Original Research Article

Response of Tomato (*Lycopersicon esculentum* Mill) to Different Levels of Liquid Organic Fertilizer in Asaba Delta State, Nigeria

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Received 27th August, 2018; Accepted 19th September, 2018; Corrected 28th September, 2018

Abstract

An experiment was conducted to test the response of tomato (*Lycopersicon esculentum* Mill) to different levels of liquid organic fertilizer (*Power-Plant* ®) in Delta State University, Asaba Campus at early and late planting periods. Six levels of the fertilizer were applied at 0, 10, 20, 30, 40 and 50 l/ha. Fifteen kilogram of soil taken from Agronomy Department Experimental Farm was weighed into experimental bags and seed of local tomato variety used was obtained from Asaba market. The seeds were sown in nursing bed for two weeks before transplanting in the bags and were arranged in a completely randomized design with four replications. Data were collected on plant height, number of leaves, leaf area, number of branches, number of fruits and fruits weight per pot and were analyzed following the ANOVA and means were adjudged with least significant differences (LSD) at $p<0.05$. Results obtained showed increased growth and yield of tomato with higher rate of liquid organic fertilizer. The 50 l/ha was superior in growth and yield data measured at both early and late planting. The soil chemical properties also improved after harvest. Therefore, the use of liquid organic fertilizer could afford tomato growers with suitable nutrient source for vegetable production both for their homes and market, and providing fresh tomato all year round.

Key words: Tomato, Liquid organic fertilizer, *Power-Plant* ®, Delta State, Soil fertility

Introduction

The Food and Agriculture Organization (FAO) developed a programme in 2004 that focused on the production and utilization of fruits and vegetables. This was to promote increased production and access as well as consumption of vegetables. Daily intake of about 400g of vegetables was recommended by FAO/WHO for households (FAO, 2007), and despite this recommendation, the production is still very low. To achieve increased production, there is need for proper soil management

Tomatoes (*Lycopersicon esculentum* Mill*)* are commercially produced throughout the world, and are also seen in almost every part of Nigeria, especially in the Savannah zone because some diseases of tomatoes are less common in the Savannah zone. It is an important source of minerals and vitamins, and one of the most important vegetable crops of *Solanaceae* grown universally (FAO, 2007). Tomato and onion are common important kitchen items cooked as vegetables and also used as condiments and salad. These uses have led to its high demand coupled with increased population, economic growth and urbanization (Fateh, 2009). Decline in tomato yield caused by poor soil fertility is of great concern to Nigerian farmers especially now that the average yield is below 10t ha^{-1} (Ogundare *et al*., 2015), which is much lower than the world average yield is about 22t ha^{-1}. Low soil fertility and inadequate fertilizer use are some of the factors that have contributed to this poor tomato yield in the country (Dantata and Oseni, 2009).

Declining soil fertility is one of the main land degradation processes, and it has been reported as the major characteristics of tropical soils (Ipinmoroti et al., 2006). This decline will no doubt threaten tomato production because it is a major constraint that affects all aspects of crop production (Mbah, 2006). One technology developed to restore the declining soil fertility and prevent soil degradation soil is the application of organic fertilizers. Olanikan, 2006) stated that organic fertilizers contain N, P, K and some essential micro-nutrients for crop production, and that use of organic fertilizers favours root growth, and increases drought tolerance by improving soil physical properties and water-holding capacity.

Power-Plant® is a type of liquid organic fertilizer that has been introduced into the Nigerian market for use for the production some crops. It could serve as a cheap source of nutrients for tomato cultivation, minimize production costs especially now that inorganic fertilizers are not readily available and affordable to farmers, and eliminate the long-term hazards associated with prolonged use of inorganic fertilizers on the soil. In light of these, the study was set up to determine the influence of varying levels of liquid organic fertilizer on the growth, yield of tomato and soil chemical properties in Asaba, Delta State.

Materials and Methods

Experimental Location

The experiment was carried out at the Department of Agronomy, Delta State University, Asaba Campus, Asaba, Nigeria. Asaba is located between Longitude 06° 49'E and Latitude 06° 14'N in the humid tropics. Its rainy season start by April till October and peaked at July and September with low precipitation in August. Average temperature is 37.3°C and relative humidity of 73.2%.

Nursery

Nursery bed was prepared and the tomato seeds were nursed in the bed for two weeks before transplanting.

Preparation of Polybags and transplanting

Fifteen kilogram of soil was weighed into each of experimental black polythene bags. The soil was taken from the Department of Agronomy Experimental Farm. Two weeks old seedlings was transplanted one seedling per bags. The first planting was done in March while second planting was in August, 2012.

Experimental design

The experiment was laid out in a completely randomized design (CRD) with four replications while the Power-Plant® liquid organic fertilizer obtained from Jos, Plateau State was applied at 0, 10, 20, 30, 40 and 50 l/ha. The liquid fertilizer was diluted by adding 4 ml to 1000ml of water and was applied at 2, 4 and 8 weeks after transplanting.

Data collection

Data collection on growth parameters (Plant height [cm], Number of leaves, leaf area [cm^2] and Number of branches) started three weeks after transplanting, and subsequently on weekly basis while yield parameters (Number of fruits and Fruit yield [$t\ ha^{-1}$]) were recorded after harvest. Soils were collected for post-harvest chemical analysis at harvest of the second planting.

Laboratory analysis

The soil analysis was done in the Analytical Laboratory, Department of Agronomy, University of Ibadan following laid down principles (IITA, 1979).

Data analysis

Data obtained were statistically analyzed using the Analysis of Variance. Least significant difference at 5% level of probability was used to separate significantly different treatment means.

Table 1: Proximate composition of *Power-Plant* ®

Nutrients	Values (%)
Nitrogen	18
Phosphorus	8.0
Potassium	4.5
Magnesium	0.56
Sulphur	1.80
Iron	0.10
Manganese	0.10
Copper	0.03
Boron	0.03
Molybdenum	0.002
Cobalt	0.002

Source: Green Planet International.

Results

Pre-planting soil physical and chemical analysis

The nutrient status of the soil before transplanting, as shown on Table 2, was sandy in nature, slightly alkaline, low in total N and in available P. The total N of 0.2 gkg^{-1} was less than the critical level of 1.5gkg^{-1}, while the7.33 $mgkg^{-1}$ available P was less than the critical level of 15 $mgkg^{-1}$ (FMARD, 2012). The pH of 6.3 was moderate for tomatoes production.

Table 2: Pre-planting Soil Physical and Chemical Properties

Parameters	**Nutrient values**
pH (H_2O)	6.40
Organic matter (g/kg)	3.97
Total nitrogen (g/kg)	0.20
Available P (mg/kg)	7.33
Exchangeable bases (cmol/kg)	
K	0.39
Mg	0.32
Ca	0.29
Na	0.54
Exchangeable Acidity	0.05
CEC	1.59
Particle sizes (%)	
Sand	65.0
Silt	25.0
Clay	10.0
Textural class	**Loamy sand**

CEC = Cation exchange capacity

Growth parameters as influenced by the different levels of the liquid organic fertilizer

Table 3 shows the growth parameters of tomato as influenced by the different levels of the liquid organic fertilizer. Plant height was significantly influenced. It increased with higher application levels and weeks after transplanting (WAT). The tallest plants were recorded in plants which received 50 l/ha of the fertilizer, and were significantly taller than those which had 30, 10 and 0 l/ha treated plants at 2, 6 and 10 WAT except for the 40 l/ha plants which were not significantly different at 10 WAT. Then during second planting, there were also significant differences. The 50 l/ha group also had the tallest plants while the 0 l/ha had the least.

Table 3: Growth of tomato as influenced by different levels of the liquid organic fertilizer (Power-Plant) at 2, 6 and 10 weeks after transplanting

		Plant Height (cm)			Number of Leaves			Leaf Area (cm^2)		
	Levels	**2**	**6**	**10**	**2**	**6**	**10**	**2**	**6**	**10**
First planting	0	23.4	69.9	84.6	42.0	78.0	78.0	14.1	25.2	24.9
	10	30.3	72.9	86.4	45.0	90.0	102.0	15.0	31.5	31.2
	20	35.1	74.4	90.3	54.0	114.0	117.0	14.7	31.8	31.8
	30	30.6	73.5	90.6	60.0	129.0	144.0	18.3	34.8	34.5
	40	34.2	75.6	92.4	63.0	162.0	177.0	17.4	36.9	37.8
	50	37.2	87.3	98.4	60.0	180.0	198.0	18.6	41.4	39.3
	SD	2.39	0.35	3.22	1.68	3.28	3.85	0.48	2.01	0.80
	LSD	5.11	1.88	7.17	3.75	1.68	8.58	1.06	4.47	1.78
	CV%	26.5	4.10	13.08	11.45	3.75	10.41	10.70	21.92	8.82
Secon -	0	24.0	61.7	78.5	38.1	68.2	72.3	13.1	20.1	22.1
	10	33.3	76.9	89.5	47.0	93.1	104.2	16.1	32.4	35.0
	20	36.1	76.6	93.0	55.2	115.1	118.3	17.2	33.8	36.8
	30	35.6	76.7	93.6	61.0	129.3	145.3	19.7	35.9	38.6
	40	37.4	78.6	102.4	62.4	164.2	179.5	20.5	39.9	42.8
	50	39.3	89.7	112.4	63.3	182.1	199.7	20.7	42.4	44.5
	SD	2.44	0.65	4.02	2.11	3.98	4.25	0.86	2.77	1.20
	LSD	5.66	2.23	7.98	4.70	2.60	9.59	1.67	4.79	2.32
	CV%	24.23	6.10	16.18	14.45	13.75	15.41	12.20	24.92	10.82

Note: C.V = coefficient of variation; **LSD** = least significant differences; **SD** = standard deviation

Number of leaves was influenced significantly; plants which received 40 l/ha had the highest number of leaves at 2WAT in first planting, while the 50 l/ha group had significantly higher number of leaves than plants which received the lower doses of the liquid organic fertilizer at 6 and 10 WAT. During the second planting, all the levels of the fertilizer greater than 0 l/ha had significantly higher number of leaves than the control group.

The leaf area increased with increase of weeks after transplanting (WAT) and levels of application. Application of 50 l/ha of the liquid organic fertilizer resulted in the highest mean leaf area in all the weeks data were collected, and was significantly higher than the values obtained at lower levels of application, except at 2 WAT. At 2 WAT, the 50l/ha treatment was not significantly higher than the 30 l/ha-treated plants in terms of mean leaf area. The control treatment (0 l/ha) had the lowest mean leaf area, except at 2 WAT that it was not significantly lower than those which had 10 and 20 l/ha. In the second planting, there were also significant differences between treatments with the 50 l/ha plants having the highest leaf area while the control group had the least.

The effect of applying varying levels of the liquid organic fertilizer on number of branches is presented on Table 3. Primary and secondary branches increased with higher application level.

Application of 50 l/ha of the fertilizer produced the highest number of branches, while the 0 l/ha group had the least in both plantings. It had significant higher number of primary and secondary branches than all except the 40 l/ha group in which the secondary branches were similar.

Yield parameters as influenced by the different levels of the liquid organic fertilizer

Table 4 shows the number of fruits and fruit weight (g per pot) after harvest. The number and weight of fruits increased with increase in the level of liquid fertilizer applied, and varied significantly among treatments. The level that produced the highest number of fruits was 50 l/ha while 0 l/ha had the least number of fruits in both first and second planting. Tomato plants to which 50 litre of liquid organic fertilizer (*Power-Plant* ®) per ha was applied had the highest fruit number and fruit weight, with mean values of both variables being significantly higher than those of plants which received the lower levels of *Power-Plant* ®. The 0 l/ha plants also had the least mean fruit weight in both first and second planting.

Table 4: Branches, and yield parameters of tomato as influenced by different levels of the liquid organic fertilizer after harvest

	First planting				Second planting			
Levels (l/ha)	**Primary branches**	**Secondary branches**	**No. of branches**	**Fruit Weight (g/pot)**	**Primary branches**	**Secondary branches**	**No. of branches**	**Fruit Weight (g/pot)**
0	9.3	48.9	60.9	603.9	8.7	45.9	59.8	580.8
10	10.2	57.9	73.2	693.5	12.4	58.8	75.3	697.6
20	10.2	74.1	84.3	751.2	12.6	75.3	87.5	762.1
30	12.9	79.8	88.2	843.9	16.0	82.6	90.4	888.7
40	17.1	84.9	97.2	930.9	17.9	88.8	103.6	915.3
50	19.8	91.2	108.9	1144.2	20.1	91.8	109.9	1165.0
SD	0.70	3.18	0.79	3.00	0.77	3.29	1.13	4.1
LSD	1.55	7.09	1.76	6.67	1.76	7.65	2.21	7.61
CV(%)	19.26	16.06	3.40	10.99	21.20	17.23	6.44	6.97

Note: C.V, coefficient of variation, **LSD**, least significant differences, **SD**, standard deviation

Nutrient content of soil as affected by different levels of Power-Plant ®

Table 5 shows the effects of different levels of *Power-Plant* ® on soils' chemical properties after harvest. The pH of treated soils was lower than those of the 0 l/ha. Values obtained were 6.30, 6.28, 6.26, 6.25 and 6.22 for 0, 10, 20, 30, 40 and 50 l/ha, respectively. The organic matter contents of treated soils were also higher than that of the control (0 l/ha).

Organic matter and total nitrogen contents of the soil also increased progressively with increase in the level of *Power-Plant* ® application (Table 5).

Table 5: Soil Chemical Properties as affected by different levels of *Power-Plant* ®

Levels	pH (H_2O)	Organic Matter (g/kg)	Total N (g/kg)	Available P mg/kg	Exchangeable bases (cmol/kg) K	Ca	Mg	Na
0	6.30	3.01	0.11	6.01	0.22	0.22	0.24	0.38
10	6.29	4.31	0.64	8.40	0.62	0.52	0.50	0.61
20	6.28	5.01	0.64	8.51	0.63	0.54	0.52	0.73
30	6.26	6.11	0.64	9.66	0.64	0.65	0.61	0.74
40	6.25	8.02	0.65	10.01	0.72	0.54	0.64	0.78
50	6.22	9.03	0.66	12.34	0.78	0.56	0.69	0.82

Discussion

The significant differences observed in the response of tomato to different levels of liquid organic fertilizer application could be attributed to the roles the nutrient played. The fertilizer's effectiveness may be attributed to its water-soluble form that made the nutrients to be easily released. The taller plants recorded with higher levels of liquid organic fertilizer application reflected the availability of the nutrients it contained (Togun *et al*., 2003). The increased vegetative growth associated with higher levels of application of the fertilizer was probably related to its high N content. Nitrogen enhances above-ground vegetable growth. Also, increasing levels of liquid organic fertilizer application have been reported to increase sweet potato growth and yield (Danbaba, 2003).

Crop response to applied nutrients depends on soil fertility status before application of such nutrients. In this experiment, initial soil nutrient content determination revealed that the soil was virtually infertile, as it was low in organic matter, total N, available P as well as in the exchangeable bases (Table 2). Consequently, tomato responded positively to the applied liquid fertilizer as is evident in the results on growth and yield parameters. The fertilizer contains micro- and macro-nutrients, which may have accounted for the beneficial effect of the fertilizer on crops through improvement in fertility of the soil. Evidence exists (Matsi, 2012; Table 1) that *Power-Plant* ® (liquid organic fertilizer) contains high amounts of readily available nutrient due to its liquid state. The quantity of this readily-available nutrients can be almost half of the total content. This is higher than what is obtainable in solid manures (Bechini and Marino, 2009). The wide array of micronutrients contained in the fertilizer can also boost the growth and yield of tomato. Continuous and high application of *Power-Plant* ® can increase the soil organic matter due to the fact that a considerable part of the fertilizer consists of organic matter (about 20%) in its liquid phase (Antil *et al*., 2005). Plants that received the liquid organic fertilizer at the 50 l/ha gave superior vegetative and higher yield compared to the lower levels. Increased growth and yield are an indication that the liquid organic fertilizer is efficient for tomato production. The fertilizer was also reported to increase the growth and yield of *Amaranthus* (Ojiefo *et al*., 2009).

Conclusion

This study showed that the liquid organic fertilizer applied to the rate of 50l/ha improved the yield of tomato, due to its high quantity of readily available nutrients. The fertilizer was efficient in supplying plant nutrients. The use of the fertilizer can afford tomato growers with a suitable nutrient source for improving production of vegetables for both their homes and market.

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