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Effect of Manufactured Organic Fertilizers on Soil Chemical Properties and Yield of Tomato (*Lycopersicum lycopersicon*) in Alfisol, Southwestern Nigeria

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Abstract Field experiments were conducted between 2010 and 2012 to determine the effect of organic, organomineral and NPK fertilizers on soil chemical properties and yield of tomato in Ondo, south western Nigeria. Organic (OG) and Organomineral Fertilizers (OMF) were each applied at the same rate of 2.5, 5 and 10 t/ha while NPK 15:15:15 fertilizer was applied at 300 kg/ha. The treatments were arranged on a Randomized Complete Block Design with three replicates. Relative to control, OG and OMF significantly increased ($p<0.05$) soil pH, OM, N, P, K, Ca, Mg, Fe, Cu, Zn and Mn. Compared with control, OM applied at 5 t/ha most increased soil total N (143%), 10 t/ha OG had the highest percentage increase in Ca (98%), K (114%) and ECEC (221%), Organic fertilizer applied at 2.5 t/ha recorded the highest available P (695%), Zn (887%) and Cu (110%). Organomineral fertilizer applied at 10 t/ha had the highest increase in Fe (232%). Relative to control, OG, OMF and NPKF significantly increased ($p>0.05$) tomato fruit yield. Organomineral fertilizer applied at 5 t/ha had the highest increase in fruit weight of tomato.
Keywords Mineralization; Plant nutrients; Plant parameters; Organomineral fertilizer; Organic manures

1 Introduction

Research attention in tropical countries especially in Nigeria has shifted to the utilization of agro based industrial wastes and farm waste products which if not converted to other economic uses such as fertilizers might pose environmental hazards. The use of agrowastes as sources of plant nutrients serve as environmental sanitation as well as reduction in craving for mineral fertilizers by farmers. Federal and state governments of Nigeria imports fertilizers especially NPK fertilizers of different grades as well as nitrogenous fertilizers. In Nigeria, poor resource farmers could not justify the economic use of mineral fertilizers in as much as the output could not justify the input as a result of high cost of fertilizers. For example, Nmadu (2002) noted that the price of 50 kg of fertilizer rose from less than 10 naira (Nigeria currency) in the 1970s and early 1980s to 2000 naira in the year 2000. Poor resource famers are unable to apply the recommended dosage of mineral fertilizer because of their inability to buy the fertilizer.

In addition, the low activity clay that dominates most of Nigeria soils hinders the application of large dose of mineral fertilizers except split application. The cost, scarcity and acidifying effect of mineral fertilizers on soils have led to the use of plant and animal wastes. Though some organic wastes have beneficial effect on soil properties and yield of crops yet they have some disadvantages. They are slow in nutrient mineralization, bulky and low in nutrient quality when compared with mineral fertilizers. Some organic wastes have high C:N ratio which causes immobilization of some plant nutrients by microorganism.

John et al. (2004) and Ayeni (2011) advocated for combined use of low level of mineral fertilizer with organic manures for the supply of adequate plant nutrients in proper balance for sustainable crop production while minimizing environmental impact from nutrient use. Management of mineral fertilizers has become increasingly critical in crop production from both economic and environmental standpoint. MOSES (2009) supported the view that soils fertilized with mineral fertilizers do not supply adequate organic

matter needed for optimum crop performance. Combining mineral fertilizers that have low C/N ratio with agro wastes with high C:N ratio shortens decomposition of organic wastes and make nutrients available for crop use. Many farmers prefer combined application of mineral fertilizers with organic manures because organomineral fertilizers combined the attributes of both organic and inorganic fertilizers (Ayeni et al., 2008). Farmers indiscriminately combine mineral fertilizers with organic manures without considering their implications on soil and water bodies. For example, it is known that excess of nitrates and phosphates cause pollution to soil and water bodies. There is need for soil test to avoid over application of plant nutrients that may lead to nutrient imbalance and environmental pollution.

In Nigeria, organic fertilizers are being developed from farm and city wastes, also organomineral fertilizers in which organic wastes are fortified with N and/or NP fertilizers. Industrially manufactured organic/organomineral fertilizers are currently being produced in Nigeria.

Tomato is one of Nigeria highly prized vegetables and ranked among the top vegetables of economic importance. Most African farmers especially in the northern part of Nigeria and Cameroun see tomato production as a means of livelihood since its marketability is high and nearly every household consumes it (World Vegetable Centre, 2007). Tomato fruit yield in Nigeria is low compared with the developing countries of the world where mechanized farming is mostly practiced.

The effect of organomineral fertilizers on crop performance and soil fertility management cannot be over emphasized. Makinde et al. (2011) confirmed that organomineral fertilizers enhanced the performance of Amaranthus cruentus in Lagos Nigeria. Ayeni, 2012 agreed that integrated plant nutrition management enhance crop performance than the sole application of either mineral fertilizer or organic manure as seen in the better performance of cocoa pod ash combined with NPK20:10:10 fertilizer than the sole application of cocoa pod ash and NPK fertilizers. There is scarce information on the use of industrially manufactured organic and organomineral fertilizers on soil chemical properties, growth and yield of tomato in Ondo Southwestern Nigeria. Hence the objective of this study was to determine the effect of industrially manufactured organic, organomineral and NPK15:15:15 fertilizers on soil chemical properties and yield of tomato.

2 Materials and Methods

The research was carried out at Ondo, southwestern Nigeria between 2010 and 2012. The same experiment was carried out in three years but at different sites within the student's research farm of Adeyemi College of Education, Ondo. Ondo is located in latitude 70°05′N, Longitude 40°55′E and at elevation of 381.3 m above the sea level. It belongs to the tropical rain forest zone. The soils belong to the order Alfisol (USDA) or Luvisol (FAO).

Surface soil sample 0-20 cm were collected randomly from each site prior to the conduct of the experiments while another set of soil samples were taken at the end of the experiment from each plot. Auger was used to collect the soil samples.

Chemical properties of the soils at the beginning and end of the experiments were determined. Percentage organic carbon was determined by the Walkley and black wet oxidation method with H_2SO_4 and $K_2Cr_2O_7$ followed by titration with Iron (II) Ammonium sulphate. Total N was determined by the Kjeldahl digestion procedure. Available P was determined by Bray 1 method. Exchangeable K, Na, Ca and Mg were extracted by ammonium acetate buffered to pH 7. Potassium was determined with a flame photometer while calcium and magnesium were determined by AAS. Soil pH in water and 0.1 N KCl was determined using a glass electrode pH meter.

Industrially manufactured organic and organomineral fertilizers were brought from Ondo State Waste Management Company. The organic manure and organomineral fertilizers were manufactured by the company and were respectively labeled sunshine organic manure and sunshine organomineral fertilizers. NPK 15:15:15 fertilizer and Roma variety of tomato was bought from Agricultural input supply company, Ondo.

The field experiment commenced in April and terminated in August, 2010, and repeated in 2011 and 2012 in the same site of Agricultural Research Farm of Adeyemi College of Education, Ondo southwestern Nigeria. The land was cleared, stumped, pegged and made into plot of 3 m by 3 m with a discard area of 1 m. The experiments were laid out in a Randomized complete Block Design (R C B D) with treatments replicated three times.

Organomineral fertilizer and organic manure were each applied at the rate of 0, 2.5, 5 and 10 t/ha while NPK 15:15:15 fertilizer was applied at 300 kg/ha.

The same cultural practices were carried out in all the experiments. Nursery of tomato was done and then transferred to the main site. Planting distance used was 60 cm by 60 cm at the rate of 1 stand per hole. Weeding was done manually at 3 weeks interval with the use of hand-hoe.

Five plants were selected and tagged per plot for the measurement of growth and yield parameters. Data were collected on number of branches per plant, leaf area and plant height at 50% flowering.

Fruit yield was also determined. Plant height was measured with measuring tape while leaf area was determined by graphical method.

Fruit weight and percentage fruit weight were determined by harvesting the fruit at least three times per week and weighed with the electronic weighing balance, the weight are recorded in kilogram and extrapolated to t/ha. The number of fruit per plant was also recorded.

3 Data Analysis

The data generated for the three years and the means were used to compute the result. Data collected was subjected to analysis of variance (ANOVA) using SPSS package and the means separated by using Duncan multiple range test (DMRT) at 0.05 level of significant.

4 Result and Discussion

The chemical properties of the soil (Table 1) showed that the soil was deficient in OM, N, P, K and Mg. Calcium and Zn were fairly adequate (Adebusuyi, 1985, Sobulo and Osiname, 1987, Agboola and Corey, 1977) indicating that the soils required fertilizer application. The nutrients compositions of NPK 15:15:15, Organic and organomineral fertilizers are presented in Table 2. N P K fertilizer had higher N, P and K than organic and organomineral fertilizers. Organomineral fertilizer had higher P and K than organic fertilizer. The soils from the three locations belong to sandy loam. The pH of the sites used for the experiment in 2010 and 201 were slightly acidic while the soil used in 2012 was acidic.

The data in Table 3 shows that application of N P K 15:15:15, Organic and organomineral fertilizers had effect on the yield and growth of tomato. Relative to control, all the treatments significantly increased ($P<0.05$) tomato height, number of branches, leaf area and fruit weight organomineral fertilizer applied at 10 t/ha had the highest plant height followed by 5 t/ha organomineral fertilizer. Organic fertilizer applied at 2.5 t/ha had the least plant height. Also, organomineral fertilizer applied at 10 t ha-1 recorded the highest number of branches followed by 5 t/ha organomineral fertilizer. Organomineral fertilizer applied at 5 t/ha had the highest leaf area but was not significantly different ($P<0.05$) from 10 t/ha organomineral fertilizer. Orgnomineral fertilizer applied at 2.5 t/ha had the highest root dry matter followed by its corresponding 5 t/ha. Organomineral fertilizer applied at 5 t/ha had the highest fruit weight.

The data in Table 4 and Table 5 show the effect of organic, organomineral and NPK15:15:15 fertilizers on soil chemical properties. Compared with control, all the treatments increased soil pH (except NPK fertilizer) N, OM, available P, Na (except NPK fertilizer), Ca, K and ECEC (except 2.5 t/ha OMF). Exchange acidity was significantly increased by the application of OMF at 2.5 and 5 t/ha.

Relative to control, all the treatments significantly increased soil Mn, Cu, Zn and Fe. The rates at which the fertilizers increase the soil micronutrient were different. Organomineral fertilizer applied at 5t ha-1 had the highest increase in Mn while OG 2.5 t/ha had the highest increase in Cu and Zn. Application of 10 t/ha OMF had highest increase in Fe.

Table 1 Initial soil properties at the three sites 2010, 2011 and 2012

Soil properties	2010	2011	2012
pH (H_2O)	6.2	6.5	5.8
pH($CaCl_2$)	6	5.9	5
organic matter	1.98	1.2	1.59
N (%)	0.12	0.08	0.1
C/N	9.4	8.62	9.14
P (mg kg^{-1})	3.49	5.62	4.89
Exchangeable bases c mol kg^{-1}			
K	0.1	0.13	0.1
Ca	2	0.97	2
Mg	0.89	1.04	0.69
Na	0.12	0.08	0.08
Micronutrient (mg kg^{-1})			
Fe	4	4.7	5.23
Zn	32	40	29
Cu	0.14	0.17	0.19
Mn	1.3	2.3	4.8

Table 2 Nutrient composition of mineral, Organic and Organomineral fertilizers (%)

Nutrient	N P K 15:15:15	Organic Manure	Organomineral fertilizer
N	15	3.5	3.5
P	15	1.0	2.5
K	15	1.2	4.0

Table 3 Mean effect of organic, organomineral and NPK15:15:15 Fertilizers growth and yield of tomato (2010~2012)

Treatment	plant height (cm)	No of branches	Leaf area (cm^2)	Fruit weight (t/ha)
Control	20.61d	2.34e	7.22c	8.42f
OMF 2.5	41.32b	5.01b	13.22b	9.63c
OMF 5	52.01a	11.31a	16.42a	21.61a
OMF 10	58.90a	12.31a	15.27a	12.49b
OG 2.5	34.85c	4.32b	12.52b	9.87d
OG 5t	37.30c	5.02b	11.12b	9.19g
OG 10	41.81b	6.03b	13.67b	10.28e
NPK300kg ha^{-1}	35.98c	6.03b	11.05b	9.03d

Table 4 Effect of organic, organomineral and NPK15:15:15 Fertilizers on soil macronutrients (2010~2012)

Treatment	pH	OM (%)	N (%)	P (mg/kg)	K	Ca	Mg (c mol kg^{-1})	Al_3^+ +H	ECEC	Base Sat %
Control	5.84b	2.21e	0.12b	2.22d	0.13b	4.19d	1.74c	0.17b	6.23d	97.27a
OMF 2.5	6.64a	2.88d	0.23a	4.18c	0.25a	4.57c	1.93b	0.15a	6.90d	97.83a
OMF 5	6.71a	4.97b	0.30a	4.78c	0.27a	7.49a	2.64a	0.12a	7.76b	98.45a
OMF 10	6.68a	4.59b	0.30a	3.48c	0.31a	7.84a	2.57a	0.10b	10.54a	99.00a
OG 2.5	6.55a	4.04c	0.26a	17.59a	0.23a	7.73a	2.48a	0.09b	10.44a	99.13a
OG 5	6.22ab	4.43ba	0.28a	14.36b	0.25a	7.24a	2.36ab	0.09ab	9.94b	99.09a
OG 10	6.86a	6.94a	0.33a	17.41a	0.33a	8.28a	2.22b	0.07b	10.90a	99.34a
NPK	5.63b	4.32b	0.28a	14.43b	0.25a	6.50b	2.69a	0.18b	9.62ab	98.13a

Note: Means with the same letter are not significantly different according to Duncan Multiple Range Test; OMF organomineral fertilizer (t/ha) and OG organic fertilizer

Table 5 Mean effect of organic, organomineral and NPK15:15:15 Fertilizers on soil micronutrients (2010~2012)

Treatment	Mn	Cu	Fe	Zn
Control	1.27d	0.22c	2.14e	0.68d
OMF 2.5	3.47a	0.30a	6.33b	1.96bc
OMF 5	3.83a	0.33a	5.59c	2.05b
OMF 10	3.67a	0.29b	7.08a	1.97c
OG 2.5	1.97c	0.44a	5.29c	6.93a
OG 5	3.07b	0.29b	4.82d	1.74c
OG 10	1.61c	0.35a	4.24d	2.22b
NPK300 kg ha^{-1}	1.97c	0.35a	4.49d	1.59c

Note: Means with the same letter are not significantly different according to Duncan Multiple Range Test; OMF organomineral fertilizer (t/ha) and OG organic fertilizer

The control experiment recorded the lowest growth and yield of tomato because it was deficient in nutrients required by the good performance of crop. This shows that the soil needs fertilizer application. The better performance of the tomato grown in the soil that was fertilized with 5 t/ha of organomineral fertilizer might be as a result of the presence of mineral fertilizer that was used to fortify the organic matter which led to quick mineralization of the nutrient elements especially N, P, K, and Ca required by tomato. The mineral fertilizer in the organic matter might have lowered the C/N ratio of the organic matter. It was also found that both organic and organomineral fertilizers increased tomato production. This is in line with the work of Libert et al. (2009) and Libert et al. (2013) that organic and organomineral fertilizers increase yield of tomato in the experiments conducted to show the Impact of organic and inorganic fertilizers on tomato vigor, yield and fruit composition under tropical Andosol soil conditions and effect of organic/inorganic-cation balanced fertilizers on yield and temporal nutrient allocation of tomato fruits under Andosol soil conditions in Sub-Saharan Africa respectively.

Though the analysis of the three fertilizers used showed that NPK15:15:15 fertilizer had higher N, P and K than both organic and organomineral fertilizer yet organomineral and organic fertilizers increased soil N, OM, P, Ca, K and CEC, Mn, Fe and Zn more than NPK 15:15:15 fertilizer. The N, P, and K present in the mineral fertilizer might have leached faster than the organic fertilizers. Also, organic and the organomineral fertilizers might contained Ca, K and the micronutrients which were not present in the mineral fertilizers used for the three experiments. This observation was in agreement with the work of Ayeni and Adetunji (2010) that organic manures contain other essential nutrients other than N, P and K. It was also observed that 300 kg/ha NPK fertilizer compared favourably with organic and in organic fertilizers in the release of Mn, Cu, Fe and Zn. This might be as a result of the native micronutrients present in the soil before the conduct of the experiments as the initial soil analysis indicated that the micronutrients present in the soil was fairly adequate.it was noted that the fertilizers release the nutrients at different rates. Application of 5 t/ha organic fertilizer and organomineral fertilizer recorded the highest OM ,N and Mn contents, 2.5 t/ha OG recorded the highest available P, Ca, K, Cu and Zn and ECEC while 5 t/ha organomineral fertilizer had the highest Mg. This shows that one could not emphatically point out which of the fertilizers or rate of the fertilizers best add all the nutrients to the soil. One could deduce that the discrepancies might have arisen from the different textural classes of the soils used for the experiment or it might be as a result of inconsistence of organic manures in the release of soil nutrients. All the fertilizer types added nutrients to the soil. This might be as a result of conducive pH which might have created good environment for microbial activities.

Fertilization of the soil with NPK 15:15:15 fertilizer did not increase soil organic matter in this experiment. This is in line with the assertion of MOSES (2009) that soils fertilized with mineral fertilizers do not add

organic matter to the soil compared with agro wastes.

References

Ayeni L.S., Adetunji M.T., Ojeniyi S.O., Ewulo, B.S., and Adeyemo A.J., 2008, Comparative and cumulative effect of cocoa pod husk ash and poultry manure on soil and nutrient contents on maize yield, American – Eurasian Journal of Sustain. Agric, 2(1): 92-97

Ayeni L.S., 2010, Effect of cocoa pod ash, NPK Fertilizer and their combinations on soil chemical properties and yield of tomato (*lycopersicum lycopersicon*) on two soil types. New York Science Journal, 3(4): 1-11

Ayeni L.S., 2012, Combined effect of cattle dung and urea fertilizer on organic carbon, forms of nitrogen and available phosphorus in selected Nigerian soils. Journal of Central European Agriculture 13(3): 601-803 http://dx.doi.org/10.5513/JCEA01/13.3.1098

Adebusuyi B.A., 1985, Soil testing and N and P requirement of maize in southwestern Nigeria, PhD Dissertation Obafemi Awolowo University, Department of Soil Science, pp225

Agboola A.A., and Corey R.B., 1977, Soil testing of NPK fertilizer on maize in the soil derived from meyamorphic and sedimentary rocks of western Nigeria, Journal of West African science association, 17(12): 93-100

Ayeni L.S., Adetunji M.T., Ojeniyi, S.O., Ewulo B.S., and Adeyemo A.J., 2008, Comparative and cumulative effect of cocoa pod husk ash and poultry manure on soil and nutrient contents on maize yield, American – Eurasian Journal of Sustain. Agric. 2(1): 92-97

Ayeni L.S., 2011, Effect of Sole and Combined Cocoa Pod Ash, Poultry Manure and NPK 20:10:10 Fertilizer on Soil organic carbon, available P and forms of nitrogen and of Alfisols in Southwestern Nigeria, International Journal of Agriculture and Soil Science. 1 (3): 77-82

Ayeni L.S., Omole O., and Ojeniyi, S.O., 2010, Integrated Application of Poultry Manure and NPK fertilizer on performance of tomato in Derived Transitional Zone of Southwest Nigeria, Science and Nature, 8(2): 50-54

Ayeni L.S., 2012, Combined effect of cattle dung and urea fertilizer on organic carbon, forms of nitrogen and available phosphorus in selected Nigerian soils, Journal of Central European Agriculture 13(3): 601-803 http://dx.doi.org/10.5513/JCEA01/13.3.1098

John L.W., Jamer D.B., Samuel L.T., Waner L.W., 2004, Soil fertility and fertilizer. An introduction to nutrient management. Person Education, India 106-153

Manios Y.I., and Kapetanois K, 1992, Effect of town refuses compost as soil amendment on greenhouse tomato crop. Acta horticulture, 302: 193-201

Midwest organic and sustainable education service (MOSES)., 2009, The importance of organic matter to soil fertility and crop health www.mosesorganic.org

Nmadu J.N., 2002, Analysis of Sorghum Production Trend in Nigeria and the Estimation of its Supply Functions. Ph.D. Thesis (Unpublished). Zaria: Ahmadu Bello University

Tonfack L.B., and Bernadac A., and Youmbi, E., Mbouapouognigni V. P., Ngueguim M., and Akoa A., 2009, Impact of organic and inorganic fertilizers on tomato vigor, yield and fruit composition under tropical andosol soil conditions, Fruits, 64(3):167-177

Tonfack L.B., Emmanuel L., Akoa A., and Anne B., 2013, Effect of Organic/Inorganic-Cation Balanced Fertilizers on Yield and Temporal Nutrient Allocation of Tomato Fruits under Andosol Soil Conditions in Sub-Saharan Africa International Journal of Agricultural and Food Research, 2(2): 27-37 http://dx.doi.org/10.1051/fruits/2009012

Sobulo and Osiname, 1987, Soil and fertilizer use in western Nigeria, Resource Bulletin No 11IAR&T, University of Ife Ile – Ife 20-26

World Vegetable Centre, 2007 Horticulture for Health: the Knowledge Management Platform Hort-e Aims at Filling the Gaps Between Nutrition Requirements, Good Practices and Public Awareness, http://www.globalhort.org