# RESPONSE OF TOMATO (L*ycopersicon esculentum* MILL) TO DIFFERENT LEVELS OF LIQUID ORGANIC FERTILIZER IN ASABA, DELTA NORTH AGRO-ECOLOGICAL ZONE, DELTA STATE

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## Abstract

*Pot experiment was conducted to test the response of tomato (Lycopersicon esculentum Mill) to different levels of "Power-Plant" liquid organic fertilizer in Delta State University, Asaba Campus atearly and late planting periods. Six levels of the fertilizer were applied at each planting (0, 10, 20, 30, 40 and 50 l/ha). Fifteen kilogram of processed soil was weighed into each of the experimental bags. The soil was taken from Department of Agronomy Experimental Farm. Local tomato variety used was obtained from Ogbe-Ogonogo market in Asaba. The seeds were sown in nursing bed for two weeks after germination before transplanting. The experimental bags were arranged in a completely randomized design with four replications. Data collected on growth and yield parameters were: plant height, number of leaves, leaf area, number of branches, number of fruits and fruits weight per pot. Data were analyzed following the ANOVA technique and mean differences were adjudged with least significant differences (LSD) at P<0.05. The results obtained showed that the growth and yield of tomato increased with increase of the liquid organic fertilizer application and the 50 l/ha was superior to lower levels in the growth and yield data measured at both early and late planting. Also, soil chemical properties were improved after harvest. Therefore, the use of the liquid organic fertilizer could afford tomato growers with a suitable nutrient source for improving the production of the vegetable for both 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 Agricultural Organization (FAO) programme developed in 2004 focused on production and utilization of fruits and vegetables. The framework was to promote increased production, availability, access as well as consumption of fruits and vegetables. Daily intake of about 400 g of vegetables was recommended by FAO/WHO for households (FAO 2004). Despite this recommendation, the productions are still low, but to achieve increased production, there is need for proper soil management. Tomato (*Lycopersicon esculentum* Mill) is an important vegetable commercially produced throughout the world, and they are also seen in almost every part of the country, especially in the Savannah zone because some diseases of tomatoes are less common in the Savannah zone. It is an important source of minerals, vitamins, health acids and one of the most important vegetable crops of solanaceae grown universally (FAO, 2007). Tomato, onion and chilies are common and important kitchen items cooked as vegetables, used as condiments and salad. These led to high demand for the crop couple with the population growth, economic growth and urbanization (Fateh, 2009). The yield reduction caused by declining soil fertility is now a major concern among farming communities in the world especially Nigerian where the average tomato yield was 10 t $ha^{-1}$. This is lower than the world average yield of 22 t $ha^{-1}$ (Ojeniyi *et al*., 2007). Low soil fertility and inadequate fertilizer use are the factors that contributed to this poor tomato yield in the country (Dantata *et al*., 2006; Dantata and Oseni, 2009).

The decline soil fertility is one of the main land degradation processes, and it has been reported as the major characteristics of the tropical soil (Ogunwale *etal*., 2002 as sited by 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 main technology exploited to restore the declining soil fertility and degraded soil is the application of organic fertilizer (Togun *et al.,* 2004). The organic fertilizer contains N, P, K and some essential micronutrients for crop production (Olanikan, 2006). Furthermore, Oguike and Mbagwu (2004) observed that organic fertilizer application favors root growth and increase drought tolerance by improving soil physical properties (soil texture) and water holding capacity.

The use of the liquid organic fertilizer to support the production of tomato would serve as a cheap source of nutrients and consequently minimize the cost of using inorganic fertilizer especially now that it is not available and affordable to the resource-poor farmers. In light of these, the study was set up to determine the growth, yield of tomato and soil chemical properties as influenced by different levels of liquid organic fertilizer in Asaba, Delta State.

**Materials and Methods**

The experiment was carried out at the Department of Agronomy, Delta State University, Asaba Campus. The first planting was done between March and July, while second planting was between August and December, 2012. Fifteen kilogram of processed soil was weighed into each experimental polythene bag. The soil was taken from the Department of Agronomy Experimental Farm. Local tomato variety used was obtained from Ogbe-Ogonogo market in Asaba, while the power-plant liquid organic fertilizer applied was obtained from Jos, Plateau State, Nigeria. The experiment was laid out in a completely randomized design (CRD) with four replications. Theliquid organic fertilizer was applied at six levels (0, 10, 20, 30, 40 and 50 l/ha). Nursery bed was prepared and the tomato seedlings were transplanted two weeks after sowing in the nursery bed, one seedling per pot. The liquid fertilizer was diluted by adding 4 ml to 1000mml of water as recommended by the manufacturer (GPI, 2012). This was applied three times, at 2, 4 and 8 weeks after transplanting according to Powell *et al.* (2011) and Pfluke *et al.* (2011). The proximate composition of the fertilizer is shown on Table 1 below.

Data collections 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 considered after harvest. Soil samples were collected for post-harvest chemical analysis (Soil pH, Organic matter, Total nitrogen, Available phosphorus and Exchangeable cations) after two consecutive applications of the fertilizer and at the harvest of the second planting. The growth and yield data measured were statistically analyzed using the Analysis of Variance Procedures 2010 Version. Least significant difference at 5% level of probability was used to separate differences among treatment means. The soil pH was on a ratio of 1:2 soil/water suspensions (IITA, 1979).

Organic carbon was determined using the Walkley Black Method (IITA, 1979). Exchangeable bases (K, Ca. Mg and Na) were extracted with 1N ammonium acetate extraction method of Jackson (1964). The Ca and Mg were determined by Atomic Absorption Spectrophotometer (AAS) while K and Na were read using Flame Photometer. The available P was extracted using Bray-1 extracting solution and further reading was carried out using a colorimeter (Federal Department of Agriculture, 1979). Total N was determined by the Kjeldhal distillation method (Anderson and Ingram, 1993). The soil analysis was done in the Analytical Laboratory, Department of Agronomy, University of Ibadan, Ibadan.

**Table 1:Proximate composition of power-plant liquid organic fertilizer**

| Nutrients | values |
|---|---|
| Nitrogen | 18% |
| Phosphorus | 8% |
| Potassium | 4.5% |
| Magnesium | 0.56% |
| Sulphur | 1.8% |
| Iron | 0.10% |
| Manganese | 0.10% |
| Copper | 0.03% |
| Boron | 0.03% |
| Molybdenum | 0.002% |
| Cobalt | 0.002% |

## Results

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

Table 2 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 plant was recorded at 50 l/ha and it was significantly taller than 30, 10, and 0 l/ha treated plants at 2, 6 and 10 WAT except 40 l/ha that was not significantly different at 10 WAT. Then during second planting, there were also significant differences, the 50 l/ha had the tallest plant while the 0 l/ha (control) had the least. Number of leaves was influenced significantly, the 40 l/ha had the highest number of leaves at 2 WAT in first planting, while 50 l/ha had significantly higher number of leaves than the lower levels at 6 and 10 WAT. Then during the second planting, all the levels greater than 0 l/ha significantly had higher number of leaves.

The leaf area increased with increase of weeks after transplanting (WAT) and levels of application. The 50 l/ha of the liquid organic fertilizer had the highest leaf area all the weeks data were collected. It was significantly higher than the lower levels of application except at 2 WAT, that it was not significantly higher than 30 l/ha treated plants. The control (0 l/ha) treated plant had the lowest leaf area except at 2 WAT that it was not significantly lower than 10 and

20 l/ha. In second planting, there also significant differences, the 50 l/ha had the highest leaf area while the least was the control. The number of branches as influenced by the levels of the liquid organic fertilizer is presented on Table 3. Primary and secondary branches increase with higher application level. The 50 l/ha of the fertilizer had the highest number of branches while the 0 l/ha (control) had the least in both planting. It had significant higher number of primary and secondary branches except that it was not significantly higher than 40 l/ha (secondary branches).

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

| | 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 |
| $S^2$ | 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 |
| C.V% | 26.5 | 4.10 | 13.08 | 11.45 | 3.75 | 10.41 | 10.70 | 21.92 | 8.82 |
| **Second planting** | | | | | | | | | |
| 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 |
| $S^2$ | 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 |
| C.V% | 24.23 | 6.10 | 16.18 | 14.45 | 13.75 | 15.41 | 12.70 | 24.92 | 10.82 |

**Note: C.V**, coefficient of variation, **LSD**, least significant differences, $\mathbf{S^2}$, standard deviation

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

Table 3 showed the number of fruits and fruit weight (g per pot) after harvest. The number of fruits increases with increase of application level and also, were significantly different. The level that produced the highest number of fruits was 50 l/ha while the 0 l/ha (control) had the least number of fruits in both first and second planting. Fruit weight was also increased and levels of fertilizer application were significantly different. Increased of the liquid organic fertilizer led to increase of fruit weight, the 50 l/ha had the highest fruit weight and it significantly higher than the lower levels, the 0 l/ha (control) also had the least fruit weight in both first and second planting.

**Table 3: Yield parameters of tomato as influenced by different levels of the liquid organic fertilizer after harvest** (g per plot)

| | --------------First planting---------------- | | | | --------------Second planting--------------- | | | |
|---|---|---|---|---|---|---|---|---|
| Levels | Primary branches | Secondary branches | Number of fruits | Fruit weight | Primary branches | Secondary branches | Number of fruits | Fruit weight |
| 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 | 903.9 | 17.9 | 88.8 | 103.6 | 915.3 |
| 50 | 19.8 | 91.2 | 108.9 | 1144.2 | 20.2 | 91.8 | 109.9 | 1165.0 |
| $S^2$ | 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 |
| C.V% | 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, $\mathbf{S^2}$, standard deviation

**Pre-soil physical and chemical analysis**

The nutrient status of the soil before transplanting is shown on Table 4, sandy in nature, slightly alkaline, low total N and available P. The total N of 0.2 $gkg^{-1}$ is less than the critical level of 1.5 $kg^{-1}$ (FMARD, 2012), while the 7.33 mg $kg^{-1}$ available P was less than the critical level of 15 mg $kg^{-1}$ (FMARD, 2012). The pH of 6.3 was moderate for rice production.

Table 4: Pre-cropping Soil Physical and Chemical Properties

| Parameter | Nutrient Status |
|---|---|
| pH ($H_2O$) 1:2 | 6.40 |
| Organic matter ($gkg^{-1}$) | 3.97 |
| Total Nitrogen ($gkg^{-1}$) | 0.20 |
| Available P ($mgkg^{-1}$) | 7.33 |
| **Exchangeable bases ($cmolkg^{-1}$)** | |
| K | 0.39 |
| Mg | 0.32 |
| Ca | 0.29 |
| Na | 0.54 |
| Exch. Acidity | 0.05 |
| CEC | 1.59 |
| **Particle Size (%)** | |
| Sand | 65.00 |
| Silt | 25.00 |
| Clay | 10.00 |
| Textural Class | Loamy sand |

**Nutrient Content of Soil as affected by different levels of power-plant liquid organic fertilizer**

Table 5 shows the effects of different levels of power-plant liquid organic fertilizer on soils chemical properties after harvest. The pH of treated soils were lower than the 0 l/ha (control treatment). The levels of the liquid organic fertilizer decreases soil pH compared to the 0 l/ha (control) (6.30, 29, 6.28, 6.26, 6.25 and 6.22 for 0, 10, 20, 30, 40 and 50 l/ha respectively). The 0 l/ha had the highest soil pH and organic matter contents of treated soils were higher than the 0 l/ha. The 50 l/ha had the highest organic matter content while 0 l/ha had the lowest organic matter (11.03 and 3.01 $g/kg^{-1}$ respectively). The 50 l/ha also had the highest total nitrogen while the least was the 0 l/ha (control) (0.11, 0.64, 0.64, 0.64, 0.65 and 0.66 for 0, 10, 20, 30, 40 and 50 l/ha respectively).

The liquid organic fertilizer slightly increased available phosphorus level in the treated soils. Increasing the liquid organic fertilizer led to higher available phosphorus. The 0 l/ha had the least available phosphorus (6.01, 8.40 8.51, 9.66, 10.33 and 12.34 $mg/kg^{-1}$ for 0, 10, 20, 30, 40 and 50 l/ha respectively). There were appreciable improvements with regard to potassium, 50 l/ha of liquid organic fertilizer had the highest exchangeable k in the soil. Calcium improved after harvest as shown on Table 4, the control had the least value. Magnesium and sodium also followed the same trend. Higher application of the liquid organic fertilizer led to increase of exchangeable Mg and Na, though, 50 l/ha had the highest value.

**Table 5: Soil Chemical Properties as affected by different levels of 'Power-Plant' liquid organic fertilizer**

| Treatments Levels | pH ($H_2O$ 1:2) | Organic M ($gkg^{-1}$) | Total N. ($gkg^{-1}$) | Available P. ($mgkg^{-1}$) | Exchangeable bases ($cmolkg^{-1}$) 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 magnitude of response by the tomato crop to different levels of the liquid organic fertilizer could be attributed to the roles the nutrient played. The effectiveness of the liquid organic fertilizer may be attributed to its water soluble form that made the nutrients to be easily released unlike the solid organic fertilizers that will undergo decomposition before the nutrients are released. The taller plants recorded with application of 50 l/ha of the liquid organic fertilizer reflected the availability of the quantity of nutrients contained in the organic fertilizer. Togun *etal*. (2003) have reported similar findings when they work on three different organic materials. The increased vegetative growth with high application levels could be probably related to its high N content. Nitrogen has been reported to enhance above ground vegetative growth of vegetables (Abidin and Yasder, 1986). Also, Danbaba (2003) observed that high level of liquid organic fertilizer increased the growth and development of sweet potato.

The rate of crop response to external nutrient is dependent on the fertility status of the soils, this was shown in this experiment. The initial soil analysis revealed that the soil was very low in fertility. The tomato crop responded positively to the applied liquid organic fertilizer as evident by the result. The fertilizer contains micro and macro nutrients, this may also be attributed to the beneficial effect of the fertilizer on crop growth, yield coupled with the macronutrients that improved the fertility of the soil. The "Power-plant" liquid organic fertilizer contains high amounts of immediately available nutrient due to its liquid content (Matsi, 2012). The quantity of this immediately available nutrient can be almost half of the total nutrient and this is higher than that of the solid manure (Bechini and Marino, 2009). Lithourgidis *et al*. (2007) and Matsi *et al.* (2007) further observed that crop yield increased is accompanied by increase in plant macronutrients concentration and uptake. Apart from the macronutrients, the micronutrients it contains are essential for plant growth, therefore it could serve directly as a source of micronutrients for plant uptake (Brock *et al.*, 2006; Nikoli and Matsi, 2011). It was also observed by Antil *et al.* (2011) that long period and at high application level can increase the soil organic matter, considerable part of the organic matter (about 20%) exist in its liquid phase (Japenga *et al.*, 1992). In addition, it was reported that application of liquid organic fertilizer could enhance solubilization of metal micronutrients through their complexation with dissolved organic matter and consequently increase availability of plant nutrients (Japenga *et al.*, 1992).

Plants that received the liquid organic fertilizer at the level of 50 l/ha gave superior vegetative and higher yield compared to the lower levels. Increased growth and yield with higher levels is an indication that the liquid organic fertilizer improved tomato yield. The observed behavior of tomato fruits in this experiment is in line with the findings of Ojiefo *etal*. (2009), who applied the liquid organic fertilizer for *Amaranthus* production. Microsoft Corporation (2003) also reported the effectiveness of the liquid organic fertilizer for vegetables production.

## Conclusion

This study showed that liquid organic fertilizer applied up to the rate of 50 l/ha improved the yield of tomato, due to its high quantity of immediately available nutrients. The fertilizer can be efficient in satisfying plant needs based on this positive growth and yield response of tomato to the "Power-Plant" liquid organic fertilizer. The use of the fertilizer may afford vegetable growers (especially tomato farmers) with a suitable nutrient source for improving the production of vegetables for both their homes and market, and for providing fresh vegetables all year round.

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