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Concentration of Soil Nutrients and Yield Response of Tomato (*Solanum Lycopersicum*) as Influence by Organic Fertilizer® (Compost) on the Soil of Makurdi, Nigeria

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Abstract

Over reliance on inorganic fertilizers as a crop nutrient source has left undesirable consequences on the soil and soil environment in the soil of Nigeria. One of the direct consequences is low yield of crops occasioned by imbalances in soil nutrients. It is expedient to adopt organic inputs in order to overcome some of these challenges. In this regard a field trial was conducted in 2018 and 2019 to evaluate the efficacy of organic fertilizer as a soil nutrient input for tomato cultivation in Makurdi. The experiment consisted of six (6) levels of compost manure (0, 0.2, 0.4, 0.6, 0.8 and 1.0) t/ha. The treatments were laid in Randomised Complete Block Design and replicated three (3) times. It was observed that organic fertilizer remarkably increased the concentration of soil organic matter (SOM) and nutrients content in the soil. Also, applications of compost at 1.0 t/ha produced plants with higher growth and yield parameters. Lower plant yields were obtained from non fertilizer treatments. Hence, organic fertilizer is recommended as a suitable agricultural input for sustainable production of tomato in the study area.

Key word: Organic fertilizer®, tomato, organic matter, soil nutrients

INTRODUCTION

Tomato is one of the most important vegetable crops grown in Nigeria (Aduayi *et al*.,2002). The crop is grown for it; edible fruits which richly supply vitamins and mineral to the human body system, acts as antioxidants which helps in cancer treatment and promotes good health. (Arab and Steck, 2000). Beside dietary and health benefit, the crop is widely known for its importance as a cash and industrial crop in most part of the world (Saeed-Awan *et al*.,2012). A study by University of Arizona indicated that imported fresh tomato from Mexico contributed $4.8 billion in sales to the US economy in 2016 (Schwartz, 2018). Nigeria is the second largest producer of tomato in Africa by Food Agriculture Organization report (FAO,2014), over one

million hectares of land has been reported to be devoted for the cultivation of the crop (Aduayi *et al*.,2002). It is estimated that over 150,000MT of tomato paste are imported yearly, valued at $170 million (Sunday *et al*.,2018). Despite this production and economic statistics, huge gaps exist between the demands and supply of the crop; according to report by Premium Times (2018), the demand for fresh tomato fruits in Nigeria was estimated at 2.45 million metric tons per annum while Nigeria produces only about 1.8 million metric tons per annum. The existing gap has been attributed to low supply of the crop occasioned by low yield per unit area of land, poor post harvest handling, pest and disease infestation etc (Robison and Kolavaillli,2010). Tomato yield like other crops depend on fertility status, whereas the soils are low in plant nutrients supply, optimal yield of the crop will be impaired. This study was thus carried out to assess the concentration of soil nutrients and performance of tomato in the soil of Makurdi amended with organic fertilizer.

MATERIALS AND METHODS

Experimental Site

The field experimental was conducted in 2018 and 2019 cropping seasons under rain-fed condition at the Teaching and Research Farm, University of Agriculture, Makurdi, Nigeria. The area falls within latitude 7^0 41^1 N and longitude 8^0 37^1 E, at an elevation of about 97 meters above sea level in the Southern Guinea Savanna Agro- Ecological Zone of Nigeria

Makurdi has a mean annual rainfall and temperature of 1250 mm and 32 ^oC respectively. The soil of Makurdi has high erodilibility, coarse textured, weak structured and low in nutrient supply (Amhakhian *et al*., 2010).

Experimental Treatments and Design

The experiment consisted of six (6) levels of compost manure (0, 200, 400, 600, 800 and 1000) kg/ha in three replicates laid in Randomised Complete Block Design.

Soil Sampling and Analysis

Surface (0-15 cm) soil samples were randomly collected at eight different points with the aid of a soil auger using. The samples were bulked for analysis. The soil samples were air dried, ground and pass through 2 mm sieve and taken for routine soil analysis in the laboratory as follows; Soil pH was determined in a 1:1 soil-water suspension by the glass electrode method, particle size analysis by the hydrometer method of Bouyoucos (1951) in which sodium hexametaphosphate (calgon solution) was used as dispersing agent. Total organic carbon was by chromic acid oxidation procedure of Walkley and Black (1934), total nitrogen was determined using the procedure described by Anderson and Ingram (1996), the Molybdenum-blue method as described by IITA (1979) was used to determine available phosphorus. Exchangeable bases were determined by the neutral ammonium acetate saturation. Na and K in the extracts were determined by the flame photometer while Ca and Mg were determined using Atomic Absorption Spectrophotometer. Cation exchange capacity was determined by summation of exchangeable bases.

Nursery Activities and Seedlings Transplanting

The tomato seedlings were raised in a nursery which was later transplanted at four weeks maturity. The planting spacing adopted in the field was 50 cm x 0.75 cm and the plot size was 3m x4m

Nutrients Application

The organic fertilizer was incorporated in the soil one (1) week before the seedlings were transplanted.

Data Collection and Analysis

Plant height (cm) and number of branches per plant, were collected; at 3, 6, 9 and 12 weeks after transplanting (WAT). The number of fruits and weight (kg) per plant were determined at harvest. Crop data collected were subjected to analysis of variance (ANOVA) and the means that were statistically different were compared using Fisher's least significant difference (F-LSD) at 5% level of probability (Obi, 2001).

RESULTS AND DISCUSSION

Soil Properties before Fertilizer Application

The soil of the study area as presented in Table 1 was moderately acidic in both seasons (6.70 and 6.30 in 2017 and 2018 respectively), low in total nitrogen (1.02 and 0.82) and available phosphorus (1.41 and 1.28) in both cropping seasons the study was conducted. The concentration of organic matter and exchangeable cations also falls below the critical range in the soils of Southern Guinea Savanna previously established by Aduayi *et al*., (2002). Considering the result of soil analysis as indicated in Table 1, it is obvious that the soil of the study area was low in nutrient supply and expectedly would respond to soil amendment.

Chemical Composition of Organic Fertilizer

The chemical composition of organic fertilizer used in the study is presented in Table 2. The organic fertilizer was industrial formulated compost from animal and plant residue and had high concentration of plant nutrient elements indicative of its ability to supply essential nutrients to plant.

Effects of Organic Fertilizer on Soil

The effect of organic fertilizer on soil pH status (Tables 3 and 4) shows that soil pH was lowered in non fertilizer plots (6.67 and 6.69 in 2017 and 2018 respectively). Conversely, soil pH was raised with organic fertilizer application in the two years of the study. The highest soil pH (6.80 and 6.88) was obtained with application of fertilizer at 1000kg/ha. Similarly, SOM, total N, available P and exchangeable cations were positively affected by organic fertilizer application in the two years of study. The study showed that organic fertilizer positively influenced concentration of nutrients in the soil and could be adopted as plant nutrient source in order to overcome the inherent low nutrients supplying capacity of soils in the study location. This result agrees with previous works by Makinde *et al*., (2001) and Adidiran *et al.,* (2014) who demonstrated that organic manure from varying sources improves soil supply of plant nutrients and consequently optimized crops yield. The effects of compost on soil properties is

widely reported by several Authors (Adeniyan and Ojeniyi,2005; Brady and Weil,2007; Adeniyan et al.,2011)

Effect of Organic Fertilizer on Plant Growth Parameters

The effect of organic amendment on growth parameters is presented in Tables 5 and 6. Organic amendment resulted in the increase in plant height and number of branches when compared to zero fertilizer plots. The control treatment had the lowest plant height across the treatments in both seasons Table 5. The highest plant height was obtained from fertilizer treatment at 1000kg/ha. Also, it was observed that though plant height varies with levels of organic amendments, there was no statistical difference at 600 kg/ha, 800kg/ha and 1000kg/ha. Table 6 presents the effects of fertilizer on the number of branches. It was inferred that though more branches were obtained from organic amended plots, this was not statistical difference from zero fertilizer plot at 3- and 6-weeks intervals. However, there was statistical difference in number of branches per plant at 9 and 12 weeks after transplanting. The effect of fertilizer amendments in varying forms on plant growth parameters has been widely reported by several Authors (Aduayi *et al*.,2002; Ewulo, *et al*.,2008; Idowu,2011; Adepetu *et al*.,2014; Havlin *et al* 2014)

Effect of Organic Fertilizer on Plant Yield Parameters

Organic fertilizer at 1000kg/ha was superior in terms of number of fruits per plant and weight of fruits per plant Table 7. The lowest fruits yield was obtained at zero fertilizer plots (15 and 22 in 2017 and 2018 respectively) in the two cropping seasons. The highest number of fruits was obtained at 1000kg/ha but was statistically the same with result obtained at 800kg/ha in the two cropping seasons. Number of fruits and weight of fruits per plants increase with increasing levels of organic amendment. However, there was no significant difference at zero fertilizer and at 200 and 400 kg/ha. Similarly, there was no statistical difference of fruits weight at 800kg/ha and 1000kg/ha of organic fertilizer amendment. As earlier indicated, organic fertilizer contains high plant nutrient elements hence must have released proportionate nutrients for plant utilization and consequently, higher yield. This observation agrees with Makinde *et al*., (2001); Brady and Weil (2007); Ogundare *et al*., (2015) and Fatima *et al*., (2016) who asserted that fertilizer was a necessary farm input to optimized crop yield.

Conclusion

The study has shown that organic fertilizer is suitable as a plant nutrient source which can raise soil organic matter, increase concentration of total nitrogen, available phosphorus and exchangeable cations. The nutrients release in the soil from the fertilizer contributed to plant growth and optimized fruits yield. Therefore, organic fertilizer can be used as a soil amendment in enhancing sustainable crop production in the study area.

Table 1: Soil Properties of the Experiment Area (2017 and 2018)

Soil parameters	2017	2018
Sand (%)	77.54	78.60
Silt (%)	12.36	11.40
Clay (%)	10.10	10.00
Textural class	Sandy loam	Sandy loam
pH	6.70	6.30
Organic matter (%)	2.12	1.80
Total nitrogen (%)	1.02	0.83
Phosphorus (mg/kg)	1.41	1.28
K (cmol kg^{-1})	0.55	0.58
Ca (cmol/kg^{-1})	3.47	3.61
Mg (cmol kg^{-1})	1.86	1.78
Na (cmol kg^{-1})	0.18	0.16
CEC (cmol kg^{-1})	6.06	6.35

Table 2: Chemical Properties of Organic fertilizer® (OF)

Parameters	O F®
pH	7.0
Organic matter (%)	48.65
Total nitrogen (%)	8.20
Phosphorus (mg/kg)	6.12
K (cmol kg^{-1})	3.80
Ca (cmol kg^{-1})	13.28
Mg (cmol/kg^{-1})	8.13
Na (cmol kg^{-1})	0.62

Table 3: Effect of Organic fertilizer® on selected soil properties in Makurdi (2017)

Treatment	pH	OM (%)	N (%)	P (mg/Kg)	K cmol/kg	Ca cmol/kg	Mg cmol/kg	Na cmol/g	CEC cmol/kg
Control	6.67	2.01	0.81	0.85	0.50	2.13	1.61	0.18	4.42
200kg/ha OF	6.72	2.18	1.03	1.86	0.54	2.67	2.09	0.18	5.48
400kg /ha OF	6.75	2.75	1.27	2.43	0.58	3.50	2.20	0.23	6.51
600kg/ha OF	6.75	3.16	1.35	3.51	1.60	3.66	2.81	0.30	8.37
800kg/ha OF	6.88	3.68	1.77	4.05	1.61	3.81	2.83	0.30	8.55
1000kg/ha OF	6.88	4.23	2.06	4.14	1.61	3.90	2.83	0.33	8.67

OF= Organic fertilizer®

Table 4: Effect of Organic fertilizer® on selected soil properties in Makurdi, (2018)

Treatment	pH	OM (%)	N (%)	P (mg/kg)	K cmol/kg	Ca Cmol /kg	Mg cmol/kg	Na cmol/kg)	CEC cmol/kg
Control	6.69	2.06	0.60	0.77	0.29	2.01	1.01	0.16	3.47
200kg/ha OF	6.73	2.33	0.63	1.07	0.37	2.33	1.10	0.21	4.01
400kg /ha OF	6.73	3.21	0.63	2.18	0.37	2.46	1.55	0.21	4.59
600kg/ha OF	6.76	3.21	0.67	3.17	0.60	2.65	2.55	0.30	6.10
800kg/ha OF	6.76	3.28	0.68	3.89	0.66	3.09	2.61	0.30	6.66
1000kg/ha OF	6.80	4.01	0.68	4.04	0.66	3.10	2.61	0.34	6.71

OF= Organic fertilizer®

Table 5: Effect of Organic fertilizer® on Plant Height (cm) of tomato in 2017 and 2018

Treatment	3WAT 2017	2018	6WAT 2017	2018	9WAT 2017	2018	12WAT 2017	2018
Control	10	11.0	15.5	23.1	36.1a	38.4a	38.0a	38.6a
200kg/ha OF	10	11.6	16.9	23.5	36.7a	38.9a	38.1a	38.9a
400kg/ha OF	08	10.2	17.7	25.6	39.6b	39.1a	40.1b	40.0ab
600kg/ha OF	06	10.1	17.6	26.4	39.6b	41.0ab	40.1b	41.6bc
800kg/ha OF	08	11.1	17.9	26.9	39.8b	41.1b	41.0b	41.6bc
1000kg/haOF	10	12.1	17.9	27.1	39.9b	41.2b	41.0b	42.0c
LSD (0.05)	NS	NS	NS	NS	2.10	1.83	1.90	1.85

OF= Organic fertilizer® , WAT= Weeks After Transplanting, Mean with same alphabet are statistically the same at 5% level

Table 6: Effect of Organic fertilizer® on number of branches per tomato plant in 2017 and 2018

Treatment	3WAT 2017	2018	6WAT 2017	2018	9WAT 2017	2018	12WAT 2017	2018
Control	03	03	05	08	14a	16a	14a	16a
200kg/ha OF	03	03	05	08	14a	16a	14a	16a
400kg/ha OF	03	02	05	08	14a	16a	14a	16a
600kg/ha OF	02	04	06	09	18b	18ab	18b	20b
800kg/ha OF	04	02	06	09	18b	18ab	18b	20b
1000kg/haOF	03	03	06	09	18b	20b	18b	20b
LSD (0.05)	NS	NS	NS	NS	3.10	3.81	2.90	3.85

OF= Organic fertilizer®, WAT= Weeks After Transplanting, mean with same alphabet are statistically the same at 5% level

Table 7: Effect of treatment on number of fruits per plant and weight (kg) of fruits per plant in 2017 and 2018

Treatment	Number of fruits per plant		Weight of fruits per plant	
	2017	2018	2017	2018
Control	15.0a	22.0a	03.3a	04.0a
200kg/ha OF	15.0a	23.0a	03.7a	05.5ab
400kg /ha OF	32.0b	42.0b	05.0a	05.9ab
600kg/ha OF	35.0b	58.0bc	05.1ab	06.7b
800kg/ha OF	48.0b	58.0bc	06.0b	09.6c
1000kg/ha OF	48.0b	63.0c	06.8b	10.0c
LSD (0.05)	15.98	18.0	1.13	1.78

OF= Organic fertilizer®, Mean with same alphabet are statistically the same at 5% level

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