INFLUENCE OF DIFFERENT NUTRIENT SOURCES ON GROWTH AND YIELD OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) IN MINNA, NIGERIA

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Abstract
A field trial was conducted at the Teaching and Research Farm of the Federal University of Technology, Gidan Kwanu, Minna, which is located in the Southern Guinea Savanna ecological zone of Nigeria, during the 2018 and 2019 cropping seasons. The experiment was a factorial laid out in a Randomized Complete Block Design, and replicated three times. The treatments consisted of three tomato genotypes (UC 82 B, Roma savannah and Dan Zaria), and five different nutrient sources (nutrient of interest was nitrogen at the rate of 92 kg N ha^{-} which was obtained from each of the sources; inorganic fertilize (Urea), (cow dung, poultry dropping and Bio-organic) no nutrient was applied on the control, each plot was measured 3×4 m (12m^2) comprising of five ridges. Parameters measured include plant height, number of leaves, stem girth, and number of productive branches at first flower but sight, opening, 50% flowering and at maturity. Fruit diameter was also determined by measuring the fruit with the use of a caliper and Fruit length was determined by using a meter rule at harvest. The data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2 at 5% level of probability and means were separated using Duncan Multiple Range Tests (DMRT). Results were presented in tables and the application of 92 kg N ha^{-1} from poultry manure gave better fruit yield of tomato. The genotype UC82B recorded higher number of plant branches at maturity, number of fresh fruits per plant, weight of fresh fruit per plant, fresh fruit diameter and fruit yield. With the result of this study, we therefore recommend tomato farmers in the zone to apply 92 kg N/ha from poultry manure.

Key words: Tomato, nutrient and growth

Introduction
Leafy and fruit vegetables are sources of income to the resource-poor farmers in many African countries, with their popularity and local demand largely unsatisfied due to campaigns on the medicinal and nutritional values (Nchore *et al*., 2012). They have nutritional and medicinal properties; they are rich in proteins, vitamins, carbohydrates and other mineral elements (Manoko and Van der Weerden, 2004). Vegetables are important components of any healthy diet, and their sufficient daily consumption could help prevent major diseases (WHO, 2003) and have nutritional balance (Adebooye and Opabode, 2004). Amujoyegbe *et al*. (2007) observed that the genetic diversity of vegetable crops in Africa generally, and particularly in Nigeria, has for a long time been preserved by the traditional cropping systems. However, in the recent times, there has been rapid deterioration of natural resources (Shebu and Sewuese, 2014), resulting in the loss of genetic diversity due to pressure on land, as a result of human activities for industrialization and urbanization.

In 2010, Nigeria was ranked the 13th largest producer of tomato throughout the globe and the highest producer of tomato in Africa (FAO, 2010). In spite of the fact that tomato has gained prominence in every Nigerian home, Nigeria imports a total of 105,000 metric tons of tomato paste, which is valued at N16 billion, in order to bridge the deficit gap between supply and demand in the country.

Tomato is an important condiment in most diets. It is a cheap source of vitamins and contains a large quantity of water, calcium and niacin; all of which are of great importance in the metabolic activities of man. Also, tomato is a good source of vitamins A, C, E and minerals which protect the body against disease (Amujoyegbe *et al.*, 2007).

In Niger state, tomato cultivation is generally at a very low scale because the cultivation is mainly carried out by smallholder farmers and the tomatoes grown are not enough for consumption compared to other neighboring states. Today, majority of the tomato in the open market are produced in Northern states like Kano, Sokoto, Zamfara, Kaduna, Katsina etc. While the yield of tomato production in Nigeria was estimated at 1,860,600 tonnes in 2010, China had an estimate for that same year as 12,858,700 tonnes for the same year (FAO, 2010). In addition, the yield per hectare in Nigeria was estimated at 1/7t ha^{-1} compared to China (FAO, 2010).

Soil fertility is a major overriding constraint that affects all aspects of crop production including tomato (Mbah, 2006). In the past years, inorganic fertilizer was advocated for crop production to ameliorate low inherent fertility of soils in the tropics. In addition to being expensive and scarce, the use of inorganic fertilizer has not been helpful in intensive agriculture because it is often associated with reduced crop yield, soil acidity and nutrient imbalance (Ojeniyi, 2000; Ano and Agwu, 2005; Agbede *et al.*, 2008). In order to increase tomato production in Nigeria, the problem of soil fertility needs to be addressed. Kolodziej (2006) reported that soil fertility is one of the main factors affecting the yield of crops and also noted that three major nutritional elements known to be deficient in most tropical soils due to intense pressure on land as a result of continuous cropping were nitrogen, phosphorus and potassium. However, the performance of tomato varieties well adapted to the Northern Nigeria in terms of morphology and fruit yield has not been adequately examined and established. Hence, the urgent need to boost tomato production in the Northern Nigeria to avoid food scarcity in the nearest future and to identify cultivars that can perform optimally in the Minna agro-ecology zone for record purpose and local farmers to adopt for optimum yield and food security.

Cultural procedures related to the development of tomatoes have been explored, but the findings are not always conclusive. The condition is worse in developing nations such as Nigeria, where there are inadequate data on the application of organic fertilizer to the production of tomatoes. For this reason, more data on agronomic and environmental variables influencing tomatoes' production must be concentrated.

Presently, no information is available on the best nutrient source with which the fruits of tomato (***Lycopersicon esculentum)*** could attain optimum growth and yield, and no attempt has been made to explore the nutrition of the mother plants. Therefore, the aim of this study is to determine the effects of different nutrient sources on growth characteristics and yield of Tomato in Minna.

Materials and Methods

Experimental site

A field study was conducted at the Teaching and Research Farm of the Federal University of Technology, Gidan Kwano (latitude 09° 31'N, longitude 06° 27'E, 212 m above sea level) during the rainy seasons (May – October) of 2018 and 2019. The experimental site is located in the Southern Guinea savanna of Niger State, Nigeria.

Experimental treatments and design

Three maize genotypes (UC82B, Roma Savanna and Dan Zaria) were evaluated. The treatments were a factorial combination of variety (UC82B, Roma Savanna and Dan Zaria) and nutrient sources [Five nutrient sources, (nutrient of interest was nitrogen at the rate of 92 kg N/ha which was obtained from each of the sources ; inorganic fertilizer, Cow dung, Poultry dropping and Bio-organic kg ha^{-1}) no nutrient was applied on the control plots laid out in Randomized Complete Block Design (RCBD) with three replications and sowing dates: (1st June) and (15th June) 2018 and 2019 respectively. The targeted P_20_5 and K_20 for all the plots was 45 kg/ha. The organic nutrients were incorporated on the plots concerned two weeks prior to transplanting for the purpose of curing while the inorganic nitrogen was applied to plants on the plots concerned two weeks after transplanting. For the inorganic nitrogen treatment, the nitrogen application was split, and the first dose was achieved by applying 100 kg N ha^{-1} using Urea (46% N) supplied at 46 kg N ha^{-1} and the second dose was achieved by applying another 100 kg Urea (46% N) to supply the balance of 46 kg N ha^{-1} at 50% flowering making the total N application to 92 kg N ha^{-1}. Planting dates were determined based on the establishment of rainfall in the experimental area. Main plot treatments were genotypes while different nutrient sources are the sub plots. Seeds of (UC 82 B, Roma Savannah and Dan Zaria) genotypes of tomato were sourced from the National Horticultural Research Institute (NIHORT) Ibadan, Oyo State and peasant farmers around Gidan Kwano, Minna and raised for four weeks and then mass transplanted on a manually prepared wet ridges at a depth of 5cm and spaced 50cm between plants on the same ridges and 75cm between plants on different ridges measuring 3×4 m (12m^2) comprising of five ridges.

Cultural practices

Before planting, the land was manually cleared and ridged with a handheld hoe at 75 cm apart. Each Tomato genotype seedling was planted one per stand on ridges at an intra-row spacing of 50 cm. Weed management was done as per the treatment combinations of the study. Fertilizer Nitrogen was applied at the rate of 92 kg Urea.

Data collection

The parameters measured include plant height (tape rule), number of leaves (count) and stem girth (vennier caliper). They were measured from the base of the plant to the tip of the last leaf, using a meter rule at first flower bud sight, first flower opening, 50% flowering and at maturity. Leaf area was determined by measuring the length of the mid-rib of the leaves and the breath using a meter rule at first flower bud sight, first flower opening, 50% flowering and at maturity. The number of productive branches at maturity was recorded by counting the number of branches that produced fruit from the plant at maturity. Flower abortion incidence at maturity was recorded by counting the number of flowers that fall after formation (opening). Furthermore, fruit diameter was determined by measuring the fruit with the use of a caliper, and the fruit length was determined using a meter rule at harvest. The number of seeds and weight of seed was also determined, together with the seed moisture content per each position after harvest.

Data analysis

Data collected was subjected to analysis of variance (ANOVA) using statistical Analysis System (SAS, 2002) version 9.2 and where significant differences among the treatments occurred, means were separated using the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Steel and Torrie, 1987).

Results

Plant height

The effects of fertilizer sources in the plant height at first flower bud sight of the three tomato genotypes in 2018 and 2019 are shown in Table 1. Plant height at first flower bud sight was significantly different among the tomato genotypes in 2019 only.

The genotypes UC82B and Roma Savanna produced statistically similar taller plants than Dan Zaria variety, which recorded the shortest plants in this study.

Fertilizer sources significantly affected plant height at first flower bud sight in 2018 only. The application of poultry manure recorded taller plant than the other fertilizer sources application compared to the control which recorded the shortest plants.

The effects of fertilizer source on the plant height at first flower bud opening of the three tomato genotypes in 2018 and 2019 are shown in Table 1. Plant height at first flower bud opening was significantly different among the tomato varieties in 2019 only. The genotypes UC82B and Roma Savanna recorded statistically similar taller plants than Dan Zaria which recorded the shortest plants. Fertilizer sources had a significant effect on plant height at first flower bud opening in 2018 only. The application of poultry manure recorded taller plants than the other fertilizer sources which recorded similar plant height compared to the control which recorded the shortest plants. The effect of fertilizer sources on the plant height at days to 50% flowering of the three tomato genotypes in 2018 and 2019 are shown in Table 1. Plant height at days to 50% flowering differed significantly among the three tomato genotypes in 2019 only. The genotypes UC82B and Roma Savanna recorded statistically similar taller plant than Dan Zaria genotype which recorded the shortest plants. Fertilizer sources had a significant effect on plant height at days to 50% flowering in 2018 only. The application of poultry manure recorded taller plants than the other fertilizer sources compared to the application of cow dung and the control which recorded statistically similar shorter plants in this study. The effect of fertilizer sources on plant height at maturity of the three tomato genotypes in 2018 and 2019 are shown in Table 2. Plant height at maturity was significantly different among the tomato genotypes in both years respectively. In 2018, the varieties, Roma Savanna and Dan Zaria, recorded statistically similar taller plants than UC82B which recorded the shortest plants. In 2019, the genotypes UC82B and Roma Savanna recorded statistically similar taller plants than Dan Zaria which recorded the shortest plants. Fertilizer sources had a significant effect in plant height at maturity in 2018 only. The application of poultry manure recorded taller plants than the other fertilizer sources compared to the control which recorded the shortest plants in this study.

Number of Leaves

The effects of fertilizer sources on the number of leaves at first flower bud sight of the three tomato genotypes in 2018 and 2019 are shown in Table 2. Number of leaves differed significantly among the three tomato genotypes in 2018 and 2019 respectively. In 2018, UC82B recorded higher number of leaves at first flower bud sight than Roma Savanna and Dan Zaria which recorded statistically similar lower number of leaves. In 2019, the genotypes UC82B and Roma Savanna recorded statistically similar higher number of leaves at first flower bud sight than Dan Zaria which recorded the lowest number of leaves at first flower bud sight.

Fertilizer sources had a significant effect on numbers of leaves at first flower bud sight in 2018 and 2019 respectively. In 2018, the application of poultry manure recorded higher number of leaves at first flower bud sight than the other fertilizer sources compared to the control which recorded the lowest number of leaves at first flower bud sight than the other fertilizer sources compared to the control which recorded the lowest number of leaves at first flower bud sight. In 2019, the application of nitrogen and poultry manure recorded statistically similar higher number of leaves at first flower bud sight than the other fertilizer sources compared to the control which recorded the lowest number of leaves at first flower bud sight similar with cow dung.

In 2019, the application of poultry manure recorded the highest number of leaves at first flower bud opening than all other fertilizer sources' component with the control which recorded the lowest number of leaves at first flower bud opening statistical similar with the application of Bio-fertilizer and cow dung.

The interaction effects between genotype and fertilizer sources in number of leaves at first flower bud opening in 2019 are shown in Table 3. The combination of UC82B genotype and application of poultry manure recorded higher number of leaves at first flower bud opening though statistically similar with the combination of Roma savanna and application of poultry manure compared with the combination of Dan Zaria and the control which recorded the lowest number of leaves at first flower bud opening though statistically similar with the combination of Dan Zaria and application of cow dung.

In 2019, the application of poultry manure recorded the highest number of leaves at days to 50% flowering than the other fertilizer sources compared to the control which recorded the lowest number of leaves though statistically similar with the application of bio-fertilizer and cow dung.
The interaction effects between genotype and fertilizer sources on number of leaves at days to 50% flowering in 2019 are shown in Table 3.

The combination of UC82B and application of poultry manure recorded the highest number of leaves at some days to 50% flowering than all the other combinations though statistically similar with the combination of Roma savanna and the application of poultry manure compared to the combination of Dan Zaria and the control which recorded the lowest number of leaves at days to

Table 1: Effect of fertilizer sources on plant height at first flower bud sight, plant height at first flower bud opening, plant height at 50% flowering and plant height at maturity of three tomato genotypes in 2018 and 2019

	PHFFBS		**PHFFBO**		**PH50%F**		**PH at M**	
	2018	**2019**	**2018**	**2018**	**2019**	**2019**	**2018**	**2019**
Genotypes								
UC 82B	80.29a	47.61a	76.26a	52.61a	89.15a	63.61a	110.25b	85.61a
Rama savanna	79.52a	46.11a	80.25a	51.11a	90.61a	62.11a	120.39a	84.11a
Dam Zaria	75.19a	42.88b	73.85a	47.88b	84.38a	58.88b	117.62a	80.88b
SEI±	2.13	0.98	2.81	0.98	2.41	0.98	2.20	0.98
Fertilizer source(F)								
NPK	80.27b	45.87a	86.28b	50.87a	95.736	61.87a	125.096	83.87a
BIO	80.48b	46.73a	76.63bc	51.73a	83.59c	62.73a	116.60c	84.73a
Poultry	97.79a	47.36a	100.70a	52.36a	115.30a	63.36a	137.16a	85.36a
Cow dung	79.26b	43.56a	67.17c	48.56a	74.44d	59.56a	107.42d	81.56a
Control	54.72c	44.17a	53.17d	49.17a	71.17d	60.17a	94.17c	82.87a
SEI±	2.75	1.26	3.62	1.26	3.11	1.26	2.84	1.26
Interaction								
G x F	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% probability level. NPK= nitrogen phosphorus and potassium, G= genotypes, F= fertilizer, NS= Not significant

50% flowering though statistically similar with the combination of Dan Zaria and the application of cow dung.

The effect of fertilizer sources on number of leaves at maturity of some tomato genotypes in 2018 and 2019 are shown in Table 2. The number of leaves at maturity was significantly different among the genotypes UC82B and Roma Savanna produced statistically similar higher number of leaves at maturity than Dan Zaria genotype which recorded the lowest number of leaves at maturity.

Fertilizer sources had significant effects on the number of leaves at maturity across the years. In 2018, the application of poultry manure recorded the highest number of leaves at maturity than the other fertilizer sources compared to the control which recorded the lowest number of leaves at maturity. In 2019, the application of poultry manure recorded the highest number of leaves at maturity than the other fertilizer sources compared to the control which recorded the lowest number of leaves at maturity though statistically similar with the application of bio-fertilizer and cow dung.

The interaction effects between genotype and fertilizer sources in number of leaves at maturity in 2019 are shown in Table 3. The combination of UC82B and the application of poultry manure recorded higher number of leaves at maturity than all the other combinations though statistically similar with the combination of Roma Savanna and the application of poultry manure compared with the combination of Dan Zaria and the control which recorded the lowest number of leaves at maturity.

Stem girth

The effects of fertilizer sources on the stem girth at first flower bud sight of some tomato genotypes in 2018 and 2019 are shown in Table 4. Stem girth at first flower bud sight was not significantly different among the three tomato varieties in 2018 and 2019 respectively. The application of nitrogen and bio-fertilizer recorded significantly bigger stems though statistically similar with the application of poultry manure and cow dung than the control which recorded the smallest stems at first flower bud sight.

The effects of fertilizer sources on the stem girth at first flower bud opening of the three tomato genotypes in 2018 and 2019 are shown in Table 4.

Fertilizer sources had a significant effect on stem girth at first flower bud sight in 2018 only. The application of nitrogen and bio-fertilizer recorded statistically similar wider stems though statistically similar with the application of poultry manure and cow dung than the control which recorded the smallest stems at first flower bud sight.

The effects of fertilizer sources on the stem girth at first flower bud sight of the three tomato genotypes are shown in Table 4. Stem girth at first flower bud sight was not differing significantly among the tomato genotypes across the years. Fertilizer sources had a significant effect on stem girth at first flower bud sight in 2018 and 2019 respectively. The application of nitrogen and bio-fertilizer recorded significantly bigger stems though statistically similar with the application of poultry manure and cow dung than the control which recorded the smallest stems at first flower bud sight.

The effects of fertilizer sources on stem girth at first flower bud sight of the three tomato genotypes in 2018 and 2019 are shown in Table 4. Stem girth at first flower bud opening did not differ significantly among the three tomato genotypes in both years of the study.

Fertilizer sources had a significant effect on the stem girth at first flower bud opening in 2018 and 2019 respectively. The application of nitrogen and bio-fertilizer recorded significantly similar wider stems though statistically similar with the application of poultry manure and cow dung than the control which recorded the smallest stems at some days to 50% flowering in this study.

Number of Productive Branches

The effects of fertilizer sources on the number of productive branches at maturity of three tomato genotypes in 2018 and 2019 are show in Table 5. The number of plant branch at maturity differed significantly among the three tomato varieties in 2018 and 2019 respectively. The use of UC82B genotype recorded higher number of plant branches at maturity, though statistically similar with Dan Zaria than Roma Savanna which recorded the lowest number of plant branches at maturity in both years.

Fertilizer sources had a significant effect on number of plant branches at maturity across the years. The application of nitrogen fertilizer recorded the highest number of branches at maturity than the other fertilizer sources compared to the application of cow dung which recorded the lowest number of plant branches at maturity, though statistically similar with the application of bio-fertilizer and the control in 2018 and 2019 respectively.

Number of fresh fruits per plant

The effects of fertilizer sources on the number of fresh fruits per plant of the three tomato genotypes in 2018 and 2019 are shown in Table 5. The number of fresh fruits per plant differed significantly

Table 2: Effect of fertilizer sources on number of leaves of first flower bud sight, number of leaves at first flower bud opening, number of leaves at 50% flowering and number of leaves at maturity of three tomato genotypes in 2018 and 2019

	NLFFBS		NLFFBO		NL50%F		NL at M	
	2018	2019	2018	2018	2019	2019	2018	2019
Genotypes								
UC 82B	113.0a	77.0a	113.0ab	82.0a	130.0a	93.0a	166.0a	128.09
Rama savanna	104.ab	75/0a	115.0a	80.0a	127.0a	91.0a	166.0a	126.0a
Dam Zaria	96.0b	67.0b	107.0b	72.ab	152.0a	83.0b	158.0b	118.0b
SEI±	2.75	1.48	2.47	1.50	2.64	1.50	2.55	1.50
Fertilizer source(F)								
Nitrogen	117.0b	74.0a	126.0b	79.0b	145.0b	90.0b	178.0b	125.0b
BIO	105.0c	73.0abc	109.0c	78.0bc	131.0c	39.abc	165.0c	124.0bc
Poultry	130.0a	79.0a	144.0a	86.0a	157.0a	97.0a	190.0a	132.0a
Cow dung	97.ac	70.0bc	102.0c	75.0bc	120.0d	86.0bc	155.0d	121.0bc
Control	73.0d	68.0c	78.0d	72.0oc	95.0c	83.0c	130.0c	113.0c
SEI±	3.55	1.91	3.19	1.93	3.41	1.93	3.30	1.93
Interaction								
G x F	NS	**	NS	**	NS	**	NS	**

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% probability level. NLFFBS: Number of first flower bud sight. Opening, 50% flowering and at maturity.

Table 3: Interaction effects between genotypes and fertilizer sources on Number of leaves at first flower bud sight, Number of leaves at first flower bud opening, Number of leaves at 50% flowering and Number of leaves at maturity in 2019

	Fertilizer Sources				
	Nitrogen	BIO	Poultry	Cow dung	Control
Genotypes		**NLFFBS**			
UC 82B	67.0a	81.0b	86.0a	78.0bc	74.0def
Rama savanna	75.0cdc	75.0cde	79.obc	71.0cfg	72.0efg
Dam Zaria	81.0b	64.0g	71.0efg	60.0h	58.01
SE± 3.31					
NLFFBO					
UC 82B	74.0cf	85.0bc	92.0a	84.0cd	80.0
Rama savanna	79.0dc	79.0de	89.0ab	76.0c	76.0e
Dam Zaria	86.0bc	69.0g	79.0de	65.0gh	68.0h
SE± 3.35					
NL50%F	85.0fg	92.0cde	103.0a	95.0cd	89.0e
UC 82B	90.0de	90.cde	100.0ab	87.0ef	87.0ef
Rama savanna	97.0bc	80.0gh	90.0de	76.0hi	74.0a
Dam Zaria					
SE± 3.35					
NLatM					
UC82B	120.0fg	131.0bc	138.0a	130.0cd	124.0cf
Rama savanna	125.0e	125.0de	135.0ab	122.0ef	122.0ef
Dam Zaria	132.0bc	115.0gh	125.0de	111.0fg	109.oi
SE± 3.35					

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% probability level. NLFFBS: Number of first flower bud sight. Opening, 50% flowering and at maturity.

Table 4: Effect of fertilizer sources on stem girth at first flower bud sight, stem girth at first flower bud opening, stem girth at 50% flowering and stem girth at maturity of three tomato genotypes in 2018 and 2019

	SGFFBS		SGFFBO		SG50%F		SGM	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
Genotypes								
UC 82B	0.59a	0.56a	0.89a	0.69a	092a	0.89a	1.52a	1.19a
Rama savanna	0.59a	0.57a	0.89a	0.69a	0.92a	0.89a	1.52a	1.99a
Dam Zaria	0.63a	0.54a	0.93a	0.73a	0.96a	0.93a	1.56a	1.23a
SE±	0.64	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fertilizer source(F)								
Nitrogen	0.68a	0.58a	0.98a	0.78a	1.01a	0.98a	1.61a	1.28a
BIO	0.68a	0.63a	0.99a	0.79a	1.02a	0.99a	1.62a	1.29a
Poultry	0.57ab	0.52a	0.87ab	0.67ab	0.90ab	0.87ab	1.50ab	1.17ab
Cow dung	0.59ab	0.53a	0.89ab	0.69ab	0.92ab	0.89ab	1.52ab	1.19ab
Control	0.49b	0.46a	0.79b	0.59ab	0.82b	0.79a	1.42b	1.09b
SE±	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Interaction: G x F								
	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% probability level. Stem girth at first flower bud sight, opening, 50% flowering and at maturity.

among the three tomato genotypes in 2018 only. The genotypes UC82B and Dan Zaria recorded significantly similar higher number of fresh fruits per plant than Roma Savanna genotype which recorded the lowest number of fresh fruits per plant.

Fertilizer sources affected the number of fresh fruits per plant significantly in 2018 only. The application of poultry manure recorded significantly higher number of fresh fruits per plant than the application of nitrogen, Bio-fertilizer and cow dung compared to the control which recorded the lowest number of fresh fruits per plant in this study.

The interaction effects between genotypes and fertilizer sources on the number of fresh fruits per plant in 2018 are shown in (Table 6). The combination of Dan Zaria and the application of poultry manure recorded the highest number of fresh fruits per plant than all the other combinations compared to the combinations of Dan Zaria and the control which recorded the lowest number of fresh fruits per plant in this study.

Weight of fresh fruits per plant

The effects of fertilizer sources on the weight of fresh fruits per plant of the three tomato genotypes in 2018 and 2019 are shown in Table 5. The weight of fresh fruits per plant was significantly different among the three tomato genotypes in 2018 and 2019 respectively. In 2018, the genotype UC82B recorded heavier fresh fruits per plant than Roma Savanna which recorded higher fresh fruits per plant. In 2019, genotypes UC82B and Dan Zaria significantly recorded statistically similar however fresh fruits per plant than Roma Savanna variety which recorded the lightest fresh fruits per plant in this study.

Fertilizer sources had a significant effect on weight of fresh fruits per plants in 2018 and 2019 respectively. In 2018, the application of poultry manure recorded heavier fresh fruits per plant than the other fertilizer sources compared to the application of cow dung which recorded lighter fresh fruits per plant. In 2019, the application of poultry manure recorded heavier fruit per plant statistically similar with the application of bio-fertilizer compared to the application of nitrogen, cow dung and the control which produced statistically similar lighter fresh fruits per plant in this study.

The interaction effects between genotypes and fertilizer sources on the weight of fresh fruits per plant in 2018 are shown in Table 6. The combination of Dan Zaria and the application of poultry manure recorded heavier fresh fruits per plant than all the other combinations compared to the combinations of Roma savanna with the application of bio-fertilizer and cow dung which recorded similar lighter fresh fruits per plant in this study.

Fresh fruit diameter

The effects of fertilizer sources on the fresh fruits' diameter of the three tomato genotypes in 2018 and 2019 are shown in Table 7. Fresh fruit diameter differed significantly among the tomato genotypes in 2018 and 2019 respectively. In 2018, the genotype UC82B recorded wider fresh fruits than Roma Savanna and Dan Zaria which recorded similar smaller fresh fruits. In 2019, Roma Savanna genotype recorded bigger fresh fruits statistically similar with UC82B than Dan Zaria which recorded the smallest fresh fruits.

Fertilizer sources had a significant effect on fresh fruit diameter in 2018 and 2019 respectively. The application of nitrogen and poultry manure recorded similar bigger fresh fruits though statistically similar with the application of bio-fertilizer than the application of cow dung and the control which recorded similar smaller fresh fruits. In 2019, the application of nitrogen and poultry manure recorded significantly similar wider fresh fruits though statistically similar with the application of bio-fertilization and cow dung than the control which recorded the smallest fresh fruits in this study.

Fresh Fruits Length
The effects of fertilizer sources on the fresh fruits' length of three tomato genotypes in 2018 and 2019 are shown in Table 7 below. Fresh fruit length was significantly different among the three tomato genotypes in 2018 only. The genotype Dan Zaria recorded longer fresh fruits similar with Roma Savanna than UC82B which recorded the shortest fresh fruits in this study.

Fertilizer sources had a significant effect on fresh fruit length in 2018 and 2019 respectively. The application of poultry manure recorded longer fruits than the other fertilizer sources compared to the application of cow dung and the control which recorded statistically similar shorter fresh fruits in 2018. In 2019, the application of poultry manure recorded longer fresh fruits though statistically similar with the application of nitrogen, bio-fertilizer and cow dung compared to the control which recorded the shortest fresh fruits in this study.

Fruit Yield
The effects of fertilizer sources on the fruit yield of the three tomato genotypes in 2018 and 2019 are shown in Table 7 below. Fruit yield was different significantly among the three tomato genotypes in 2018 and 2019 respectively. In 2018, UC82B recorded higher fruit yield than the other genotypes compared with Roma Savanna which recorded the lowest fruit yield.

Table 5: Effects of fertilizer sources on the number of productive branches at maturity, number of fresh fruits per plant and weight of fresh fruits per plant of three tomato genotypes for 2018 and 2019

	NPBM		NFFPP		WFFPP	
	2018	2019	2018	2019	2018	2019
Genotypes						
UC 82B	20.99a	15.99a	79.47a	76.27a	236.13a	234.67a
Rama savanna	18.10b	13.10b	48.47b	45.93a	55.57c	156.30b
Dam Zaria	19.33ab	14.33ab	77.60a	123.27a	244.92b	221.25a
SE±	0.95	0.95	3.81	28.61	2.94	17.26
Fertilizer source(F)						
Nitrogen	26.98a	21.98a	72.67b	69.67a	133.33c	188.42bc
BIO	18.74bc	13.74bc	71.33b	68.56b	204.41b	245.72ab
Poultry	19.49b	14.49b	104.89a	101.67a	319.61a	270.44a
Cow dung	15.32c	10.32c	64.73b	143.11a	116.38d	143.50c
Control	16.84bc	11.84bc	28.89c	26.11a	203.97b	172.28c
SE±	1.22	1.22	4.92	36.93	3.79	22.29
Interaction: G x F						
	NS	NS	*	NS	**	NS

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% probability level. NPBM: Number of productive branches at maturity, NFFPP: Number of fresh fruit per plot, WFFPP: Weight of fresh fruit per plot.

Table 6: Interaction effects between genotypes and fertilizer sources on number of fresh fruits per plant and weight of fresh fruit per plant in 2018

	Fertilizer sources				
	Nitrogen	**BIO**	**Poultry**	**Cow dung**	**Control**
Genotypes		**NFFPP**			
UC 82B	102.00b	74.67cd	105.67b	68.33d	46.67f
Rama savanna	51.00f	43.33f	82.00c	52.67ef	13.33h
Dam Zaria	65.00de	96.00b	127.00a	73.33cd	26.67g
SE±			8.53		
		WFFPP			
UC 82B	270.50c	208.67d	306.13b	124.17g	271.20c
Rama savanna	113.53h	91.33i	292.83b	95.93i	184.20e
Dam Zaria	165.97f	313.23b	359.87a	129.03g	156.50f
SE±		6.57			

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% probability level. NFFPP: Number of fresh fruit per plot. WFFPP: Weight of fresh fruit per plot.

In 2019, the genotypes UC82B and Dan Zaria recorded significantly similar higher fruit yield than Roma savanna which recorded the lowest fruit yield in this study.

Fertilizer sources have a significant effect on fruit yield across the years in this study. In 2018, the application of poultry manure recorded higher fruit yield than all the other fertilizer sources compared with the application of cow dung which recorded the lowest fruit yield. In 2019, the application of poultry manure recorded higher fruit yield similar with the application of bio fertilizer than the application of cow dung and the control which recorded similar lower fruit yield though statistically similar with the application of nitrogen fertilizer.

Table 7: Effect of fertilizer sources on fresh fruit diameter, fresh fruit length and fruit yield of three tomato genotypes in 2018 and 2019

	FFD		FFL		Yield	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**
Genotypes						
UC 82B	3.25a	2.62ab	4.97b	4.98a	0.24a	0.23a
Rama savanna	2.78b	2.88a	5.38ab	4.77a	0.15c	0.16b
Dam Zaria	2.5ab	2.33b	5.68a	5.58a	0.22b	0.22a
SE±	0.15	0.12	0.17	0.33	0.003	0.017
Fertilizer source(F)						
Nitrogen	3.16a	2.87a	6.07b	5.54ab	0.18c	0.19bc
BIO	2.82ab	2.60ab	5.71b	4.78ab	0.2ab	0.25ab
Poultry	3.31a	2.82a	6.98a	5.89a	0.32a	0.27a
Cow dung	2.52b	2.50ab	4.26a	5.07ab	0.12d	0.14c
Control	2.46b	2.26b	3.71c	4.8b	0.20b	10.17c
SE±	0.19	0.16	0.22	0.42	0.004	0.022
Interaction						
G x F	NS	NS	NS	NS	**	NS

Means with the same letter(s) in a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% probability level. FFD: Fresh fruit diameter. FFL: Fresh fruit length. NS= Not significant, *= significant, **= highly significant

Discussion

The highest number of leaves produced by the varieties UC82B and Roma savanna may be ascribed to their genetic composition and adaptability mechanism within the environmental or weather conditions. Also, the taller heights of the genotypes are great determinants of a greater number of leaves in this study. This finding is in line with the report of Olaniyi *et al*. (2010) which observed higher number of leaves with the taller genotypes of tomato in Nigeria. The highest number of plant branches recorded with UC82B tomato genotype may be due to taller plants recorded by the genotype in the study, it is more of genetic characteristics towards the production of more branches coupled with its adaptability to the environmental conditions. These findings align with the results obtained by Anwar et al. (2016) which reported higher number of branches with Money maker tomato genotype due to its taller height. Davis *et al*. (2003) reported that numbers of branches are varied in different cultivars due to their genetic make-up. The results are also support the findings of Iqbal et al. (2011). Ajayi *et al*. (2018) reported that UC82B produced significantly higher number of branches than tropimech genotype in Nigeria.

Ajayi *et al*. (2018) reported that UC82B genotype produced significantly higher number of branches than Tropimech and Ibadan local varieties in Nigeria. The higher number of fresh fruits per plant with UC82B may be due to its superior genetic make-up, adaptation to the environmental conditions, taller plants, higher number of leaves and higher number of branches in our study. Anwar *et al*. (2016) reported that Moneymaker tomato genotype produced maximum number of fruits per plant than Roma savanna and super classic tomato genotypes due to differences in the cultivars genetic make-up in Pakistan. The heavier fresh fruits per plant produced by UC82B could be attributed to higher number of fresh fruits per plant recorded by the genotype in this study. The numbers of fresh fruits per plant are important determinants of weight of fresh fruits per plant in tomato production. This result contradicts the findings of Ajayi *et al*. (2018) which claimed that Ibadan local variety produced significantly higher average fruit weight than UC82B and Tropimech tomato genotypes in Nigeria.

The bigger fruits recorded by UC82B could be attributed to the taller plants, higher number of leaves, and the number of branches recorded by the genotype which supported its fruit development in this study. It may also be due to the genetic characteristics of the genotype and its adaptation to the environmental conditions. Jose *et al*. (2018) reported variation on the fruit diameter of eleven tomato accessions in Mexico due to differential genetic make-up of the accessions. The longer fruits recorded by Dan Zaria may be attributed to the genetic potential of the variety in attaining days to first flower bud sight in this study. Jose *et al*. (2018) reported longer fruits with LLMO1 tomato accession than the other accessions in Mexico due to its genetic characteristics in Mexico. The higher fruit yield recorded with UC82B could be attributed to taller plants, higher number of leaves, higher number of branches and bigger fruits recorded by the genotype in our study. The size of fruit is a great determinant of fruit, yield in tomato production. It may also be due to the genetic make-up of the genotype and its adaptive mechanism to the environmental conditions of the study location. The findings are in conformity with Rab and Ihsan (2012) which affirmed that variations in total yield of tomato might be due to the variation in the genetic make-up of different cultivars. It is also the possible reason for variation in yield, because each cultivar requires different environmental location for proper growth and development to produce optimum yield (Davis *et al.*, 2003). Ahammad *et al*. (2009) reported higher fruits yield with BARI tomato 5 and ascribed this to its genetic potentials and adaptation to the environmental conditions. Zakari *et al*. (2017) reported that Icrixina tomato genotype recorded higher fruit yield than the other genotypes due to genetic differences among the genotypes since they were grown under the same environmental conditions in Nigeria. Olaniyi *et al*. (2010) reported higher fruit yield of tomato with UC82B than the other genotypes, due to its superior genetic composition in Nigeria.

Conclusion

This study examined the influence of different nutrient sources on growth and yield of three genotypes of tomatoes in Minna. The study revealed useful information for tomato crop farmers on the adoption of low input technology, since the lives of the people are largely dependent on food. In this study, it is recommended that farmers in the agro-ecology of Nigeria should plant the UC82B tomato genotype with the application of 92 kg/ha poultry manure for increased growth and yield of tomato.

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