Adamawa State University Journal of Scientific Research
Volume 7 Number 2, August, 2019; Article no. ADSUJSR 0702038
ISSN:2705-1900(Online); ISSN: 2251-0702 (Print)
http://www.adsujsr.com

The influence of NPK 15:15:15 Fertilizer Rates in the production of Tomato (*Lycopersicum esculentum L.*) in Delta state, Nigeria

Ojobor, S. A.
Department of Agronomy, Asaba Campus, Delta State University, Nigeria
Correspondence: Email smartojobor@gmail.com; +2348065938821

Abstract

The field experiment was conducted in two locations (Abraka and Asaba), Delta State to evaluate the response of tomato growth and yield to different rates of NPK15:15:15 within August and November, 2016. The fertilizer was applied at 0, 200, 300 and 400 kg ha^{-1} and replicated three times. Plant height (cm), number of leaves, leaf area (cm^2), stem girth (cm), number of fruit and fruits yield (t ha^{-1}) were measured. The data were analysed with analysis of variance and means separated with Duncan Multiple Range Test at 5% level of probability. Results indicated that all the NPK15:15:15 fertilizer rates significantly increased the growth and yield of tomato over the control in both locations. Application of 400 kg ha^{-1} significantly produced the tallest plant (66.8 and 91.0 cm), number of leaves (54.3 and 61.8), number of fruits (22.2 and 20.2) and fruit yield (33.1 and 31.7 t ha^{-1}) in Abraka and Asaba, respectively.

Keywords: Abraka; NPK15:15:15; Soil Fertility; Tomato Yield; Variety.

Introduction

Tomato (*Lycopersicum esculentum*) which belongs to Solanaceae family was first domesticated in Mexico (Ara *et al.*, 2007). It is the second most important vegetable after potato and the present world production is about 100 Mt fresh fruit (CBN, 2011). Tomato is a source of vitamins and minerals and contains important acids that help in human health development. It is also used as condiment and processed into purees or pastes used for cooking and production of fruit drinks. These have placed great demand on its cultivation that force its expansion leading to increase in cropping area by 168% while its consumption increased by 314% (CBN, 2011). The market demand for tomatoes as reported by FAO (2012) was put at 584,000 tons per annum with population of about 160 million people.

Decline in soil fertility among other factors is a distinct challenge responsible for the inadequate tomato production in the country. The yield reduction caused by soil fertility declined is a major challenging factor faced by farmers in Nigeria with average tomato yield put at 10 t ha^{-1} compare to average yield of 22 t ha^{-1} in other countries (Ogundare *et al*., 2015).

There is need to increase tomato production to meet the growing tomatoes industries and daily consumption needs of humans in Nigeria. Maintaining soil fertility with appropriate fertilizer application is imperative and a panacea to boast tomato growth and yield. Nutrient use efficient is another major focus in nutrient management. For instance, nitrogen is needed at the vegetative stage while phosphorus and potassium encourages tomato flowering and fruits setting. Therefore, it is necessary to balance and maintain plant nutrient in the soil to a level that will guarantee good growth and optimum yield without being detrimental to the soil (Dantata and Oseni, 2009; Abdulmaliq *et al*., 2019). The soil fertility decline can therefore be corrected with adequate fertilizer usage. It is against this background that the work examines effects of NPK15:15:15 on tomato growth and yield in Asaba and Abraka, Delta State, Nigeria.

Materials and Methods

Description of experimental site

The experiment was conducted at two locations (Asaba and Abraka Campus) in Delta State. Asaba is in rainforest zone with longitude 6^o 14$'$E and latitude 6^o 14$'$N. The region experience rainfall from March to October and dry season between November to February. Average temperature of 29.5^o C and soil order is ultisols classified as typic tropaquult [Egbuchua, 2007]. The location used for the study was cropped to cassava, maize and yam for years without record of fertilizer usage. Abraka is also in a rainforest like Asaba with longitude 6^o 00' E and 6^o 15' E and latitude 5^o 45' N and 5^o 50' N. Rainfall pattern for the two locations were similar with average temperature of 28.1^o C.

Experimental design and cultural practices

Clearing and seed beds preparations were done manually with simple farm tools. Soil samples were collected at 0 – 30 cm depth with soil auger for initial routine soil analysis. Land area measuring 11.4 by 17.4 m was demarcated into four blocks (replicates) that measured 11.4 by 3.6 m per replicate block. Each block was further divided into plots (beds) that measured 2.1 m by 3.6 m and 1 m was left between blocks and plots. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replicates. Plant spacing of 35 by 60 cm was used that gave plant population of 36 stands per bed. The NPK15:15:15 fertilizer obtained from Agricultural Development Programme, Asaba was applied two weeks after transplanting at the rate of: 0 (control), 200, 300 and 400 kg ha^{-1}. Tomato seeds used was Ibadan local, purchase from University of Ibadan, Department of Agronomy. The seeds were nurse for two weeks in nursery bed and the seedlings were transplanted one per hole on 20th of August, 2016 simultaneously in the two locations. Weeding was done as when due and watery between rain events was done to keep the soil moist for normal tomato growth.

Data collection

Data collections on growth parameters were done three weeks after transplanting and subsequently on weekly basis while yield parameters were assessed after harvest. Plant height (cm) was taken by measuring the plant from the base to the highest leaf with a meter rule. Number of leaves was obtained by counting all the visible leaves. Stem girth (cm) was measured with vernier caliper at 5 cm above ground level. Leaf area (cm^2) was measured through graphical methods. Number of fruit was obtained by counting all the visual fruits. Fruit yield was measured by weighing all the harvested fruits. Soil samples were also taken after harvest and the following soil parameters were measured: Soil pH was on a ratio of 1:2 soil/water suspensions (IITA, 1997). Organic carbon was determined using the Walkley and Black (1934) Method. Exchangeable bases (K, Ca. Mg and Na) were extracted by ammonium acetate (Jackson, 1964), Ca and Mg were determined by Atomic Absorption Spectrophotometer while K and Na were read using Flame Photometer. The available P was extracted with Bray-1 extracting solution and reading was done Colormetrically. Total N was determined by the Kjeldhal distillation method (Anderson and Ingram, 1993).

Data analysis

The data were statistically analyzed with Analysis of Variance and Duncan Multiple Range Test was used to separate significance treatment means at 5 % level of probability.

Results

Pre-planting soil analysis

Soil physical and chemical properties before planting are shown in Table 1. The soil texture of Asaba and Abraka were sandy clay loam and sandy loam, respectively. Soil organic matter at Asaba was low but was moderate at Abraka. Total nitrogen was low while available P was moderate in both locations. Exchangeable cations were low for Ca and effective cation exchange capacity was also low since both were less than 10 in the two locations.

Table 1: Physico-chemical properties of pre-planting soils

Parameters	Locations	
	Asaba	Abraka
Particle size (g/kg^{-1})		
Sand	675.00	644.00
Silt	95.00	196.00
Clay	220.00	160.00
Textural class	**Sandy clay loam**	**Sandy loam**
pH(H_2O) 1:2	5.50	5.70
Organic matter (gkg^{-1})	16.0	18.00
Total nitrogen (gkg^{-1})	1.40	1.50
Available P ($mgkg^{-1}$)	12.00	14.00
Exchangeable bases ($cmolkg^{-1}$)		
K	0.50	0.60
Mg	1.50	1.40
Ca	1.40	1.30
Na	0.52	0.50
Exch. Acidity	0.53	0.50
ECEC	4.45	4.30

Plant height

Table 2 shows the effects of NPK15:15:15 rates on plant height and there were significant differences except at 3 weeks after transplanting (WAT) at Asaba. At 3, 4 and 7 WAT, 400kg ha^{-1} of NPK15:15:15 had the highest plant height in both locations. At 5 WAT, 400kg ha^{-1} of NPK15:15:15 had the highest plant height in Abraka while 300kg ha^{-1} of NPK15:15:15 had the highest plant height in Asaba. At 6 WAT, 200 kg ha^{-1} of NPK15:15:15 had the highest plant height in Abraka while 300kg ha^{-1} of NPK15:15:15 had the highest plant height in Asaba.

Number of leaves

At Abraka, leaves were statistically similar at 3 WAT while it was significant at Asaba (Table 3). At 4 WAT, highest number of leaves was observed with application of 400 and 200 kg ha^{-1} of NPK15:15:15 in Abraka and Asaba, respectively. At 4, 5 and 7 WAT, 400 kg ha^{-1} of NPK15:15:15 had the highest number of leaves in the locations.

Leaf area

At Abraka, 300kg ha^{-1} of NPK15:15:15 had the highest leaf area at 3, 4 and 5 WAT while at 6 and 7 WAT, 400kg ha^{-1} of NPK15:15:15 had the highest leaf area (Table 4). In Asaba, 200kg $ha^{-1}$of NPK15:15:15 had the highest leaf area at 3 WAT, 400kg ha^{-1} of NPK15:15:15 had the highest leaf area at 4 WAT, while at 5, 6 and 7 WAT, 300kg $ha^{-1}$of NPK15:15:15 had the highest leaf area.

Stem girth

Table 5 shows the effects of NPK15:15:15 on tomato stem girth and 300kg ha^{-1} of NPK15:15:15 had the highest stem girth at 3 WAT while 400kg ha^{-1} had the highest at 4, 6 and 7 WAT in Abraka. In Asaba, 400kg ha^{-1} rates of NPK15:15:15 had the highest stem girth at 4, 5 and 6 WAT while 200-400kg ha^{-1} had the highest stem girth at 7 WAT.

Table 2: Effects of NPK15:15:15 on tomato plant height (cm) at 3-7 WAT in both locations

Fertilizer rates (kgha^{-1})	Weeks After Transplanting 3	4	5	6	7
		Abraka			
0	14.0b	34.0c	47.1b	52.2b	60.5b
200	16.1a	37.4b	54.7a	62.4a	66.4a
300	16.7a	39.8a	56.4a	61.2a	65.5a
400	16.8a	41.0a	56.5a	60.6a	66.8a
		Asaba			
0	14.5a	31.0c	47.7c	61.3c	68.3d
200	14.6a	33.1b	52.5b	66.0b	78.2c
300	15.6a	36.5a	59.0a	64.2b	84.5b
400	15.8a	36.8a	54.7b	71.5a	91.0a

Treatments within each column with the same letters are not significantly different at P< 0.05 and WAP = Weeks After Transplanting

Table 3: Effects of NPK15:15:15 on tomato number of leaves at 3-7 WAT in both locations

Fertilizer rates (kg ha^{-1})	Weeks After Transplanting 3	4	5	6	7
		Abraka			
0	6.8a	15.3c	28.1d	34.0b	41.3c
200	6.5a	19.2b	33.6c	45.5a	47.2b
300	7.9a	2.4.0a	38.4b	45.4a	48.8b
400	7.4a	24.5a	43.4a	46.1a	54.3a
		Asaba			
0	7.0b	12.8b	24.7c	36.5b	40.8d
200	7.4b	15.2a	28.4b	46.7a	55.3b
300	7.5b	14.3a	32.8a	47.9a	54.8c
400	9.4a	14.8a	35.6a	48.1a	61.8a

Treatments within each column with the same letters are not significantly different at P< 0.05 WAP = Weeks After Transplanting

Table 4: Effects of NPK15:15:15 on tomato leaf area (cm^2) at 3-7 WAT in both locations

Fertilizer rates (kg ha^{-1})	Weeks after transplanting 3	4	5	6	7
		Abraka			
0	93.6c	220.3c	265.4d	278.0d	287.0c
200	94.6c	231.6c	272.5c	312.0c	360.6a
300	141.1a	301.2a	316.8a	316.8b	324.2b
400	118.4b	287.8b	298.2b	333.4a	366.2a
		Asaba			
0	69.0b	122.6b	154.2d	187.0b	222.0c
200	78.9a	169.9a	280.3c	288.1a	301.4b
300	67.8c	171.4a	287.8b	291.0a	327.4a
400	71.7b	172.1a	256.9a	288.7a	325.5a

Treatments within each column with the same letters are not significantly different at P< 0.05 WAP = Weeks After Transplanting

Table 5: Effects of NPK15:15:15 on tomato stem girth (cm) at 3-7 WAT in both locations

Fertilizer rates	Weeks after transplanting				
(kg ha^{-1})	3	4	5	6	7
		Abraka			
0	4.4b	5.5c	6.4c	7.4b	8.6c
200	4.3b	6.1b	7.8b	9.3a	9.8bc
300	5.3a	7.2a	8.3b	9.8a	11.5a
400	4.5b	7.5a	9.1a	10.1a	10.8a
		Asaba			
0	4.3a	6.0b	7.1c	8.2b	8.8b
200	4.4a	6.6ab	8.3b	9.8a	10.4a
300	4.5a	7.2a	8.9a	9.9a	11.0a
400	4.5a	7.4a	9.2a	9.8a	11.8a

Treatments within each column with the same letters are not significantly different at P< 0.05 WAP = Weeks After Transplanting

Yield parameters

Effects of NPK15:15:15 on tomato yield parameters are shown on Table 6. There were significant (P>0.05) differences among the fertilizer treatments in yield parameters. The 400kg ha^{-1} of NPK15:15:15 had the highest number of primary and secondary branches, number of flower, highest number of tomato fruits and highest tomato fruits yield. Plants fertilized with 300 and 400kg ha^{-1} had the highest number of secondary branches. Fruits weight at Abraka was higher than that of Asaba.

Table 6: Effects of NPK15:15:15 on tomato parameters in both locations

Fertilizer rates (Kg ha^{-1})	Number of primary branches	Number of secondary branches	Number of Flowers	Number of Fruits	Tomatoes fruits yield (t ha^{-1})
		Abraka			
0	8.0d	45.2d	12.2d	10.4d	12.8d
200	10.1c	54.4c	18.1c	14.4c	25.3c
300	11.8b	77.4a	21.2b	19.2b	31.0b
400	12.2a	78.5a	25.2a	22.2a	33.1a
		Asaba			
0	7.8c	43.0c	11.1d	9.3d	12.2d
200	9.8b	53.1c	17.8c	13.4c	24.4c
300	11.4b	61.7a	20.2b	17.1b	28.1b
400	12.0a	63.8a	24.6a	20.2a	31.7a

Treatments within each column with the same letters are not significantly different at P< 0.05

Discussion

Analysis of soil before transplanting showed that Asaba and Abraka had sandy loam and loamy sand, respectively. The major plant nutrients were low except available phosphorus that was moderate in both locations. In this type soil with poor fertility cannot be crop without fertilizer application to produce optimum yield, this justifies the need for fertilizer application to enhance tomato growth and yield in the study area. The low nitrogen content cannot support optimum tomato production, this will caused decreased in photosynthesis that will reduce growth of tomato. The soil organic matter, available phosphorus and total nitrogen were less than the critical levels of <20 gkg^{-1}, <15 $mgkg^{-1}$ and <15 gkg^{-1} in both locations, respectively.

Plants growth rate at Abraka was higher at the first three weeks compared to at 6 and 7 weeks. This could be caused by the variation in rainfall, relative humidity and temperature (Nigeria Meteorological Center, Abuja, 2017). Rainfall was higher at Abraka which led to higher soil moisture content that affects both the growth and yield of tomatoes. Increasing the rates of fertilizer corresponds with increase of plant height and this was more evidence in Asaba. The tallest plant recorded could be due to high rate of nutrient released from the fertilizer material (Ogundare *et al*., 2015) that led to increase of vegetative growth. Nitrogen can enhance above ground vegetative growth and increased the growth and development of tomato (Ewulo *et al*., 2015).

The 400kg ha^{-1} of fertilizer produced the highest plant height at 7 WAT in both locations. This may be influenced by the higher nutrient released from the fertilizer material. Growth of crops depends on the amount of nutrients absorbed from the soil (Abdulmaliq *et al*., 2019). The nutrients in the fertilizer are readily available to the plants that accounted for accelerated growth rate observed with application of the inorganic at higher levels in both locations (Seneviratne *et al*., 2000 and Agbede *et al*., 2018). Nutrient content in Abraka soils was higher and this could be responsible to the observed higher growth and yield in Abraka than Asaba. The increased of tomato yield due to increasing rate of fertilizer application was also reported by Ewulo *et al*. (2015) and Isah (2014) that stated that application of inorganic fertilizer increases the growth and yield of tomatoes. Quality of tomato that of crucial importance also be greatly influenced by nutrient status of the soil (Pandey and Chandia, 2014; Babatunde *et al*., 2019). This makes it very necessary to maintain optimum nutrient level in the soil that can sustain tomato production.

Conclusions

The study was carried out in two locations (Abraka and Asaba) to evaluate the influence of NPK 15:15:15 fertilizer rates in the production of tomato (Lycopersicum esculentum L.) in Delta state, Nigeria. The growth and yield of tomato were enhanced with the fertilizer application rates. The 400 kg ha^{-1} produced the highest yields and successfully used to produce tomato in the study area.

References

Abdulmaliq, S.Y., Kumar, N., Bello, O.B. and Nduka, K. I. (2019). Influence of Poultry Manure and NPK Fertilizer as Amendment on the Performance of Tomato (Solanum lycoperscum L. Moench) Varieties at Lapai, Southern Guinea Savannah. Annals of Biotechnology & Bioengineering 1(1): 1003

Agbede, T.M., Adekiya, A.O., Ale, M.O. and Eifediyi, E.K. (2018). Effects of green manures and NPK fertilizer on soil properties, tomato yield and quality in the forest-savanna ecology of Nigeria. Experimental Agriculture 55(5): 793-806

Anderson, J. M. and Ingram, J. S. I. (1993). *Tropical Soil Biology and Fertility*. A hand book of methods 2nd (ed). CAB International Information Press Ltd, Eiynsham, U. K. pp 105.

Ara, N., Bashar, M.K., Begum, S. and Kakan, S. S. (2007). Effects of spacing and stem pruning on the growth and yield of tomato. *International Journal of Sustainable Crop Production*, 2(3): 35-39.

Babatunde, K.M., Shittu, K.A, Adekanmbi, O.A. and Adesina. A. (2019). Effects of Individual and Combined Application of Organic Plus NPK (15:15:15) Fertilizers on the Growth Parameters of Tomato (Lycopersicon esculentum. Mill). Journal of Agriculture and Horticulture Research 2(1): 1- 5

CBN, (2011). Central Bank of Nigeria Statistical bulletin. Ed. By Sani I. Doguwa, volume 22, Statistics Department, PMB 0187, Garki, Abuja.

Dantata, I.J. & Oseni, T.O. (2009). Growth, yield and fruit characteristic of tomato as affected by nitrogen. *Biological and Environmental Sciences Journal for the Tropics*, 6:43-46.

Egbuchua, C. N. (2007). Pedogenetic characterization and fertility evaluation of some wetland soils in Delta State. Ph.D. Thesis, Delta State University, Delta State, 142p.

Ewulo, B.S., Sanni, K.O. and Adesina, J.M. (2015). Response of tomato to different levels of nitrogen and phosphorus fertilizer in South Western Nigeria. *International Journal of Applied and Pure Science and Agriculture*, 1(10): 13-20.

FAO (2012). Food and Agriculture Organization Statistical Databases (FAOSTAT) Agriculture, Fisheries, Forestry, Nutrition. Rome, Italy.

IITA (1997). International Institute of Tropical Agriculture Selected methods for soil and plant analysis. Manual Series No. 7, IITA, Ibadan, 32p.

Isah, A. S. (2014). Productivity of tomato (*lycopersicon lycopersicum*, Karst.) varieties in response to npk fertilizer and green manure rates. Ph.D. dissertation submitted to School of Postgraduate Studies, Ahmadu Bello University, Zaria, Pp191.

Jackson, M.L. (1964). Soil Chemical Analysis. Pergaman Press, New York. 432p.

Ogundare, S.K., Babalola, T.S., Hinmikaiye, A.S. and Oloniruha, J.A. (2015). Growth and fruit yield of tomato as influenced by combined use of organic and inorganic fertilizer in Kabba, Nigeria. *European Journal of Agriculture and Forestry Research*, 3(3):48-56.

Pandey, S.K. and Chandra, K.K. (2013). Impact of integrated nutrient management on tomato yield under farmers field conditions. *Journal of Environmental Biology*, 34: 1047-1051.

Seneviratne, G., Van Holm, L.H.J. and Ekanayake, E.M.H. (2000). Agronomy benefits of rhizobial inoculants use over nitrogen fertilizer application in tropical soybean. *Field Crop Research*, 68: 199-203.

Walkley, A. and Black, C.A. (1934). An examination of the Degtjareff method for determining soil organic matter and a propose modification of chromic acid titration method. *Soil science* 39: 29-38.