Applied Tropical Agriculture
Volume 22, No. 1, 111-116, 2017.

Comparative Effect of NPK 20:10:10, Organic and Organo-mineral Fertilizers on Soil Chemical Properties, Nutrient Uptake and Yield of Tomato (*Lycopersicon esculentum*)

Ayeni, L.S.* and Ezeh, O.S.

Department of Agricultural Science, Adeyemi College of Education, Ondo, Nigeria
*Corresponding author: leye_sam@yahoo.com

ABSTRACT

A Screen-house experiment was carried out at Adeyemi College of Education, Ondo Southwest Nigeria to evaluate the effect of NPK 20:10:10 (NPKF), organic (OF) and organo-mineral (OMF) fertilizers on soil chemical properties, nutrient uptake and yield of tomato. The treatments used were organic and organo-mineral fertilizers applied the same rates of 0, 12.5, 25 and 50 g/plant and NPK 20:10:10 fertilizer applied at 2 g /plant. There were eight treatments replicated six times and arranged in a completely randomized block design. The result showed that OF, OMF and NPKF had significant effect on agronomic parameters and nutrient uptake of tomato. The increase in tomato fruit weight were in the order of OMF25g > OMF50g >. OMF12.5g > OF12.5g > NPKF > OF50g > control > OF25g. Application of OMF and OF fertilizers at all rates significantly increased N, P and Ca concentration (p>0.05) in tomato plant as well as soil nutrients showing that organic fertilizers had better residual effects on soil chemical properties. The order of increase in N concentration in tomato plants were OF 25g > OMF 50g > OMF25g > OMF12.5g > OF50g > NPKF > OF25g > control. Organomineral fertilizer applied at 25g recorded highest leaf P concentration (0.06g) while control recorded least P (0.02g). OMF applied at 12.5g/plant recorded highest K (4.53g) in tomato leaf while control recorded least K (3.07g). Compared with control, all the treatments significantly (p>0.05) increased soil pH (except NPKF), OM, total N, Ca, Mg, K and CEC.

Key words: yield, leaf area, branches, micronutrients, macronutrients

INTRODUCTION

Tomato is one of Nigerians prize vegetables. It ranks among the top three vegetables in importance to commercial growers. Tomato fruit yield in Nigeria is very low compared with countries like China, Japan and United States. According to FAO (2001), yield per hectare in Nigeria is 9.9 tonnes per hectare (t/ha), 25.3 t/ha in China, 52.8 t/ha in Japan and United States. In addition, the world total tomato output was 77.5 million tonnes from 2.9 million hectares in 2000. Most of these were from temperate countries.

Most African soils show nutrient deficient problems after only a short period of cultivation because of their nature as well as prevailing environmental conditions (Rafi, 1996; Law-Ogbomo and Egharevba, 2009). Tropical soils are known to be low in organic matter and mark depletion in its store occurs within two years of cultivation. However, extensive use of inorganic fertilizer has a depressing effect on yield (Okunlola *et al*., 2011). This causes reduction in number of fruits, delays and reduces fruit setting which consequently delays ripening and leads to heavy vegetative growth (John *et al*., 2004; Okunlola *et al*., 2011). Management of mineral fertilizers has also become increasingly critical in crop production from both economic and environmental standpoint. The use of mineral fertilizer by farmers is limited because of scarcity, high cost and inability to substantially redress the physical fragility and chemical deterioration of the soil (Adeniyan and Ojeniyi, 2005; Okunlola *et al*., 2011). These are bottlenecks for crop cultivation in Nigeria. This necessitates research into the use of organic wastes such as poultry manure, cow dung, swine dung, urban wastes etc. that are cheap, readily available and environmental friendly as fertilizers (Ayeni *et al*., 2010; Okunlola *et al*., 2011).

In addition, research interest in tropical countries has shifted to the utilization of agro industry and organic waste which can pose environmental hazards if not converted to agricultural and economic uses (Ayeni, 2010). Researches carried out in Nigeria and elsewhere confirmed poultry manure as effective nutrient source for increasing yield and nutrient status of crop such as maize, *amaranthus,* sorghum, pepper and tomato (Adeniyan and

Ojeniyi, 2005; Okunlola *et al*., 2011). John *et al*. (2004) advocated integral use of organic manure and inorganic fertilizer for the supply of adequate quantities of plant nutrient required to sustain maximum crop productivity and profitability while minimizing environmental impact from nutrient use. Organo-mineral fertilizer is a low input technology of improving the nutrient status of tropical soils for sustainable crop production (Okunlola *et al*., 2011). Organo-mineral fertilizer combines the attributes of both organic and inorganic fertilizers (Ayeni, 2008).

Studies by Okunlola *et al*. (2011), Olaniyi *et al*. (2010), Rekhi *et al*. (2000) recorded responses of watermelon, okra and rice respectively to organic fertilizers. Similarly, Makinde *et al*. (2010) recorded that the use of organo-mineral fertilizer enhanced better growth in *Amaranthus cruentus*.

The dearth of knowledge on the comparative effect of organo-mineral, organic and NPK 20:10:10 fertilizers on soil chemical properties, nutrient uptake and yield of tomato necessitated the need to conduct this research. The objective of this study was to evaluate the effect of organic, organo-mineral and NPK fertilizers on soil chemical properties, growth, nutrient uptake and yield of tomato.

MATERIALS AND METHODS

The experiment was conducted at the screen-house of Adeyemi College of Education in the rain forest zone of south-western Nigeria. The experimental design used was completely randomised block design with eight (8) treatments replicated six (6) times to give 48 pots. Organic Fertilizer (OF) and Organo-mineral Fertilizer (OMF) were individually applied at 0, 12.5, 25 and 50 g/kg plant while NPK 20:10:10 fertilizer was applied at 2 g/plant. Organic and organo-mineral fertilizers were sourced from Ondo State Waste Management Company, Akure. Tomato seeds used was hybrid variety from the International Institute of Tropical Agriculture (IITA), Ibadan. The treated soils of 1 kg/pot were put in plastic buckets with holes.at the bottom and equal amount of water was added weekly.

Prior to tomato planting and after harvesting, soil samples were collected. Twenty core soil samples were collected with auger, bulked, air dried and sieved through 2mm mesh. and analysed using standard laboratory procedure Organic carbon was determined by dichromate oxidation method, total N was determined by Microckjedahl wet oxidation method while soil pH was determined in 1:2 soil - H_2O and read with pH meter. Available P was determined by Bray -1- method, exchangeable K, Ca and Mg were extracted with ammonium acetate. Potassium was determined by photometer while Ca amd Mg were determined by AAS. The micronutrients were extracted with HCl and determined by AAS in order to establish the nutrient status of the soil before and after planting respectively. Tomato seedlings used for the experiment were grown in nursery and transplanted to the pots. One seedling of tomato was transplanted into each pot. Weeding was carried out at two weeks interval by hand. The seedlings were staked.

Data were collected on soil, plant growth and yield parameters such as height, leaf area, number of branches, fruit yield and root biomass production. Tomato leaf samples collected at 50% flowering were enveloped and oven-dried at 65°C for 24 hours, milled with mortar and pestle and analysed as described by Tel and Hagarty (1984). Total N was determined by Microkjedahl method. The ground tomato leaf samples were digested with 1M HCl. The P was determined colometrically, K by photometer and Ca and Mg by AAS. The agronomic parameters were determined as follows: Plant height was determined by measuring the tomato stand from the base to the tip, leaf area was determined by graphical method, the number of tomato branches were counted, the fruits were hand- picked weekly and weighed and the tomato was uprooted and severed from the base, oven dried to constant mass and weighed.

Statistical Analysis

Data on agronomic parameters, nutrient concentration and soil nutrients were subjected to analysis of variance and Duncan Multiple Range Test was used for mean separation at 5% level using statistical Analysis Institute Package (2000).

RESULTS

The physical and chemical properties of the soil used for the conduct of the experiment are presented in Table 1. The textural class of the soil was sandy loam with high proportion of sand (91.6%). The soil was slightly acidic, low in OM, N, P, K and Mg. Calcium, Mn and Zn were fairly adequate.

The nutrient composition of the three fertilizer sources (NPK, OG and OMF) according to the manufacturer showed that NPK 20:10:10 fertilizer had higher N, P and K content than organic and organo-mineral fertilizers. Organo-mineral fertilizer had higher P and K content than organic fertilizer but with equal percentage of N. Organic fertilizer had 3.5, 1 and 1.2% N, P and K respectively while organo-mineral fertilizer had 3.5, 2.5 and 4% N, P and K respectively. The comparative effect of NPK, organic and organo-mineral fertilizers on the growth and yield parameters of tomato is presented in Table 2. Relative to Control, all the treatments significantly increased ($P<0.05$) tomato height, number of branches, leaf area, fruit yield and root biomass production. This indicates that the nutrient supplement added improved plant growth and yield irrespective of the dosage. OMF applied had better performance on the growth and yield of tomato relative to OG and NPK fertilizers. This could be due to immediate release of inorganic nutrient composition which was readily mopped up by the plant and gradual release of nutrient present in the organic material. Organic fertilizer also improved the growth and yield of tomato but relatively lower effect as was recorded in plants treated with OMF. OMF applied at 25 and 50 g/plant showed better performance and increased the growth and yield of tomato. NPK was expected to give a better growth and yield relative to other fertilizer sources but recorded lower performance compared to OMF 25 and 50 g/plant. This could be due to rapid mineralization or imbalance nutrients.

Table 1: Pre-Cropping Soil Physical and Chemical Properties

Soil Properties	Value
Sand (%)	91.6
Silt (%)	6.2
Clay (%)	2.2
Textural Class	Sandy loam
Bulk Density (g/cm^3)	1.47
Porosity (%)	33
pH (H_2O)	6.4
Organic Matter (%)	1.9
N (%)	0.11
C/N	18
P (mg/kg)	3.51
Exchangeable Bases (cmol/kg)	
K	0.14
Ca	2.88
Mg	0.89
Na	0.14
Micro Nutrients (mg/kg)	
Fe	4.28
Zn	45
Cu	0.16
Mn	1.2

Tomato plants grown on amended soil had higher uptake of N, P and K relative to plants grown on unamended soil (i.e. control) as shown in Table 3. Organic fertilizer rates (OF 12.5g and OMF 50g) significantly increased leaf N and P of tomato plants relative to Control. Compared with Control, all tomato grown on amended soil significantly increased ($P<0.05$) P, K and Ca except plants treated with inorganic nutrient source. Application of OF 12.5g recorded the highest Fe (0.97g) and Zn (0.70g) concentration in tomato leaf tissue, whereas, OMF (12.5g) had the highest Mn (0.65g).

Table 4 shows the effect of NPK, organic and organomineral fertilizers on soil macro nutrients and exchangeable bases. Relative to Control, all the treatments increased soil pH except NPKF. Inorganic fertilizers are known to decrease soil pH level thus increasing soil acidity .The soil amendments used increased soil N and P concentrations in all the amended plots while control recorded lower soil nutrients. Relative to control, OMF (50g) and OF (25g) significantly increased N. Also, all the treatments significantly increased soil available P, K and Ca relative to control. Compared with control, all the treatments significantly increased Mg except OMF (50g), OF (50g) and NPKF.

Relative to Control, all amended soil samples significantly ($P<0.05$) increased Mn, Cu and Fe. Application of OMF at 25 and 50g recorded higher Mn concentration in the soil as shown in Table 5. Application of OF 12.5g had the highest Cu and Zn content in the soil, whereas, OMF 50g recorded highest Fe concentration. Both organic and inorganic soil amendments used increased Mn content compared with control.

DISCUSSION

Based on the established critical level of 3% for OM, 0.15% for total N, 10mg/kg for available P, 0.20 cmol/kg for K, 2.0 cmol/kg for exchangeable Ca and 0.26 cmol/kg for exchangeable Mg recommended by Adebusuyi (1985), Sobulo and Osiname (1987). The soil at the beginning of the experiment was low in OM, deficient in N, P, K and adequate in Ca and Mg. The low soil N, P and K status are expected to benefit from the application of soil amendments. Organic and organo-mineral fertilizers used increased soil pH and OM status of the soil after planting. This is an indication that fertilizers from organic source did not only serve as nutrient reserve but also improved soil properties.

Table 2: Comparative effect of NPK 20:10:10, organic and organo-mineral fertilizers on growth and yield component of tomato /plant

Treatment	Plant Height (cm)	Number of Branches	Leaf Area (cm^2)	Root Dry Matter Yield (g)	Fruit Yield (g)
Control	29.60d	3.33e	8.21c	14.17d	182.13f
OMF 12.5g	39.33b	6.00b	14.21b	53.10a	538.60c
OMF 25g	42.00a	12.33a	15.43a	50.47a	1349.70a
OMF 50g	48.93a	13.33a	16.26a	44.63b	779.97b
OF 12.5g	24.87c	5.33b	13.50b	15.31d	493.33d
OF 25g	27.33c	6.00b	12.20b	13.72d	135.73g
OF 50g	31.80b	7.00b	14.66b	15.63d	328.13e
NPKF 2g	25.97c	7.00b	12.04b	30.18c	430.37d

Means with the same letter in a column are not significantly different according to Duncan Multiple Range Test (P<0.05). OMF – Organo mineral Fertilizer
OG – Organic Fertilizer NPK – NPK 20:10:10

Table 3: Nutrient uptake of tomato leaf tissue as influenced by NPK 20:10:10, organic and organo-mineral fertilizers

Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn
Control	4.39b	0.02c	3.07c	1.87d	0.70b	2.83f	0.29d	0.19d
OMF 12.5g	4.69b	0.05ab	4.53a	2.09c	0.81ab	4.85d	0.65a	0.37c
OMF 25g	4.93b	0.07a	4.23a	3.05a	0.92a	6.82bc	0.51b	0.49b
OMF 50g	5.06a	0.05ab	4.45a	2.23bc	0.74b	5.49c	0.37c	0.39c
OF 12.5g	4.85b	0.04b	3.72b	2.93b	0.95a	7.42b	0.61a	0.55ab
OF 25g	5.09a	0.06a	3.80b	3.70a	0.97a	9.58a	0.50b	0.70a
OF 50g	4.88b	0.03b	3.65b	2.65b	0.78b	8.08ab	0.35c	0.62a
NPKF 2g	4.69b	0.04b	3.50bc	1.94d	0.48c	2.92e	0.31cd	0.19d

N, P, K, Ca and Mg are in percentages (%) while Fe, Mn and Zn are in mg/Kg. Means with the same letter in a column are not significantly different according to Duncan Multiple Range Test (P<0.05). OMF – Organo mineral Fertilizer
OG – Organic Fertilizer NPK – NPK 20:10:10

Table 4: Post-cropping soil macro nutrients status

Treatment	pH (H2O)	N (%)	O.M (%)	Av. P (mg/kg)	Exchangeable bases (cmol/kg)				Exch Acidity	CEC (cmol/kg)	Base Sat. (%)
					Ca	Mg	Na	K	Al+H		
Control	6.83c	0.14b	2.20e	3.21d	4.18e	1.76c	0.22c	0.24b	0.06b	3.51e	99.29a
OMF 12.5g	7.63a	0.21a	2.86d	5.17c	4.56d	1.91b	0.35b	0.33a	0.14a	7.18d	97.74a
OMF 25g	7.70a	0.29a	4.96b	5.77c	7.48a	2.67a	0.35b	0.35a	0.11a	10.85b	98.91a
OMF 50g	7.87a	0.27a	4.57b	4.47c	7.83a	2.55a	0.49a	0.39a	0.07b	11.24a	99.39a
OF 12.5g	7.53a	0.25a	4.02c	18.58a	7.72a	2.46a	0.23c	0.31a	0.08b	10.70b	98.93a
OF 25g	7.23b	0.34a	6.39a	15.35b	7.23a	2.34ab	0.19c	0.32a	0.09ab	10.08b	98.52a
OF 50g	7.07b	0.27a	4.42b	18.40a	8.27a	2.20b	0.43a	0.40a	0.06b	11.26a	99.28a
NPK F 2g	6.07c	0.27a	4.31b	15.41b	6.49c	2.67a	0.20c	0.32a	0.07b	9.68c	99.27a

Means with the same letter in a column are not significantly different according to Duncan Multiple Range Test (P<0.05). OMF – Organo mineral Fertilizer. OG – Organic Fertilizer NPK – NPK 20:10:10

Table 5: Post-cropping soil micro nutrients status

Treatment	Minerals (mg/kg)			
	Mn	Cu	Fe	Zn
Control	2.28d	0.30c	3.13e	1.70d
OMF 12.5g	4.48a	0.42a	7.30b	2.94bc
OMF 25g	4.84a	0.44a	6.57c	3.03b
OMF 50g	4.68a	0.37b	8.07a	2.96c
OF 12.5g	2.98c	0.52a	6.27c	7.91a
OF 25g	4.08b	0.39b	5.80d	2.73c
OF 50g	2.94c	0.43a	5.22d	3.12b
NPKF 2g	2.61c	0.43a	5.47d	2.60c

Means with the same letter in a column are not significantly different according to Duncan Multiple Range Test (P<0.05). OMF – Organo mineral Fertilizer. OG – Organic Fertilizer NPK – NPK 20:10:10

There were increases in soil and tomato leaf tissue nutrient status due to the soil amendments used. This is consistent with the finding that the organic materials are composed of macro and micro nutrients. Studies by Ayeni (2010) and Okunlola *et al*. (2011) showed that organic and organo-mineral fertilizers increased soil organic matter, N, P, K, Ca and Mg. All the treatments with soil amendments recorded higher yield of tomato relative to control. This agrees with the work of Akanbi and Olaniyi (2007) who found that OMF and inorganic fertilizers increased yield of fluted pumpkin (*Telfaria occidentalis*). Similarly, Makinde *et al*. (2010) found that organic and organo-mineral fertilizers improved the nutritional quality of *amaranthus* The more balanced nutrition due to OMF ensured high cumulative yield than use of organic and NPK fertilizers. OMF 25g recorded the highest yield and this might be as a result of quick mineralization of inorganic component present in organomineral fertilizer and the slow nutrient release of the organic constituents which sustained the better performance of tomato Higher plant height and number of branches recorded could be attributed to symptoms of excessive supply of Nitrogen. Brady and Weil (1999) recommended 2.5 –3.5, 0.02 – 0.05 and 1.5 – 3.0% as critical levels for N, P and K plant uptake respectively. Based on this recommendation, tomato grown on amended plots had adequate N, P and K in their leaf tissue. Application of OF and OMF increased uptake of micro nutrients in tomato leaf tissue. This affirms that both organic amendments enhanced the availability of micro nutrients in the soil.

The chemical properties of the soil were altered by the application of both organic and inorganic amendments. NPK reduced soil pH and this affirmed the finding that mineral fertilizers increase soil acidity (Giwa, 2004). Application of OF and OMF increased soil pH due to their ability to enhance soil buffering capacity. Calcium (Na) and K contents of the soil increased with application of 50 g/plant of OF and OMF. Organic amendments used improved soil organic matter content and cation exchange capacity. The micro nutrients concentration of the soil was increased by all the fertilizer types but inorganic fertilizer recorded lower nutrient relative to OF and OMF.

CONCLUSION

Conclusively, soil amendments are crucial to plant growth as they play pivotal role in determining the performance and establishment of plant. Nutrient deficiency causes abiotic stress in plants which brings about alteration of plant metabolism or plant death. Soil amendment is known to complement nutrient deficiencies by altering both physical and chemical properties of the soil and the extent of alteration depend more on the type of amendment used whether organic or inorganic. Soil amendments used indisputably improved tomato growth and yield, nutrient uptake and soil properties. Application of OF and OMF had more advantage over the inorganic fertilizer by adding more nutrients to the soil especially the nutrient elements that are not present in mineral fertilizers. Sequel to this research finding, organo-mineral fertilizer applied at the rate of 25g/plant is suitable fertilizer for the cultivation of tomato in South Western Nigeria.

REFERENCES

Adebusuyi, B. A. (1985). Soil testing and Nitrogen, Phosphorus requirement for maize in south western Nigeria. Ph.D thesis, Obafemi Awolowo University, Ile-Ife, Nigeria. 225 pp.

Adeniyan, O. N. and Ojeniyi, S. O. (2005). Effect of poultry manure and NPK 20:10:10 and combination of their reduced levels on maize growth and soil chemical properties. *Nigeria Journal of Soil Science,* 15: 34-41.

Ayeni, L. S. (2008). Integration of cocoa pod ash, poultry manure and NPK 20:10:10 fertilizer for soil fertility management – incubation study. *Continental Journal of Agronomy,* 2: 25-30.

Ayeni, L. S. (2010). Effect of combined cocoa pod ash and NPK fertilizer on soil properties, nutrient uptake and yield of maize. *Journal of American Science,* 6(3): 79-84.

Akanbi, W. B. and Olaniyi, J. O. (2007).Effect of organomineral and inorganic fertilizers on the yield quality of fluted pumpkin (*Telfaria occidentalis* hook F.). *African Journal of Crop Science,* 8: 347-350.

Ayeni, L. S., Adeleye, E. O., Ojeniyi, S. O. (2010). Effect of poultry manure on soil physico-chemical properties, leaf nutrient contents and yield of yam (*Dioscorea rotundata*) on alfisol in south western Nigeria. *Journal of American Science,* 6(10): 871-878.

Brady, N. C. and Weil, R. R. (1999).The nature and properties of soils. New Jersey: Prentice Hall, Upper Saddle River.

FAO, (2001). Food and Agricultural Organization.Yearbook Volume 55. FAO, Rome, Italy.

Giwa, D. O. (2004). Comparative effect of pig manure and NPK fertilizer on soil fertility and performance of tomato (*Lycopersicon lycopersicum* Mill.). M. Agric. Tech. Dissertation, Federal University of Technology, Akure, Nigeria. 59 pp.

John, L. W., Jamer, D. B., Samuel, L. T., Waner, L. W. (2004). Soil fertility and fertilizer: an introduction to nutrient management. Pearson Education, India. pp 106-153.

Kallo, G. (1993). Tomato in: genetic improvement of vegetable crops. Oxford, England: Pergamon Press. 6 pp.

Law-Ogbomo, K. E. and Egharevba, R. K. A. (2009). Effects of planting density and NPK fertilizer application on yield and yield component of tomato in forest location. *World Journal of Agricultural Science,* 5(2): 152-158.

Makinde, E. A., Ayeni, L. S., Ojeniyi, S. O. and Odedina, J. N. (2010). Effect of organic, organo-mineral and NPK fertilizers on nutritional quality of *Amaranthus* in Lagos, Nigeria. *New York Journal of Science,* 2(2): 91-96.

Okunlola, A. I., Adejoro, S. A. and Fakanlu, G. (2011). Evaluation of some manure types for the growth and yield of watermelon in South Western Nigeria. *Researcher,* 3(3): 61-66.

Olaniyi, J. O., Akanbi, W. B., Olaniran, O. A. and Ilupeju, O. T. (2010). The effect of organomineral and inorganic fertilizers on the growth, fruit yield, quality and chemical composition of okra. *Journal of Animal and Plant Science,* 9(1): 1135-1140.

Rafi, U. M. (1996). Stem pruning and spacing effect on yield of tomato. In: ARC. AVRDC Training Report. pp 168-173.

Rekhi, R. S., Benbi, D. K. and Singh, B. (2000). Effect of fertilizers and organic manures on crop yield and soil properties in rice – wheat cropping system. New Delhi, India: Rice – Wheat Consortium for the Indo-Gangetic Plains.

Sobulo, R. A. and Osiname, O. A. (1987). Soil and fertilizer in western Nigeria. Resource Bulletin No. 11, IAR&T, Unife, Ile-Ife. Pp.20-26.

Statistical Analysis Institute (2004). A Guide to the ANOVA and GLM Procedure. SAS Institute, Cary, NC

Tel, D. A. and Hagarty, M. (1984). Soil and plant analysis. IITA Ibadan/University of Guelph, Ontario, Canada. 277 pp.

*****