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IMPACT OF ORGANIC AND INORGANIC FERTILIZERS ON THE YIELD, LYCOPENE AND SOME MINERALS IN TOMATO (*LYCOPERSICUM ESCULENTUM MILL)* FRUIT.

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ABSTRACT: *Lycopene, an antioxidant contained in tomatoes, which is found to reduce the risk of cancer can be affected by management practices. A field experiment was carried out behind Recreational Centre of Institute of Agricultural Research and Training (I.A.R&T), Moor Plantation, Ibadan (latitude 7º22'N and longitude 3º50'SE). The experiment was done during the rainy season of 2014 between May and July. Effectiveness of organic and inorganic fertilizers in the growth, yield and nutrient composition of tomato were compared in a Randomized Complete Block Design (RCBD) with four treatments which include sole application each of NPK and Organic fertilizer, there complimentary application and the control replicated three times. Tomato premier (variety UC-82-B) was planted at 50 cm × 50 cm at 1 seedling per stand. The Aleshinloye Compost (Grade B) organic fertilizer was applied two weeks before transplanting at 100 kgN/ha at the appropriate plots while NPK 15:15:15 was applied 2 weeks after transplanting at 100kgN/ha. Parameters assessed were plant height (cm), number of leaves, number of branches, stem girth (mm) while the yield parameters observed were days to 50 % flowering, number of flowers/plot, number of flowers aborted, number of rotten fruits/plot, number of fruits/plot and fruit weight (g). Nutrient component determined in the laboratory were lycopene, potassium and sodium. The fertilizer sources did not affect the growth of tomato but were better than the control plots. At 8 weeks after transplanting (8 WAT), NPK 15:15:15 treated plant had more flower abortion of 34.7 than the lowest flower abortion of 24.67 from the control plots. NPK 15:15:15 at 100 kgN/ha gave the highest fruit yield of 18.60 t/ha while the lowest yield (4.07 t/ha) was obtained from the control plots. Highest value of lycopene content of 2.65 % was found in plots supplied with NPK but is comparable with the control plot but higher than other sources. Potassium content of 20.80 % was lowest in NPK plots while potassium accumulation of 23.20% was highest in the control but not different statistically from each other. Sodium content had highest percentage in untreated plot with 0.43 % and sodium ion was lowest in NPK + organic treated plot which have the value of 0.31%.*

KEYWORDS: Tomato, Lycopene, Yield, Fertilizer, Nutrient Composition

INTRODUCTION

Tomato (*Lycopersicon esculentum Mill*) which belongs to the family Solanaceae is one of the three important annual fruit vegetables of the tropical region which originated in South and Central America (Julel, 2001). Tomato is one of the popular and most consumed vegetable in the world. It is tasty and easily digestible and its bright colour stimulates appetite. Like other vegetable, tomato plays a very important role in human diets; because it supplies some of the nutrient deficient in other food materials e.g. tomato fruits are rich in minerals and vitamin (Biwasi, 1999). It is also rich in nutrients and calories. It is a good source of Fe and vitamin A, B and C. Tomatoes have been reported to be an important source of nutrient antioxidant

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such as lycopene and vitamin C in human diet. Lycopene, the most important antioxidant has been linked with reduced of prostrate and other forms of cancer as well as heart diseases (Barber and Bryson, 2006). The antioxidants components of tomatoes have been reported to be influenced by the cultivars, growing conditions and seasons, harvesting stage and ripening on and off-vine (Toor *et al.,* 2005). However, there is limited information on the effects of different forms of fertilizer on the antioxidant component of tomatoes. Because the mineral composition of crops depends on the amount and type of nutrients taken from the growth medium, such as soil, it is necessary that adequate amount of nutrients should be available for the production and nutrient content of tomatoes (Barker and Bryson, 2006). Generally, the production of agricultural crops depends on many factors which can improve the soil fertility and this is through the application of organic and inorganic fertilizers. Organic manure is very important in improving soil productivity and its function is performed through the improvement of the physical condition of the soil structure (Lombin *et al.,* 1991). The various constraints affecting tomato could be averted by the use of appropriate practices such as early sowing, transplanting, mulching, staking, application of fertilizer, pesticides application and other improved crop husbandry practices. Schan (1992) observed that mineral, protein and vitamins content of crops, were improved by soil fertilizer. 99.5percent of fertilizers used in Nigeria were inorganic fertilizers and this has a negative effect on the plant, the soil and even human who consume the produce obtained from inorganic farming (Williams, 2009). Therefore, there is a compelling need to determine the nutritional value ascribable to the consumption of fruit vegetables raised from organic and inorganic fertilizer sources.

i) To evaluate effect of fertilizer source on the growth and yield of tomato.
ii) To evaluate effect of fertilizer source on lycopene and some minerals of tomato

MATERIALS AND METHODS

The field experiment was carried out behind Recreational Centre of the Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan with latitude 7^{o} 22 SN and longitude 3^{o} 50 SE. The experiment was done during the early rainy season of 2014 between May and July. Seedlings of tomato variety (UC-82-B) from IAR&T seed store were raised in the nursery for 5 weeks after which transplanting of the most vigorous seedlings was done to the field already ploughed and harrowed. Plot size was 2 x 1 m, 2 m with 1 m margin between plots and 2 m margin between blocks. Tomato premier (variety UC-82-B) was planted at 50 cm x 50 cm, 1 seedling per stand. The Aleshinloye Compost (Grade B) organic fertilizer was applied (2) two weeks before transplanting at 100 KgN/ha at the appropriate plots. NPK 15:15:15 was applied 2 weeks after transplanting at 100 kgN/ha. The experimental design was Randomized Complete Block Design (RCBD) comprising of 3 fertilizer sources: NPK, Organic, NPK+ Organic and the control plot replicated three times. Collection of data commenced two weeks after transplanting from randomly selected four plants tagged per plot. Growth parameters measured were plant height (cm), number of leaves, number of branches, and stem girth (mm) while the yield parameter include: days to 50 % of flowering, number of fruits/plot, fruits weight (g) plot. Fruit analysis was done in the laboratory to determine the effects of fertilizer source on lycopene, potassium and sodium.

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Determination of Lycopene

0.1 g of tomato sample was weighed and shaken vigorously with 10 ml of acetone hexane (4:6) for 1 minute, then filtered through filter paper and the absorbance of the filtrate at 453, 505, and 645 was read at 663 mm.

Determination of minerals

0.5 g of sample was weighed into a 100 ml digestion tube and 20 ml of concentrated nitric acid was added at a temperature of 135 ^{o}C for 1hr 30 mins. It was filtered into a 25 ml flask and made up to mark with distilled water.

Collected data were analyzed using analysis of variance and the means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION

Physical chemical properties of the soil prior to planting

The soil is loamy sand. The soil is slightly acidic with pH 5.9; it is deficient in organic matter and nitrogen which are the major determinants of soil fertility in tropical soils (Table 1).

Effects of Fertilizer Sources the Growth of Tomato at 7 WAT

It was observed that growth of tomato in terms of number of branches, number of leaves, and plant height were not significantly affected by fertilizer source while growth was significantly hampered in unfertilized plots (Table 2). One of the methods through which plants would display its potential genetic capacity is by supplying the plants with adequate amount and types of fertilizer at the right time (Olaniyi, 2006). Similarity observed in the stem girth of treated and untreated plots may be due to excess N in the soil which could cause nutrient imbalance in the tomato crop and a reduction in the uptake of certain nutrients, which may be responsible for poor response of tomato to fertilizer (Ewulo *et al.*,2008),

Effects of fertilizer sources on number of fruit of tomato

The effect of fertilizer sources on number of fruit showed in Table 3. Except at the first and sixth harvest, treated plots significantly produced more fruits than the untreated plot which is evident in the work of Baker and Taiwo, (2005). The number of fruits per plot was comparable at the onset until second and third harvest where NPK treated plot gave better result than other treatments (Agbede, 2008). Also, the complementary application of fertilizer also gave higher number of fruits per plot at the fourth and sixth harvest periods while the organic fertilizer treated plot gave better result at fifth harvest even though the result is not significantly difference from other treated plots. However, control plot produced the least number of fruit per plot of 141.0 which is significantly lower than treated plots. NPK treated plot gave the highest value of 341.33 which is comparable with other treated plots. These results confirmed the report of Awodun, (2007) that there is a significant influence on the growth and yield of *Telfaria* by application of fertilizers.

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Effect of fertilizer sources on days to 50 % flowering and fruit yield of tomato

The effect of fertilizer source on days to 50 % flowering and fruit yield showed in (Table 4). There was no significant difference in the number of days to 50 % flowering in both the treated plot and the untreated plots, even though flower initiation was fastest under plot treated with NPK fertilizer at 80 days while it was mostly delayed in organic treated plot till 90 days which may be due to slow release of nutrient (Agboola and Odeyemi, 2009). There was no significant difference in fruit yield of tomato between the treated and untreated plot until fifth harvest period. Except at second and sixth harvest, NPK treated plots produced higher yield of tomato than other treated plots even though the results is comparable. Meanwhile, at sixth harvest, complementary application of fertilizer gave higher fruit yield which is not significantly difference from other treated plots. Organic manure alone or in combination with mineral fertilizer exerts more beneficial effect on fruit yield when compared to fertilizer applied alone (Ehigiator, 1998). Fruit yield was best enhanced by application of NPK to the tune of 18.60 t/ha which is comparable with other treated plots while the least productivity was from the control plot of 4.07 t/ha.

Effects of fertilizer sources on lycopene content of tomato fruits

It was observed that the highest value of lycopene content of 2.65 % was found in plots supplied with NPK but is similar with the control plot but significantly higher than the lowest value of 0.42% from organic fertilizer source probably due to poor mineralization as a result of high C/N ratio (Figure 1). Conversely, organic fertilizer application influenced availability of lycopene in tomato more than inorganic fertilizer (Adeniyi and Ademoyegun, 2012). However, Babalola, (2006), stated that, lycopene content in tomato varies with cultivar, geographical location, system of cultivation like nutrient source, climatic conditions and degree of ripeness of tomato fruits. Toor *et al.* (2006) observed that excess potassium content on chemically fertilized soil may decrease antioxidant content in vegetables, which may be responsible for the poor performance of the inorganic constituent.

Effects of fertilizer sources on potassium (K) content of Tomato fruits

It was observed that potassium content had the least percentage in NPK plots of 20.80 % while potassium accumulation was highest in the control and organic fertilizer plots but they are not difference statistically from organic + NPK plots (Figure 2). Fertilizer application generally improved the concentration of potassium content of tomato which is important in enhancing fruit color, quality and reduce incidence of diseases (Hartz *et al.*, 2005). Similarly, according to Adekiya and. Agbede, (2009) all levels of poultry manure alone and NPK fertilizer + poultry manure increased leaf N, P, K, Ca and Mg amounts significantly, the concentration of nutrients increased with the amount of poultry manure up to 40 t ha NPK fertilizer + poultry manure gave higher leaf N, P and K contents than poultry manure alone.

Effects of fertilizer sources on sodium (Na) content of tomato fruits

The effects of fertilizer sources on sodium content of tomato shown in Figure 3. It was observed that sodium content had highest percentage in untreated plot with 0.43 %. The quantity of sodium ion was lowest in NPK + organic treated plot which have the value of 0.30%. Fertilizer application can improve the mineral content of the tomato which is evident in the work of Schan, (1992) who observed that mineral content of crops, were improved by soil fertilizer.

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CONCLUSION

Based on the findings of this study, growth of tomato was similar under different fertilizer sources but was significantly higher than the unfertilized plots. NPK 15:15:15 treated plants flowered earlier than the other treatments which might be responsible for earlier fruiting and productivity of the crop as it gave the highest fruit yield, even if it is not significantly different from other sources. Application of NPK 15:15:15 fertilizer to the soil improved nutrient availability to the crop and enhance good growth and yield of the crop. Lycopene secretion was enhanced best with the NPK 15:15:15 fertilizer. Potassium content was lowest in NPK plots while potassium accumulation was highest in the control but not different statistically from each other. Sodium content had highest percentage in untreated plot and sodium ion was lowest in NPK + organic treated plot.

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APENDIX

Table 1: Pre-planting size and chemical soil analysis

Soil properties	Value
pH	5.9
Total Nitrogen (g/kg)	0.9
Available phosphorus (mg/kg)	5
Organic carbon (g/kg)	8.6
Exchangeable bases (cmol/kg)	
Ca^{2+}	2.2
Mg^{2+}	0.8
K^{+}	0.3
Na^{+}	0.4
Exchangeable acidity (H^{+}) cmol/kg	0.1
ECEC (cmol/kg)	3.8
Particle size analysis (g/kg)	
Sand	820
Silt	76
Clay	104
Textural class	Loamy sand

Table 2: Effects of fertilizer sources on the growth of tomato at 7 weeks after transplanting

Treatment	No. of Branches	No of leaves	Plant height (cm)	Stem diameter (mm)
Control	15.67b	36.75b	21.13b	8.18
NPK	25.75a	60.42a	34.54 a	11.01
Organic	24.58a	63.58a	39.96a	12.39
NPK + Organic	22.50a	85.42a	39.27a	9.93
				Ns

ns = Not significant; Values followed by the same letter in a column are not significantly different, 5% level, Duncan's

Multiple Range Test.

Table 3: Effects of fertilizer sources on number of fruits / plot of tomato

Treatment	HARVESTING						Cumulative number of fruits /plot
	1st	2nd	3rd	4th	5th	6th	
Control	23.33	48.00c	40.00b	10.00b	8.67b	11.00b	141.00b
NPK	33.67	118.33a	106.67a	30.00a	28.00a	24.67ab	341.33a
Organic	25.33	85.00b	85.33a	31.33a	30.67a	27.00a	284.67a
NPK + Organic	23.00	98.67ab	95.67a	36.33a	28.00a	38.67a	320.33a

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					ns			

ns: not significant; Values followed by the same letter in a column are not significantly different, 5% level, Duncan's

Multiple Range Test.

Table 4: Effect of Fertilizer Source on day to 50 % flowering and fruit yield of tomato (g/plot)

Treatment	Days to 50 % flowering	1st	2nd	3rd	4th	5th	6th	Cumulative fruit yield (t/ha)
Control	86.00	77.69	348.89	227.28	64.91b	27.22c	68.76b	4.07b
NPK	80.00	348.87	224.15	963.65	689.59a	691.45a	801.98a	18.60a
Organic	90.33	219.27	160.33	734.92	503.97a	514.98b	743.31a	14.40a
NPK + Organic	85.00	324.37	199.00	610.11	558.58a	505.60b	939.37a	15.80a

ns: not significant

means with the same letter in a column are not significantly different according to DMRT.

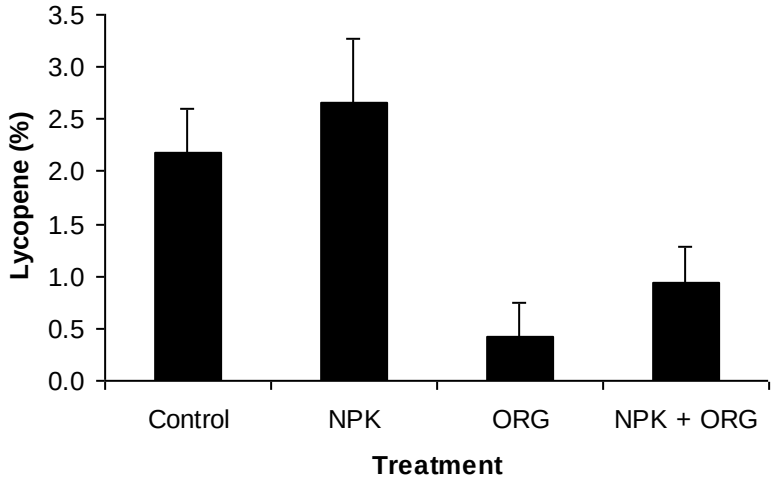

Fig 1: Effect of fertilizer sources on lycopene of tomato fruits
NPK= 15:15:15
ORG= Organic fertilizer
NPK+ORG= NPK 15:15:15 + Organic fertilizer

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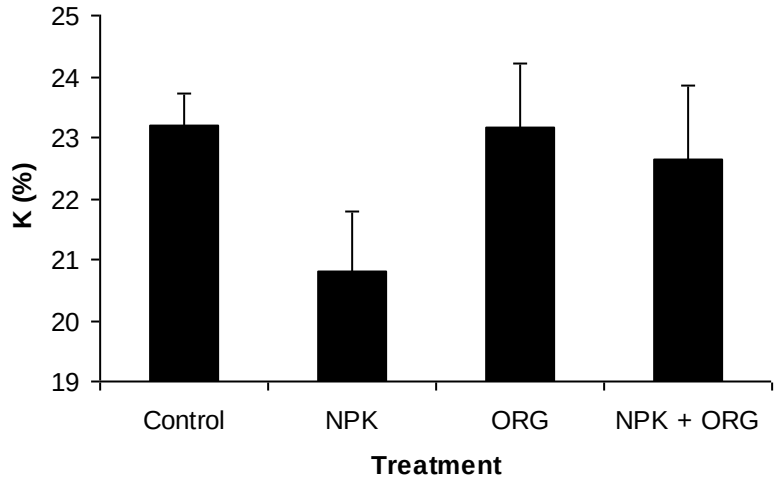

Fig 2: Effect of fertilizer sources on potassium content of tomato fruits
NPK= 15:15:15
ORG= Organic fertilizer
NPK+ORG= NPK 15:15:15 + Organic fertilizer

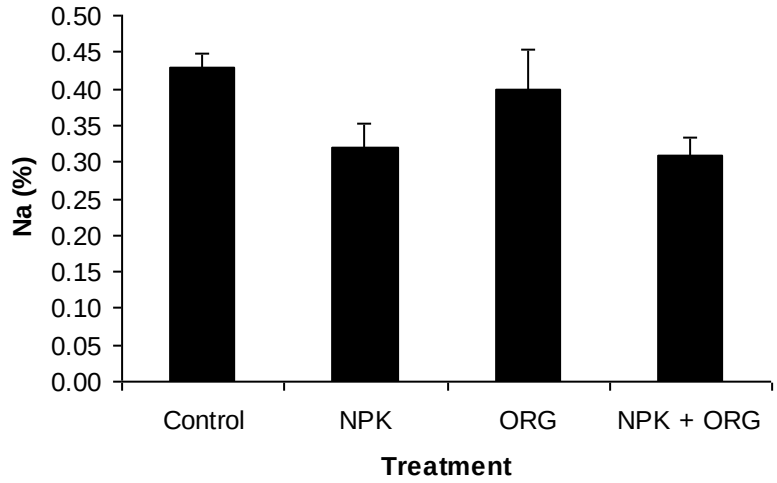

Fig 3: Effects of fertilizer sources on sodium content of Tomato fruits
NPK= 15:15:15
ORG= Organic fertilizer
NPK+ORG= NPK 15:15:15 + Organic fertilizer

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