS

Field experiment was carried out at Akure (7° 16^1 N longitude, 5°12^1 E latitude) in rainforest zone of Southwest Nigeria. The experimental sites were located at Federal College of Agriculture (FECA) and Federal University of Technology (FUTA). The sandy loam soils are classified as clayey skeletal kaolinitic oxic paleustalf or ferric luvisol (FAO) (Adeniyan and Ojeniyi, 2002). The sites were cropped to maize and cassava for 10 and 6 years, respectively before clearing. After manual clearing in 2004, core soil samples were collected to 15 cm depth and bulked for analysis.

The experiment compared five levels of poultry manure namely 0,10, 20,40 and 50 t ha^{-1}, which were replicated three times in a randomized complete block design. Tomato (Roma VF) seedlings were raised in nursery for 3 weeks before transplanting to ploughed and harrowed land at 75×60 cm. Each of the 15 plots at each site was 25 m^2 given a plant population of 66. Each block

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was 1m apart while the plots were 0.5 m apart. There were two trials at each site with seedlings transplanted in May and August 2004. Manure was air-dried for 3 weeks before being applied on surface soil by ring method two weeks after transplanting.

Fifteen staked plants were selected per plot for determination of plant height, number of branches and leaf area (by graph method) at beginning of flowering. Number of ripe fruits were determined and weighed during each harvest, which covered 6 weeks. The mean fruit diameter was also determined. After harvesting, plants were excavated for measurement of taproot length.

Leaf analysis: At 50% flowering, leaf samples were collected oven-dried at 80°C and ground. Analysis was done as described by Tel (1984). Total N was determined using micro-Kjeldahl method. For P, K, Ca and Mg, ground leaf sample was ashed and dissolved in HCL. The P was determined using vanadomolybdate colorimetry, Ca and Mg by EDTA titration and K by flame photometer. Poultry manure was also analysed.

Soil properties: After the two trials in each site, three core soil samples collected between 5 to 15 cm depth were used for gravimetric determination of moisture content and bulk density. Soil temperature was determined to 5 cm depth at 15.00 h using soil thermometer. Total porosity was calculated from bulk density using particle density of 2.65 g cm^{-3}.

Chemical analysis of composite soil samples collected at 0-15 cm depths over each study site was done as described by Tel (1984). Organic matter was determined by Walkley Black dichromate method, total N by Kjeldah method, available P was extracted with Bray-Pi solution and determined using molybdenum blue colorimetry. The exchangeable K, Ca and Mg were extracted using I N neutral ammonium acetate and K determined by flame photometer and Ca and Mg by EDTA titration. The P^H in soil $Cacl_2$ 1:2 ratio was determined using a glass electrode P^H meters 6.7.

Statistical analysis: Mean data for two crops at each site were calculated and subjected to analysis of variance. The Duncan multiple range test at 95% level of probability was used to compare mean data for manure treatments.

RESULTS AND DISCUSSION

Initial soil analysis data for FECA and FUTA sites at Akure were, respectively P^H ($Cacl_2$) 6.3 and 6.7, organic matter (OM) 14.7 and 15.3 g kg^{-1}, total N 1.3 and 1.4 g kg^{-1}, exchangeable k 0.31 and 0.44 Cmol kg^{-1}, Ca 11.2 and 1.8 cmol kg^{-1}, Mg 0.05 and 0.05 and 0.98 cmol kg^{-1} and available P at FECA. Therefore it is expected the soils and tomato crop would benefit from application of poultry manure Table 1.

Data on soil physical properties are given in Table 2. At FECA and FUTA sites, soil bulk density reduced with level of poultry manure between 0 to 50 t ha^{-1} while total porosity expectedly increased. Soil moisture content increased, while soil temperature expectedly reduced with level of manure. Therefore poultry manure improved soil physical properties as indicated by reduced density and temperature and improved porosity and moisture content. Due to its ability to stabilize soil structure, organic matter derived from the manure improved soil total porosity, reducing its density and also acted as mulch thus reducing water evaporation by reducing soil temperature. High positive correlations coefficients between level poultry manure and soil bulk density (60.83) soil moisture content (0.99) were recorded. Adesodun *et al.* (2004) had evaluate effects of rice mill wastes and poultry manure on C, N and P distribution in water table aggregates of ultisol of Southeast Nigeria. They found a significant correlation between organic carbon and mean weight diameter of the aggregates. Aluko and Oyedele (2005) also indicated that poultry waste incorporation enhanced the structure and stability of soil aggregates. Greenland cited by Adetoro (2003) found that water retention by soil at field capacity and wilting point was enhanced by increase in supply of organic matter to sandy loam soils at kwadoso, Ghana.

The improvement in soil physical conditions due to poultry manure application led to improved nutrient uptake by tomato as in Table 2. It could be seen that at both sites of study, leaf N, P, K, Ca and Mg concentrations of tomato tended to increase with level of manure up to 50 t ha^{-1}. The fact that poultry manure improved soil moisture content, moderated soil temperature, improved soil porosity thereby reducing soil density, led to enhancement of root growth (Table 3) and uptake of the nutrients. Apart from these positive effects, decomposition of poultry manure led to mineralization of organic nutrients and release of N, P, K, Ca and Mg. Hence in this work high positive correlations were recorded between amount (level) of poultry manure and mean leaf N (0.99) for the sites, leaf P (0.92), leaf K (0.90), leaf Ca (0.92) and leaf Mg (0.89). Studies by Macrere *et al.* (2001) in Tanzania, Adeniyan and Ojeniyi (2003; 2005) in South West Nigeria had shown that poultry manure increased soil organic C, N, P, K, Ca and Mg. Adeniyan and Ojeniyiu (2003) found that poultry manure at 7 t ha^{-1} increased leaf P, K, Ca and Mg significantly. In the present study, poultry manure had 14.9 C, 11.1% N, 26 P, 2.38 K, 0.19 Ca and 0.17% Mg (Akanni, 2005).

Table 1: Effects of levels of poultry on soil physical properties

	Temperature (°C)		Bulk densitygm cm^{-3}		Moisture (%)		Total porosity (%)	
Poultry manure (t ha^{-1})	FECA	FUTA	FECA	FUTA	FECA	FUTA	FECA	FUTA
0.00	27.39^{b}	27.69^{a}	1.43^{d}	1.13^{e}	11.99^{a}	22.04^{a}	46.52^{a}	57^{a}
10.00	26.89^{ab}	26.69^{a}	1.29^{c}	0.99^{b}	12.74^{a}	25.48^{a}	51.57^{b}	63^{b}
20.00	25.48^{ab}	25.79^{a}	1.25^{c}	0.94^{c}	14.62^{b}	25.96^{a}	53.59^{b}	64^{b}
40.00	25.33^{ab}	25.66^{a}	1.15^{ab}	0.92^{c}	16.39^{c}	28.09^{b}	57.61^{c}	64^{b}
50.00	24.98^{a}	25.28^{a}	1.11^{a}	0.92^{c}	17.19^{c}	29.13^{b}	58.62^{c}	65^{b}

Table 2: Effects of levels of poultry manure on leaf nutrient (%)

Poultry	Nitrogen		Phosphorus		Potassium		Calcium		Magnesium		Soil pH ($Cacl_2$ 2:1)	
manure(t ha^{-1})	FECA	FUTA	FECA	FUTA	FECA	FUTA	FECA	FUTA	FECA	FUTA	FECA	FUTA
0.00	3.95^{a}	1.76^{a}	0.12^{a}	0.37^{a}	2.32^{a}	3.24^{a}	0.16^{a}	0.66^{a}	0.09^{a}	0.14^{a}	6.7	6.8
10.00	4.25^{ab}	2.72^{b}	0.15^{b}	0.57^{bc}	3.78^{b}	4.18^{b}	0.36^{c}	0.73^{a}	0.13^{b}	0.16^{a}	6.3	6.4
20.00	4.41^{b}	3.43^{c}	0.50^{c}	0.57^{bc}	4.16^{c}	5.35^{c}	0.39^{c}	0.94^{b}	0.23^{d}	0.26^{b}	6.2	6.3
40.00	4.16^{b}	4.68^{d}	0.54^{c}	0.53^{b}	4.86^{d}	5.98^{d}	0.32^{b}	1.01^{b}	0.21^{c}	0.30^{c}	6.1	6.2
50.00	4.89^{c}	4.67^{d}	0.54^{c}	0.60^{d}	4.16^{c}	5.95^{d}	0.37^{c}	1.09^{c}	0.20^{c}	0.27^{b}	5.9	6.1

Table 3: Effects of levels of poultry manure on growth of tomato

	Plant height (cm)		No. of branches		Leaf area (cm^2)		Tap root length (cm)	
Poultry manure (t ha^{-1})	FECA	FUTA	FECA	FUTA	FECA	FUTA	FECA	FUTA
0.00	61.17^{a}	56.23^{a}	10.54^{a}	6.19^{a}	17.45^{a}	15.75^{a}	22.88^{a}	21.90^{a}
10.00	73.95^{b}	55.39^{a}	14.01^{b}	8.33^{b}	19.65^{b}	16.16^{a}	25.65^{b}	28.97^{b}
20.00	78.09^{b}	60.9^{ab}	13.92^{b}	9.10^{c}	20.52^{b}	18.63^{b}	30.93^{c}	30.73^{b}
40.00	85.63^{c}	59.3^{ab}	16.23^{c}	9.4^{c}	26.34^{c}	19.64^{b}	34.98^{d}	33.24^{c}
50.00	88.64^{c}	62.71^{b}	17.22^{c}	12.44^{d}	28.09^{c}	25.01^{a}	35.78^{d}	34.92^{c}

Table 4:Effects of levels of poultry manure on yield of tomato

	No. of fruit/plant		Yield (t ha^{-1})		Fruit diameter (cm)	
Poultry manure (t ha^{-1})	FECA	FUTA	FECA	FUTA	FECA	FUTA
0.00	22.02^{a}	20.64^{ab}	16.37^{a}	18.86^{a}	3.37^{a}	2.27^{a}
10.00	24.37^{b}	20.34^{a}	27.06^{c}	28.70^{c}	3.63^{a}	3.49^{a}
20.00	30.64^{c}	33.35^{c}	31.55^{d}	39.73^{d}	4.35^{b}	3.55^{b}
40.00	23.38^{ab}	33.44^{c}	22.70^{b}	25.99^{b}	4.48^{b}	4.37^{b}
50.00	22.29^{ab}	21.54^{b}	21.25^{b}	24.78^{b}	4.52^{b}	4.45^{b}

Table 4 shows data on plant height, number of branches, leaf area and taproot length of tomato as influenced by poultry manure treatments. The parameters increased with level of manure up to50 t ha^{-1}. Therefore increased availability of nutrients to tomato due to application of poultry manure increased growth of tomato and thus led to increase in fruit yield as shown in Table 4. High positive correlations were recorded for the relationship between level of manure and mean root length (0.98).

However while vegetative growth increased with level of poultry manure up to 50 t ha^{-1}, it was the 20 t ha^{-1} manure that gave highest value of number of fruits and yield at the sites. Thus the enhancement vegetative growth after 20 t ha^{-1} did not translate to fruit yield. This could be due to excessive supply and dilution effect of an acid N, which is known to influence vegetative growth and leaf production. It could be seen that at FECA site, leaf Ca and Mg reduced at 40 or 50 t ha^{-1} manure. The excessive supply of N, P and K from high levels of poultry manure could have cause nutrient imbalance leading to reduce intake of other nutrients such as Ca, Mg and micronutrients. For example Saxena and Locascio observed that foliar contents of Ca were reduced at higher rate of N application. The leaf N, P and K recorded for 40 and 50 t ha^{-1} manure were clearly above 4.2, 0.44 and 2.5%, respectively regarded as adequate for tomato. However the value of leaf Ca and Mg were quite low considering 5.7 Ca and 0.75% Mg regarded as critical. Therefore excessive supply of N, P and K could exacerbate Ca and Mg, deficiency and nutrient imbalance. Delay in flowering and fruit maturity of tomato due to application of N was reported by Uzo (1970) and Fawusi (1977) observed delayed flowering with application of N, P and K to tomato.

Improvement in soil physical properties adduced to poultry manure, such as reduced soil bulk density and improved soil moisture status contribute to enhanced growth and yield of tomato, although the manure also influenced nutrient availability. High negative correlations recorded between mean soil bulk density and mean leaf N (-0.90), leaf P (-0.86), leaf K (-0.92), leaf Ca (-0.91) and leaf Mg (-0.78). Also negative correlations were recorded between soil bulk density and mean fruit yield (-0.47), root length (-0.91), number of branches (-0.84), leaf area (-0.76) and plant height (-0.90) for the tow sites, respectively. High positive correlations were recorded between soil moisture content and leaf N (1.000), leaf P (0.93), Leaf K (0.94) Leaf Mg (0.89) and leaf Ca (0.95), root length (0.99), number of branches (0.98), leaf area (0.96) and plant height (0.99).

Consideration of the mean values for both sites of study indicates that relative to control, 10, 20, 40 and 50 t ha^{-1} poultry manure increased number of fruits by 5, 50, 33 and 3%, respectively. The increased in fruit yield (weight) were 59, 102, 39 and 31%. Therefore the 20 t ha^{-1} manure is recommended. Adediran *et al.* (2003) in their comparison of effect of poultry manure, market waste, maize waste and urban waste also found that 20 t ha^{-1} of the wastes gave highest yield of tomato and the 40 t ha^{-1} wastes reduced yield compared with 20 t ha^{-1} waste.

It is concluded that poultry manure applications improved soil physical properties and nutrient uptake by tomato thereby leading to enhanced crop growth and fruit yield. The 20 t ha^{-1} manure is recommended.

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