DOI: https://doi.org/10.67042/njss.2013.yghbeqea

Nigerian Journal of Soil Science

journal homepage:www.soilsjournalnigeria.com

INFLUENCE OF PLANT AND ANIMAL MANURES ON SOIL CHEMICAL PROPERTIES AND TOMATO *(Lycopersicum esculentum)* YIELD

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ABSTRACT

Low nutrient status of tropical soils requires external source of nutrients for sustainable cropping. Field experiments were conducted in 2009 and 2010 cropping seasons at the Federal University of Agriculture, Abeokuta, Nigeria to evaluate the effect of plant and animal manures on soil chemical properties and yield of tomato. Treatments used were: poultry manure (PM), *Tithonia diversifolia* composted with poultry manure (CP), Fresh *Tithonia diversifolia* (GM), Neem organo compound Fertilizer (NF), Sunshine organo-mineral Fertilizer at the rate of 10 t/ha, N-P-K 20-10-10 (CF) at the rate of 120 Kg N/ha and control (C), Randomized Complete Block Design was used with four replicates. The test crop was tomato *(Lycopersicum esculentus)*. Parameters evaluated were: plant height, stem girth, number of leaves, yield and uptake of nitrogen, phosphorus and potassium. Post-planting soil samples were analyzed for nitrogen, phosphorus, potassium, pH, organic matter, calcium and potassium. Data were analyzed using the analysis of variance. Results showed that neem organo compound fertilizer significantly increased tomato height and number of leaves compared to the control while tomato stem girth was improved by the application of OMF and NF. Tomato yield was increased by OMF application and OMF, NF and CP improved the uptake of nitrogen, phosphorus and potassium, while all organic based fertilizers improved soil properties.

Key words: Neem organo compound Fertilizer, Sunshine organo mineral fertilizer, composted, manure.

INTRODUCTION

Nutrient depletion has been reported to be responsible for the deterioration in the quality of soil capital in sub-Saharan Africa (IFDC, 2003). The only way to alleviate poverty, hunger and malnutrition which may result from the above according to Chude (2010), is through increase in productivity of land and water. This can be achieved through the use of fertilizers either organic or inorganic which have been reported by many workers to improve both crop yields and soil properties (Adeleye and Ayeni, 2010; Adekunle *et al*., 2009). Inorganic fertilizer usage has been reported to be associated with problems such as reduced yield, increased soil acidity, scarcity, nutrient imbalance and high cost (Asawalam, 2009, Nottidge *et al*., 2005). Tomato which is a fruit vegetable is largely produced by small

holder farmers who may not be able to afford the high cost of inorganic fertilizers. On the other hand, organic based fertilizers have been reported to increase crop yield as well as crop and soil quality (Olowokere, 2004, Babalola and Olowokere, 2005). It is also cheaper when compared with inorganic fertilizers, it could also be prepared by the farmers using plant and animal residues. Residual effect of organic based fertilizers has also been reported to increase crop yield (Adenawoola and Adejoro, 2005). It is therefore, necessary to compare the effect of inorganic fertilizers and organic based fertilizers for recommendation purposes. This experiment was therefore, designed to compare the effects of the following selected organic based fertilizers: poultry manure, sunshine organo-mineral fertilizer, *Tithonia diversifolia* applied as green manure, neem organo compound fertilizer, *Tithonia diversifolia* composted with poultry manure with inorganic fertilizer on soil chemical properties and tomato yield as well as nitrogen phosphorus and potassium uptake by tomato.

MATERIALS AND METHODS

The experiment was carried out at the Organic Research Farm of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria in 2009 and 2010 cropping seasons. The area lies between longitude 7º 15′ N and Latitude 3º 25′ E with average rainfall of 1130 mm and a bimodal rainfall pattern. The first peak is June and the second is September. Mean monthly temperature is 29.63 ºC. Soils of the area are formed on basement complex with Alfisols extensively distributed in the uplands while Entisols and Inceptisols are in the lowland (Salako *et al*., 2006).

Tomato Nursery

Tomato Nursery: Land area measuring 5 m by 5 m was manually cleared and raised to form a bed, tomato (Roma variety) seeds sourced from the Institute of Agriculture Research and Training, Moore Plantation, Ibadan, Oyo State, Nigeria were mixed with soil and broadcasted on the bed, watered and covered with palm fronds to prevent them from direct heat of the sun. The nursery was watered very early in the morning daily. The palm fronds were carefully removed a week after planting and a shed was constructed on the nursery, the shed was gradually removed after four weeks to harden the tomato seedlings.

Land Preparation/Plot Demarcation

At four weeks after nursery establishment, the experimental area measuring 868 m^2 was manually cleared, pre-planting soil samples were collected randomly on the plot with a soil auger, these were properly mixed together to form a composite sample and used for the analysis of physical and chemical properties. Plots measuring 4 m by 3 m were demarcated with pegs, plots were spaced 1 m apart while 2 m was left between blocks.

Fertilizer Application

The treatments applied were: N-P-K 20-10-10 (CF) at 120 kg N/ha, poultry manure (PM), Green manure (GM) made up of fresh *Tithonia diversifolia*, compost (CP) derived from poultry manure and *Tithonia diversifolia*, sunshine organo-mineral fertilizer (SF), neem organo-compound fertilizer (NF) all applied at the rate of 10 t/ha and control (C) where fertilizer was not applied. Organic based fertilizers were applied at two weeks before tomato transplanting by broadcasting and incorporation into the soil while chemical fertilizer was applied at two weeks after tomato transplanting using row application method.

Tomato Transplanting

Tomato seedlings were transplanted on July 30, 2009 and July 22, 2010 for 2009 and 2010 planting seasons respectively. The transplanting was done in the evening by planting two tomato seedlings per hole using 0.40 cm and 0.60 cm spacing. These were thinned to one seedling per stand a week later.

Data Collection

Ten plants were randomly selected at the middle of each plot at five weeks after transplanting from which the following

parameters were measured; plant height with the aid of a meter rule by measuring from the soil level to the apex leaf, number of tomato leaves by physical counting and stem girth with the aid of vernier caliper. Whole tomato plants were sampled at the onset of flowering by cutting at the soil level, oven dried at 65 ^{o}C to constant weight and milled for analysis. Yield was determined by harvesting ripe tomato fruits and weighing them on a mettler balance.

Post-Planting Soil Sampling

At the end of the experiment for each planting season, soil samples were collected at four points from each plot with the aid of a soil auger, these were mixed together to form composite samples.

Fertilizer/Plant Analysis

Oven dried plant samples were weighed and ground using mortar and pestle, these and the organic based fertilizers were analyzed for nitrogen using Kjeldahl method, phosphorus by Vanado molybdate method and potassium by flame photometry (Juo, 1981).

Soil Analysis

Pre- and post-planting soil samples were air dried, crushed with mortar and pestle and sieved with 2 mm and 0.5 mm sieves. Nitrogen was determined from 0.5 mm sieved soil by Kjeldahl method (Bremmer, 1996), phosophorus by Bray 1 extraction method followed by molybdenum blue colorimetry (Bray and Kurtz, 1945) and potassium by flame photometry after extraction with neutral ammonium acetate solution. Calcium and magnesium were read on atomic absorption spectrophotometer, organic carbon was by wet oxidation method (Nelson and Sommers, 1996). Particle size was by hydrometer method while pH was determined in water by glass electrode method (Mclean, 1982).

RESULTS

The physico-chemical properties of the soil used for the experiment are shown in Table 1, nitrogen, phosphorus, potassium and organic matter are low (FPDD, 1989). The pH is neutral and loamy sand in texture. Nitrogen content of the organic based fertilizers used for the experiment ranged between 2.0 % and 3.8 %, neem organo compound fertilizer had the highest value while the lowest value was observed in poultry manure. Highest phosphorus and potassium values (1.33 % and 6.4 % respectively) were given by neem organo compound fertilizer while sunshine organo-mineral fertilizer was highest in organic carbon content (Table 2).

The effect of inorganic and organic based fertilizers on the height, number of leaves and stem girth of tomato in 2009 and 2010 is shown in Table 3. Tomato height and number of leaves were not significantly affected by fertilizer application in 2009. Tomato stem girth values ranged from 0.43 cm to 0.63 cm. The highest value (0.63 cm), which is significantly ($p<0.05$) higher than the control was observed on plants treated with sunshine organo-mineral fertilizer. The values for plants treated with other organic based fertilizers and inorganic fertilizer were not significantly different from the control. In 2010, the tallest (56.78 cm) tomato plants were ones with the application of neem organo compound fertilizer. The value is significantly ($p<0.05$) higher than the control as well as GM treated plants which had the lowest value (38.63 cm). A similar trend was observed for the number of tomato leaves where the application of neem organo compound fertilizer increased the number of tomato leaves to 100.90, a value significantly ($p <0.050$) higher than control and other organic based fertilizers with the exception of OMF treated plants. Tomato stem girth ranged from 0.42 cm to 0.59 cm.

Table 1: Pre-planting Soil chemical Properties and Texture

Chemical Property	Value
pH (H_2O)	6.80
Organic Matter (%)	1.30
Total Nitrogen (%)	0.14
Available P (mg/kg)	7.67
K (cmol/kg)	0.12
Ca (cmol/kg)	3.34
Mg (cmol/kg)	2.40
Sand (%)	86.4
Silt (%)	3.6
Clay (%)	10
Texture	Loamy sand

Table 2: Chemical Properties of the Organic Based Fertilizers used for the Experiment

Fertilizer	N(%)	P(%)	K(%)	O.C.(%)
Poultry manure (PM)	2.0	0.65	5.7	8.84
Sunshine organio-mineral (OMF)	3.5	1.0	1.2	8.98
Neem organocompound (NF)	3.8	1.33	6.4	8.95
Tithonia diversifolia (GM)	3.5	0.35	5.9	8.17

Table 3: Tomato height, number of leaves and stem girth as affected by organic and inorganic fertilizers.

	Year					
	2009			2010		
Treatiment/ha	Tomato height (cm)	Number of leaves	Stem girth (cm)	Tomato height (cm)	Number of leaves	Stem girth (cm)
GM/10 t	27.20	61.25	0.48ab	38.63b	46.85b	0.43b
OMF/10 t	36.90	88.00	0.63a	51.20ab	76.25ab	0.59a
NF/10 t	30.18	74.93	0.53ab	56.78a	100.90a	0.59a
PM/10 t	29.36	67.05	0.53ab	50.70ab	68.70b	0.47ab
CP/10 t	30.96	67.60	0.50ab	48.85ab	68.70b	0.45ab
CF/120 kg N	26.62	55.36	0.47ab	44.05ab	77.35ab	0.53ab
C	26.85	48.09	0.43b	42.50b	69.10b	0.42b
	NS	NS				

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

GM – Green Manure
OMF – Organo-mineral Fertilizer
NF – Neem organo compound fertilizer
CP – Compost
PM – Poultry Manure
CF – Inorganic Fertilizer
C – Control

Plants with organo-mineral and neem organo compound fertilizer applications had highest value (0.59 cm) which is significantly ($P<0.05$) higher than the control but not significantly different from other fertilizer values. Tomato yield values in 2009 were between 0.86 t/ha and 3.65 t/ha, yield increase in relation to fertilizer application follows this order: OMF > NF > GM > CF > PM > CP > C. The highest value (3.65 t/ha) was obtained from OMF treated plants, this value is significantly ($p<0.05$) higher than the ones for other fertilizers with the exception of neem organo compound fertilizer. In 2010, highest tomato yield value of 6.82 t/ha was given by OMF treated plants, the value is not significantly different from that of plants with inorganic fertilizer application (6.66 t/ha). The lowest value (1.42 t/ha) was given by the control plants (Table 4).

Nitrogen content of post-planting soil in 2009 was highest (0.22 %) in plots amended with neem organo compound fertilizer, this value is significantly ($p<0.05$) higher than that of control and CF amended plot which had the lowest value (0.15%). Application of GM increased the phosphorus content of post planting soil to 17.92 mg/kg. This value is significantly ($p<0.05$) higher when compared to the value obtained from PM (13.18 mg/kg) and NF (11.94 mg/kg) amended plots. Potassium content of post planting soil was not significantly affected by fertilizer application in 2009. In 2010, nitrogen content of post planting soil was highest (0.24 %) in OMF amended plots, this value is significantly ($p<0.05$) higher than the value obtained in CP amended (0.18 mg/kg) and control (0.16 mg/kg) plots. Plots with NF application had highest phosphorus content (18.00 mg/kg), the value is significantly ($p<0.05$) higher than the control which had the lowest value (13.00 mg/kg). Phosphorus content of post planting soil in 2010 planting season ranged from 13.00 mg/kg to 18.00 mg/kg. The highest significant value (18.00 mg/kg) when compared with control (13.00 mg/kg) was given by plots treated with NF. Order of P increase relative to fertilizer application goes thus: NF > GM, OMF, PM, CF > CP > C. Application of OMF and PM significantly ($p<0.05$) increased post planting soil potassium values (0.22 cmol/kg and 0.23 cmol/kg respectively) when compared with the control and CP amended plots. The values were however, not significantly different from other fertilizer types (Table 5).

Nitrogen, phosphorus and potassium uptake by tomato as influenced by inorganic and organic fertilizer applications is shown in Table 6. In 2009, nitrogen uptake was not significantly affected by fertilizer application, OMF and PM applications significantly promoted P uptake (14.50 kg/ha and 12.70 kg/ha respectively) when compared with the control which had the lowest value of 7.7 kg/ha. Potassium uptake was significantly ($p<0.05$) increased above the control by the application of OMF, GM and CF. In 2010, plants with the application of NF and OMF took up significantly ($p < 0.05$) higher nitrogen (0.53 t/ha and 0.51 t/ha respectively) and phosphorus (27.4 kg/ha and 23.9 kg/ha respectively) when compared with the control (0.12 t/ha and 13.9 kg/ha respectively). Potassium uptake ranged from 6.20 t/ha to 6.63 t/ha. The highest value which is

Table 4: Effect of Plant and Animal Manures on Tomato Yield (t/ha)

	Year	
Treatment/ha	**2009**	**2010**
GM/10 t	1.66b	2.18b
OMF/10 t	3.65a	6.82a
NF/10 t	2.29ab	6.39ab
PM/10 t	1.26b	2.95b
CP/10 t	0.92b	2.16b
CF/120 kg N	1.82b	6.66a
C	0.82b	1.42b

Means with the same alphabet(s) in a column are not significantly different from each other at $p<0.05$.
GM – Green Manure
OMF – Organo-mineral Fertilizer
NF – Neem organo compound Fertilizer
CP – Compost
PM – Poultry Manure
CF – Inorganic Fertilizer
C – Control

Table 5: Post-Planting Soil Chemical Properties as affected by plant and animal manures

	Year													
	2009							2010						
Treatment/ha	pH (H_2O)	N (%)	P (mg/kg)	K	Ca Cmol/kg)	Mg	O.M. (%)	pH (H_2O)	N (%)	P (mg/kg)	K	Ca Cmol/kg	Mg	O.M. (%)
GM/10 t	6.35ab	0.17ab	17.92a	0.12	3.45	2.19	5.58a	6.0	0.19abc	16.00ab	0.19ab	7.75	2.19	5.28a
OMF/10 t	6.63a	0.17ab	14.68ab	0.16	3.24	2.20	5.25ab	6.0	0.24a	16.00ab	0.22a	8.00	2.10	6.54a
NF/10 t	6.25b	0.22a	11.94b	0.16	3.34	2.17	4.41b	7.0	0.23ab	18.00a	0.19ab	8.00	2.07	6.93a
PM/10 t	6.40ab	0.18ab	13.18b	0.10	3.36	2.26	4.45b	6.0	0.21abc	16.00ab	0.23a	7.75	2.16	5.31b
CP/10 t	6.63a	0.19ab	14.57ab	0.12	3.46	2.32	4.42b	6.0	0.18bc	14.00ab	0.17b	8.25	2.22	5.50b
CF/120	6.25b	0.15b	14.36ab	0.10	3.45	2.20	4.42b	6.0	0.21abc	16.00ab	0.19ab	6.50	2.10	5.69b
N	6.20b	0.16b	15.50ab	0.12	3.36	2.25	4.46b	6.0	0.16c	13.00b	0.17b	8.25	2.15	4.57c
C				NS	NS	NS		NS				NS	NS	

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

GM- Green Manure
OMF- Organo-mineral fertilizer
NF- Neem organo compound fertilizer
CP- Compost
PM- Poultry Manure
CF- Inorganic Fertilizer
C- Control

Table 6: Effect of Plant and Animal Manures on Nitrogen, Phosphorus and Potassium uptake by tomato

	Year					
	2009			2010		
Treatment/ha	**N(t/ha)**	**P (kg/ha)**	**K(t/ha)**	**N (t/ha)**	**P (kg/ha)**	**K (t/ha)**
NF/10t	0.61	11.10ab	0.60b	0.53a	27.4a	6.25bc
OMF/10t	0.88	14.50a	1.60a	0.51a	23.9ab	6.48ab
GM/10t	0.69	11.00ab	1.40a	0.30b	19.3bc	6.35bc
PM/10t	0.74	12.70a	0.80b	0.31b	17.4c	6.40abc
CF/10t	0.89	11.20ab	1.50a	0.23b	17.9c	6.25bc
CP/10t	0.64	10.70ab	0.40b	0.22b	17.3c	6.63a
C	0.51	7.70b	0.60b	0.12b	13.9c	6.20c
	NS					

Means with the same alphabet (s) in a column are not significantly different from each other at $p<0.05$

GM- Green Manure
OMF – Organo –mineral Fertilizer
NF – Neem organo compound Fertilizer
CP – Compost
PM – Poultry Manure
CF – Inorganic Fertilizer
C – Control

significantly higher than the control and other fertilizer values with the exception of OMF and PM treated plants was observed on plants treated with CP.

DISCUSSION

Response to fertilizer application on the soil used for the experiment was expected due to low nutrient status of the soil. Fertilizer application had no significant effect on tomato height and number of leaves in 2009 while significant effect was observed in 2010, this may be as a result of the combined effect of fertilizer application in both years. Application of OMF increased the stem girth of tomato to the maximum in both years, OMF is a combination of organic and inorganic portion with gradual release of nutrient from the organic portion. John *et al.* (2001), reported that OMF increased the cob circumference of maize. Highest plant height, number of leaves and stem girth given by neem organo compound fertilizer might be due to the supply of various nutrients essential for crop growth. Neem manure has been reported to be rich in sulphur, potassium, calcium, nitrogen thus, nourishing the soil and plants by producing all macro and micro nutrients (Subbalakshmi, *et al.*, 2012). Nutrient release from neem fertilizer is gradual, thus, neem cake admixed with urea has been reported to improve efficiency of fertilizer utilization in crop production by gradual release of nitrogen to crops (Kektan, 1983). Neem cake was also reported to have significantly reduced root-knot nematodes index to zero which improved the growth of tomatoes (Ogbewu *et al.*, 2011). Organo-mineral fertilizer application increased tomato

yield to the maximum in both years, OMF application was reported to increase the yields of wheat, French beans and maize (Tejada *et al.*, 2005; Bello and Hafom, 2008; Ogazi and Omueti, 2000). Green manure application significantly increased the organic matter content of post-planting soil in 2009 and 2010, this is similar to the findings of Babalola and Olowokere (2005), who reported that green manure increased the available phosphorus and organic matter contents of soil grown with maize. Similar results were obtained by N'dayeganwye and Thi, (2001), where colza, millet and buck-wheat green manures increased soil organic carbon. Phosphorus content of post-planting soil was highest in GM plots in 2009, the release of phosphorus from soil as a result of incorporation of green *Tithonia diversifolia* biomass has been said to be rapid (Jama *et al*., 2000). Nziguheba *et al.* (1998), also reported that incorporation of green *Tithonia diversifolia* biomass reduced P sorption in an acid soil.

High nitrogen uptake was given by neem organo-compound and organo-mineral fertilizers in 2010; this could be as a result of the combined effect of fertilizer application in both years. In addition to this, neem cake is a nitrogen inhibitor (Puri, 1999) which therefore prolongs the availability of N in the soil thus, making it available for plant uptake. Likewise, nitrogen in OMF was released gradually and this assisted plant to take up enough nitrogen from the soil. Phosphorus and potassium uptake by plants treated with OMF were highest in both years, crop benefited from the P and K contents of the organic portion of OMF which released its nutrients gradually. Potassium uptake was also significantly higher than control in GM plots in 2009. *Tithonia diversifolia* which was used as green manure had high K content. The highest K uptake value recorded in CP treated plants in 2010 could be as a result of high K content of *Tithonia diversifolia* and PM from which CP was derived.

CONCLUSION

The finding from this experiment showed that organo-mineral fertilizer increased tomato yield and compared favourably well with chemical fertilizer while organo-compound fertilizers improved the growth of tomato, both fertilizer increased the quality of tomato. All the organic based fertilizer improved soil quality. Organo-mineral fertilizer is recommended for higher yield while OMF and neem organo compound fertilizer are recommended for better crop quality on soils similar to the one used for this experiment.

ACKNOWLEDGMENT

This work was supported by research grant, RG 221, from Research and Development Centre (RESDEC) now institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR), Federal University of Agriculture, Abeokuta, Ogun-State, Nigeria.

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