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Evaluation of Tomato Genotypes Growth, Yield, and Shelf Life Enhancement in Nigeria

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ABSTRACT

Nine tomato genotypes ('NACGRAB-1', 'NACGRAB-2', 'NACGRAB-3', 'NACGRAB-4', 'NACGRAB-5', 'NACGRAB-6', 'NACGRAB-7', 'NACGRAB-8'and 'NACGRAB-9') from the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria; with four commercial varieties ('Petomech', 'Uc 82B', 'Yolince' and 'Derica') and two landraces ('Ekwunato' and 'Tomato Mmiri') were evaluated for their agronomic performance in a derived savannah region. Morphological and floral data were collected on them. At maturity, forty tomato fruits, each from five selected genotypes, were immersed in 0.1, 0.2, and 0.3 g L^{-1} $AgNO_3$ varying concentrations of silver/neem (*Azadirachta indica*) solutions and a control to study the storability of the fruits. During storage, number of days to 10, 50, and 100% fruit rot incidences were monitored on the treated fruits. 'NACGRAB-7' took the longest number of days to 10, 50, and 100% fruit rot and was significantly different from the other genotypes. The lowest number of days to fruit rot was obtained from 'NACGRAB-6'. Solution-B containing (8 g L^{-1} neem extract plus 0.2 g L^{-1} $AgNo_3$) had the highest number of days to 10 and 50% fruit rot. The fruits that were not treated rotted faster than the treated fruits.

Keywords: *Azadirachta indica*, Fruit rot, Fruit storability, Nanotechnology, Silver neem solution.

INTRODUCTION

Tomato is the second most consumed vegetable in the world after potato (Suresh *et al*., 2014). Tomato fruit constitute rich source of essential amino acids, minerals, and vitamins (Guil-Guerrero and Rebolloso-Fuentes, 2009). The fruit is also rich in lycopene which is known to reduce the risk of cancer (Kamenetzky *et al*., 2010). Tomato is a regular part of the diet of the average Nigerian household (Amuji *et al*., 2013). Nigeria is the second largest tomato producer after Egypt in Africa (FAO, 2013). Nigeria consumes about 2.3 million tons of tomato annually, while producing about 1.8 million tons locally (Ugonna *et al*., 2015) leaving a gap of 0.5 million tons. The commercial tomato production hub in Nigeria is the northern Guinea savannah and Sudan ecologies (Olaniyi *et al*., 2010) but researches are on-going in the derived Savannah ecologies to make it another key tomato production area to meet tomato demand in Nigeria.

For a meaningful crop improvement to be carried out, there must be sufficient genetic resources whose potentials for use in crop improvement are known. According to Ng (1991), genetic resources are useful to scientists and plant breeders only if they have been properly characterized and evaluated. Such characterization and evaluation enables plant scientists to study the diversity of a species to search for direct

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introduction as cultivars, or to provide genetic variability in a breeding program. Gene introduction is a known approach for increasing the biodiversity and yield of a plant in a given location (Acquaah, 2007). Multi-locational trial of a genotype has the advantage of measuring the environmental influence on the gene that aids the breeder in proper recommendation of a genotype to a specific location (Yan and Tinker, 2006).

About 68% of the global tomato production is consumed fresh while the remaining 32% are processed (Ugonna *et al*., 2015). In Nigeria, more than 50% of tomatoes produced are lost to poor storage system, poor transportation, and lack of processing enterprises (Ugonna *et al*., 2015). The genetic constituent of the tomato variety used can influence this loss (Tigist *et al*., 2012). Therefore, selecting high yielding varieties for production should not only satisfy consumer preferences but also have a good shelf life. Although post-harvest losses in tomato may not be eliminated, it can be reduced drastically by applying appropriate post-harvest technology. Nanotechnology, the creation and use of materials at extremely small scale (Yang and Luzzi, 2009), when integrated into crop production has the potential of protecting crops and avoiding loss to pests and diseases (Abd-Elsalam, 2012). A number of nanotechnologies can improve existing crop control protocols in the short to medium term (Perez-de-laque and Rubiales, 2009). The applications of nano materials to the agricultural sector are also attracting attention. Since silver displays various modes of inhibitory action to plant pathogens, it may be used for controlling various plant pathogens in moderately safer way, compared to synthetic fungicides (Park *et al*., 2006).

Nigeria is projected to double its population in two decades (United Nation Population Fund, 2016) without an accompanying increase in land area, thus increasing the food demand gap in the country. Lack of adequate processing and storage facilities coupled with the rapid rate of decay of freshly harvested tomatoes may further complicate the problem. The necessity to reduce these post-harvest losses led to the initiation of this study with the following objectives: to evaluate the agronomic performance of fifteen tomato genotypes and to determine the effect of silver solution on the shelf life of freshly harvested tomato produce.

MATERIALS AND METHODS

Field and laboratory experiments were carried out in 2014 and in 2015 at the research field and laboratory of the Department of Crop Science, University of Nigeria, Nsukka Enugu State Nigeria. Nsukka latitude: 6° 51′ E and longitude: 7° 29′ N, at altitude of 475 m above sea level.

Nine tomato genotypes (‘NACGRAB-1’, ‘NACGRAB-2’, ‘NACGRAB-3’, ‘NACGRAB-4’, ‘NACGRAB-5’, ‘NACGRAB-6’, ‘NACGRAB-7’, ‘NACGRAB-8’and ‘NACGRAB-9’) were obtained from the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria; four commercial varieties (‘Petomech’, ‘Uc 82B’, ‘Yolince’ and ‘Derica’) and two landraces (‘Ekwunato’ and ‘Tomato Mmiri’) were obtained from the open market and tomato farmers, respectively, to evaluate their agronomic performance in a derived savannah region.

The tomato seeds were germinated in the nursery using a 3:2:1 nursery medium of topsoil, poultry manure, and sawdust, respectively, measured by volume. Four weeks after planting, vigorous seedlings were transplanted to the field. The research field was cleared, ploughed, and the bed prepared manually. The field was demarcated into three blocks. Each block contained 15 plots containing each genotype. The plot measured 3×2 m with 12 seedlings, using the plant spacing of 75×65 cm. A distance of 1 m and 0.5 m was maintained between blocks and plots, respectively. Poultry manure was applied at

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the rate of 1.5 tons per hectare one week before transplanting. Three Weeks After Transplanting (WAT), NPK (15:15:15) was applied at the rate of 90 kg per hectare. Urea was applied at the same rate as top dressing at the onset of flowering. Weeding was manually done.

At fruit maturity, forty tomato fruits each from five random genotypes ('NACGRAB-3', 'NACGRAB-4', 'NACGRAB-6', 'NACGRAB-7' and 'Yolince') were taken to the laboratory and washed under running tap water before being immersed in silver neem (*Azadirachta indica*) solutions. After the immersion, the treated fruits were kept on the shelf at room temperature to monitor the efficacy of the solutions in controlling fruit rot in tomato. The experimental design used for the study was 5×4 factorial in complete randomized design with three replications. Five genotypes were combined with three concentrations of silver neem solutions and a control. Each replicate contained ten fruits.

Neem leaf extract was used for the reduction of silver ions (Ag+) to silver (Ag). The extract was prepared by dissolving 8g of finely ground fresh neem leaves in 1,000 mL distilled water at 50°C. After the extraction, three different silver nitrate solutions (0.1, 0.2 and 0.3 g) were added to the neem extracts resulting in three different solutions as:

Solution A=8 g L^{-1} neem extract plus 0.1 g L^{-1} $AgNo_3$

Solution B= 8 g L^{-1} neem extract plus 0.2 g L^{-1} $AgNo_3$

Solution C= 8 g L^{-1} neem extract plus 0.3 g L^{-1} $AgNo_3$

Control = water

Data Collection

At 2, 4, 6 and 8 WAT, a flexible meter was used to measure the plant height (cm) from the soil level to the tip of the plant, and number of leaves, nodes, and internode per plant were counted. Number of branches was counted at 4, 6 and 8 WAT. At the onset of reproductive phase, number of days to first and 50% anthesis; first and 50% fruit set, and first fruit ripening were recorded. Numbers of flowers per plant, aborted flowers per plant, fruits per truss, and fruits per plant were counted.

At maturity, the harvestable fruits were counted and weighed using electronic sensitive balance to obtain the fruit weight and number per plot. Twenty fruits were randomly selected from each plot; their lengths and circumference were measured using Vernier caliper to determine the average fruit diameter and circumference. During storage, number of days to 10, 50 and 100% fruit rot incidences were monitored on treated fruits.

Data Analysis

The data collected were analyzed using GenStat Discovery edition 4 according to the procedures for randomized complete block design for the field experiment and factorial in complete randomized design for the shelf life experiment. *F*-LSD at 5% level of probability was used to separate the means when there is significant *F*-test in the analysis of variance. The two years were pooled together during analysis without considering year as a factor.

RESULTS

'NACGRAB-6' and 'NACGRAB-8' produced the highest number of branches that was significantly different from 'Ekwunato', 'Petomech' and 'Derica' at 4 WAT (Table 1). At 6 and 8 WAT, 'NACGRAB-5' gave the highest number of branches that was statistically different from 'NACGRAB-1', 'NACGRAB-2', 'NACGRAB-4', 'NACGRAB-7', 'NACGRAB-9', 'Derica', 'Ekwuanto', 'Petomech' and 'UC82 B'. 'NACGRAB-3' had the highest number of leaves that was significantly different from 'NACGRAB-5' and 'Uc82 B'. At 4, 6 and 8 WAT,

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Table 1. Influence of genotypes on number of branches and leaves of *S. lycopersicum* over 8 Weeks After Transplanting (WAT).

Genotypes	Number of Branches			Number of leaves			
	4 WAT	6 WAT	8 WAT	2 WAT	4 WAT	6 WAT	8 WAT
'Derica'	1.3	3.3	4.3	6.0	17.7	46.0	51.3
'Ekwunato'	1.7	4.0	4.3	7.3	21.0	66.7	70.7
'Petomech'	1.3	2.9	4.1	5.7	16.0	19.3	23.9
'Tomato Mmiri'	3.3	4.4	5.3	6.2	19.0	36.8	36.9
'Uc82 B'	2.7	3.0	3.3	4.7	16.7	21.3	25.3
'NACGRAB-1'	2.3	4.0	4.7	8.0	23.7	50.0	55.7
'NACGRAB-2'	2.7	3.3	3.7	6.3	25.3	48.7	48.8
'NACGRAB-3'	3.7	5.7	6.3	8.3	36.3	51.0	54.3
'NACGRAB-4'	3.0	4.0	5.0	7.7	30.3	46.3	56.0
'NACGRAB-5'	4.3	6.7	7.3	4.3	30.0	64.0	67.7
'NACGRAB-6'	4.7	5.3	6.3	7.3	40.7	69.3	77.0
'NACGRAB-7'	3.0	4.0	5.0	6.3	36.7	69.0	74.3
'NACGRAB-8'	4.7	5.2	6.0	6.3	29.7	50.6	57.4
'NACGRAB-9'	3.7	4.0	4.7	7.0	32.7	58.3	65.3
'Yolince'	3.7	5.3	6.7	8.0	21.1	66.3	70.7
F-LSD $_{(0.05)}$	2.8	2.3	2.2	2.9	21.0	31.9	30.7

'NACGRAB-6' produced the highest number of leaves that was statistically different from 'Uc82 B', 'Tomato Mmiri' and 'Petomech'. At the same WAT, 'Petomech' gave the least number of leaves among all the genotypes.

'NACGRAB-6' consistently produced the highest number of nodes, except at 2 WAT, where 'NACGRAB-4' gave the highest number of nodes which was not statistically different from 'NACGRAB-6' at 5% probability level (Table 2). Also, 'NACGRAB-6' consistently had the highest number of internodes, except at 4 WAT, where 'Yolince' produced the highest number of internodes which was not statistically different from 'NACGRAB-6'. 'Yolince' gave the tallest plant height from 2 to 8 WAT which was statistically different at 2, 6 and 8 WAT (Table 3). The lowest plant height was obtained by 'Uc82 B' at 2 and 8 WAT, while at 6 WAT, 'Tomato Mmiri' gave the shortest plant.

The shortest number of days to the first flower opening and fruit set was observed in 'NACGRAB-4' while the shortest number of days to 50% anthesis and fruit set was recorded in 'Yolince' (Table 4). 'NACGRAB-5' produced the highest number of flowers that was significantly different from the other genotypes. The lowest number of aborted flowers was recorded in 'Tomato Mmiri'. 'NACGRAB-6' and 'NACGRAB-7' were the first to ripe and had significantly lower number of days to fruit ripening than 'NACGRAB-2' and 'NACGRAB-9' that had the highest.

'NACGRAB-5' gave the highest number of flowers per truss, flowers per plant, and flowers per plot that was significantly higher than other genotypes, except 'NACGRAB-2', 'NACGRAB-3', 'NACGRAB-4', and 'NACGRAB-6' on number of flowers per truss (Table 5). It also gave the lowest value for average fruit circumference, length, fruit weight, fruit weight per truss, and fruit weight per plant and per plot. 'NACGRAB-9' produced the highest average fruit circumference, fruit weight per truss and per plot that was significantly different from the other genotypes. 'Yolince' was significantly higher than the other genotypes in fruit length while 'Uc82B' had the highest average individual fruit weight.

'NACGRAB-7' took the longest number of days to 10, 50, and 100% fruit rot and was significantly different from the other genotypes (Table 6). The lowest number of days to 10, 50, and 100% fruit rot was

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obtained for 'NACGRAB-6'. Solution B had the highest number of days to 10 and 50% fruit rot, while Solution A gave the highest number of days to 100% fruit rot. The fruits that were not treated (control) rotted faster than the treated fruits.

'NACGRAB-6' and 'NACGRAB-7' immersed in solution B took the longest number of days to 10, 50, and 100% rot (Table 7). They were significantly different from the other treatment combinations in number of days to 10, 50, and 100% rot, except 'NACGRAB-7' immersed in Solution A in number of days to 100% fruit rot. 'Yolince' immersed in Solution A gave the lowest number of days to 10% fruit rot that was not significantly different from 'NACGRAB-3' and 'NACGRAB-6'

Table 2. Influence of genotypes on number of nodes and internodes of *S. lycopersicum* over 8 Weeks After Transplanting (WAT).

Genotypes	Number of Nodes				Number of Internodes			
	2 WAT	4 WAT	6 WAT	8 WAT	2 WAT	4 WAT	6 WAT	8 WAT
'Derica'	6.0	14.3	27.3	30.7	2.7	7.3	12.3	14.0
'Ekwunato'	7.0	15.7	24.3	37.7	2.7	9.0	16.0	17.3
'Petomech'	5.7	10.4	10.6	13.6	2.0	2.9	6.1	8.6
'Tomato Mmiri'	5.7	13.9	16.6	23.6	2.4	6.9	9.1	11.6
'Uc82 B'	5.0	8.7	10.7	12.7	2.7	5.0	5.0	5.3
'NACGRAB-1'	5.0	19.7	31.3	32.0	3.3	9.1	14.7	16.0
'NACGRAB-2'	6.3	22.7	23.8	32.3	4.0	12.0	12.3	15.3
'NACGRAB-3'	6.0	28.7	41.3	41.9	3.3	13.0	15.0	22.3
'NACGRAB-4'	7.7	24.0	29.3	31.0	3.7	5.7	17.7	27.0
'NACGRAB-5'	4.3	28.3	38.7	40.0	2.7	15.3	20.0	22.7
'NACGRAB-6'	7.3	35.7	46.0	48.0	4.3	16.7	21.7	28.7
'NACGRAB-7'	6.0	27.3	34.7	40.3	3.3	16.3	21.3	22.1
'NACGRAB-8'	6.3	24.0	33.0	33.6	3.7	7.4	16.9	17.0
'NACGRAB-9'	7.0	27.0	33.7	35.0	3.7	12.3	17.3	18.7
'Yolince'	7.3	31.3	38.7	41.7	3.7	17.3	17.7	26.0
F-LSD $_{(0.05)}$	2.2	17.1	20.9	17.3	1.7	11.0	10.2	10.1

Table 3. Influence of genotypes on Plant height (cm) of *S. lycopersicum* over 8 Weeks After Transplanting (WAT).

Genotypes	2 WAT	4 WAT	6 WAT	8 WAT
'Derica'	15.30	44.70	49.30	63.00
'Ekwunato'	28.20	48.50	82.30	87.30
'Petomech'	16.10	42.40	59.30	62.70
'Tomato Mmiri'	21.60	41.10	42.80	71.70
'Uc82 B'	14.20	41.80	58.20	60.70
'NACGRAB-1'	24.00	52.20	78.80	82.30
'NACGRAB-2'	22.70	40.70	65.30	70.00
'NACGRAB-3'	22.00	51.70	70.70	78.80
'NACGRAB-4'	24.20	46.20	72.00	83.70
'NACGRAB-5'	16.70	40.80	69.70	69.80
'NACGRAB-6'	27.00	57.20	78.20	79.70
'NACGRAB-7'	22.20	49.00	62.80	64.30
'NACGRAB-8'	24.70	59.10	74.30	78.70
'NACGRAB-9'	22.80	41.70	78.80	84.70
'Yolince'	29.00	60.30	82.50	89.30
F-LSD $_{(0.05)}$	9.90	ns	16.40	17.30

ns= Non-significant.

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Table 4. Influence of genotypes on some flowering and fruit traits of *S. lycopersicum.*

Genotypes	1st Anthesis	50% Anthesis	No of flowers	No of aborted flowers	1st Fruit set	50% Fruit set	1st Fruit ripe
'Derica'	24.3	26.3	19.0	10.7	36.3	42.0	59.7
'Ekwunato'	22.7	27.0	36.0	12.7	36.3	41.7	62.7
'Petomech'	20.9	36.2	35.1	5.4	29.4	41.4	60.9
'Tomato Mmiri'	22.4	25.7	38.3	4.4	32.4	37.4	59.4
'Uc82 B'	26.7	30.3	24.6	9.0	33.0	38.2	60.7
'NACGRAB-1'	23.0	27.0	32.0	6.7	38.3	40.7	61.7
'NACGRAB-2'	24.0	25.7	30.1	12.3	40.3	49.3	63.0
'NACGRAB-3'	18.3	28.0	45.0	8.7	31.3	38.0	60.3
'NACGRAB-4'	15.7	26.7	68.2	19.7	27.0	37.3	59.0
'NACGRAB-5'	21.3	23.3	376.0	23.0	32.7	34.0	59.7
'NACGRAB-6'	17.3	24.7	42.1	8.7	27.7	33.0	57.3
'NACGRAB-7'	20.3	29.0	42.3	8.7	36.7	38.0	57.3
'NACGRAB-8'	16.2	26.2	63.2	25.9	30.1	34.2	58.3
'NACGRAB-9'	23.7	28.3	42.0	8.7	36.7	39.0	63.0
'Yolince'	16.3	17.0	46.2	11.0	28.0	30.7	60.7
F-LSD $_{(0.05)}$	8.9	15.6	136.2	17.4	6.5	ns	5.2

ns= Non-significant.

Table 5. Influence of genotypes on some fruit parameter of S. *lycopersicum.*[a]

Genotypes	NFT	NFPl	NFP	FD (cm)	FL (cm)	IFW (g)	FWT (g)	FWPl (g)	FWP (g)
'Derica'	3.0	9.3	11.1	3.6	4.6	45.3	125.3	239.0	372.0
'Ekwunato'	3.7	24.1	58.0	2.9	4.2	28.7	89.7	305.0	785.0
'Petomech'	4.0	30.0	71.3	3.8	3.9	60.5	175.7	405.0	1347.0
'Tomato Mmiri'	3.5	33.0	59.2	3.4	2.6	22.5	93.4	302.0	909.0
'Uc82 B'	3.7	16.3	43.0	4.1	6.6	61.7	193.0	351.0	847.0
'NACGRAB-1'	4.0	26.0	62.0	3.1	3.5	16.7	59.7	370.0	934.0
'NACGRAB-2'	4.7	18.0	23.0	3.0	5.6	28.7	95.7	240.0	437.0
'NACGRAB-3'	5.0	36.1	72.1	2.7	3.0	18.3	80.0	440.0	2987.0
'NACGRAB-4'	4.7	59.3	175.1	1.7	2.9	13.0	62.3	398.0	1493.0
'NACGRAB-5'	5.3	376.0	646.0	0.9	1.1	0.3	2.9	96.0	153.0
'NACGRAB-6'	4.5	33.2	131.2	2.8	6.4	19.0	25.0	491.0	1961.0
'NACGRAB-7'	3.7	34.1	90.2	2.1	2.6	2.0	16.3	226.0	522.0
'NACGRAB-8'	4.0	37.4	102.1	3.3	4.5	28.9	148.1	1158.0	3015.0
'NACGRAB-9'	3.7	34.2	112.1	5.1	3.5	59.0	230.0	883.0	6160.0
'Yolince'	3.7	44.1	136.3	3.5	6.9	32.3	133.7	709.0	2016.0
F-LSD $_{(0.05)}$	0.9	125.8	17.4	0.6	0.2	2.7	7.7	459.0	3049.0

[a] Number of Fruits per Truss= (NFT), Number of Fruits per Plant= (NFPl), Number of Fruits per Plot= (NFP), Fruit Diameter= (FD), Fruit Length= (FL), Individual Fruit Weight= (IFW), Fruit Weight per Truss= (FWT), Fruit Weight per Plant= (FWPl) and Fruit Weight per Plot = (FWP).

Table 6. Main effects of genotype and silver concentration on number of days to *S. lycopersicum* fruit rot.

Genotypes	Days to 10% rot	Days to 50% rot	Days to 100% rot	Treatments	Days to 10% rot	Days to 50% rot	Days to 100% rot
'NACGRAB-3'	16.5	24.1	26.2	Solution A	13.2	23.5	31.2
'NACGRAB-4'	15.7	22.6	26.3	Solution B	19.1	24.2	28.4
'NACGRAB-6'	12.1	19.0	25.6	Solution C	17.7	23.5	23.5
'NACGRAB-7'	18.8	28.1	33.6	Control	12.5	21.9	23.0
'Yolince'	14.9	22.7	27.7	*F*-LSD $_{(0.05)}$	0.3	0.2	0.3
F-LSD $_{(0.05)}$	0.3	0.2	0.3				

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Table 7. Interaction of genotype and silver concentration on number of days to *S. lycopersicum* fruit rot.

Genotypes	Treatments	Days to 10% rot	Days to 50% rot	Days to 100% rot
'NACGRAB-3'	Solution A	12.0	21.1	30.1
	Solution B	20.5	24.2	24.3
	Solution C	21.6	23.9	23.9
	Control	12.0	27.2	27.2
'NACGRAB-4'	Solution A	14.9	24.0	30.1
	Solution B	15.2	21.1	24.2
	Solution C	18.0	24.1	24.2
	Control	14.8	21.1	21.0
'NACGRAB-6'	Solution A	12.2	21.1	30.0
	Solution B	29.9	33.2	36.1
	Solution C	18.2	27.2	24.7
	Control	12.0	24.7	24.7
'NACGRAB-7'	Solution A	15.2	27.1	36.1
	Solution B	29.9	33.2	36.1
	Solution C	18.2	27.2	27.2
	Control	12.0	24.7	24.7
'Yolince'	Solution A	11.7	24.1	30.0
	Solution B	18.0	21.0	30.1
	Solution C	18.1	27.1	27.1
	Control	12.0	18.6	18.6
F-LSD $_{(0.05)}$		0.5	0.2	0.7

immersed in Solution A; untreated 'Yolince', 'NACGRAB-3', 'NACGRAB-6', and 'NACGRAB-7'. 'Yolince' control was significantly lower than the other treatment combinations in number of days to 50 and 100% fruit rot.

DISCUSSION

Significant differences were observed among the tomato genotypes studied indicating genetic variability among the genotypes, a prelude for meaningful breeding program. This is consistent with the findings of Enujike and Emuh (2015) who reported that differences in growth and yield characters could be attributed to variation in genetic constitution of the genotypes. Atugwu and Uguru (2011) reported that genetic constitution of tomato varieties influenced growth characters that they expressed.

'NACGRAB-6' genotype, which consistently produced higher number of leaves than other genotypes, could possibly have superior photosynthetic activities. This is in harmony with the works of Enujike and Emuh (2015) that attributed the variations in growth characters of crop genotypes to differences in distribution of leaf surface area, canopy, arrangement, and photosynthetic enzymes and activities.

The highest number of flowers per plant with little flower or fruit abortion was observed in 'NACGRAB-5'genotype, which could be attributed to its better genetic constitution. Earlier report by Olaniyi *et al*. (2010) showed the relationship between flower abortion and fruit development. They identified fruit size to be genetically controlled in tomato production. Significant variation was observed in fruit weight, 'NACGRAB-8' genotype scored the highest for fruit weight while 'NACGRAB-5' genotype, despite better fruit number, scored the least. This least fruit weight observed in 'NACGRAB-5' genotype is a result of its small fruit size and genetic make-up. Atugwu and Uguru (2011) reported mean

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single fruit weight of 0.2 g for wild tomato genotype (*Solanum pinpinellifolium*) with about 400-800 fruits per plant. It might be that 'NACGRAB-5' genotype shares similar gene make-up with the wild tomato (*Solanum pinpinellifolium*).

Post-harvest quality of any crop largely depends on the interaction between the genetic make-up of the crop and storage environmental conditions. Postharvest tomato losses during storage and transportation are estimated to be as high as 20% in Nigeria (Olayemi *et al*., 2010). The number of days to 100% fruit rotting obtained with Solution B (8 g L^{-1} neem extract plus 0.2 g L^{-1} $AgNo_3$) is higher than 26 days obtained by Bukar and Magashi (2013) where *P. biglobosa* extract was used to preserve tomato. The higher number of days to fruit rotting recorded in the treated tomato over the untreated (control) showed that there was treatment effect. Etebu *et al*. (2013) implicated bacteria and fungi as the two primary classes of microorganisms that cause decay in tomato. The antifungal activity of silver nanoparticles had been shown on sclerotia forming phyto-pathogenic fungi (Min *et al*., 2009), filamentous ambrosia fungi (Kim *et al*., 2009), plant pathogenic spores of *Fusarium culmorum* (Kasprowicz *et al*., 2010), and *Fusarium oxysporum* (Musarrat *et al*., 2010). Silver nanoparticles strikingly decreased the number of germinating fragments and sprout length, relative to the control. The broad spectrum activity as well as economic and environmental friendly nature of plants extracts have made them a desirable alternative to their chemical counter-parts. The difference in the reaction of the genotypes to the neem/silver solutions indicates their genetic diversity.

CONCLUSIONS

Genotypes 'Uc82B' and 'Petomech' produced the highest individual fruit weight, while genotypes 'NACGRAB-9' and 'NACGRAB-8' showed superior performance in fruit weight per truss, fruit weight per plant, and fruit weight per plot. These tomato genotypes are recommended for inclusion in tomato improvement programs in the derived Savanna ecology of Nigeria. Solution B (8 g L^{-1} neem extract plus 0.2 g L^{-1} $AgNo_3$) is recommended for use in tomato fruit treatment for improved shelf life.

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ارزیابی رشد، عملکرد و بهبود عمرانباری ژنوتیپ های گوجه فرنگی در نیجریه

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چکیده

در این پژوهش، نه ژنوتیپ گوجه فرنگی (NACGRAB-1، NACGRAB-2، NACGRAB-3، ACGRAB-4 ، NACGRAB-5، NACGRAB-6، NACGRAB-7، NACGRAB-8، و NACGRAB-9) که از مرکز ملی منابع ژنتیکی و بیوتکنولوژی(NACGRAB) واقع در ایبادان در نیجریه اخذ شده بود و نیز چهار رقم تجارتی (Petomech'، Uc 82B، Yolince، و Derica) و دو رقم بومی (Ekwunato و Tomato Mmiri) از نظر عملکرد اگرونومیکی در یک منطقه ساوانای تبدیلی ارزیابی شد و داده های مورفولوژیکی و گلدهی آنها جمع آوری گردید. در مرحله رسیدگی (بلوغ)، برای بررسی پایداری میوه ها، ۴۰ میوه گوجه فرنگی، هرکدام از پنج ژنوتیپ انتخاب شده، در محلول هایی حاوی ۰/۱، ۰/۲، و ۰/۳ گرم در لیتر نیترات نقره $AgNO_3$در غلظت های مختلف حاوی نقره و neem (*Azadirachta indica*) فروبرده شد و یک تیمار شاهد هم در نظر گرفته شد. در طی دوره انبار داری، تعداد روزهای وقوع پوسیدگی در حد ۱۰٪، ۵۰٪، و ۱۰۰٪ روی میوه های تیمار شده پایش شد. ژنوتیپ NACGRAB-7 بیشترین تعداد روزهای رسیدن به ۱۰٪، ۵۰٪، و ۱۰۰٪ پوسیدگی میوه را داشت و به طور معناداری از ژنوتیپ های دیگر متفاوت بود. کمترین تعداد روزها به مرحله پوسیدگی میوه مربوط به NACGRAB-6 بود. محلولB (حاوی ۸ گرم در لیتر عصاره neemو ۸ گرم در لیتر AgNO3 بیشترین تعداد روزهای رسیدن به ۱۰٪ و ۵۰٪ پوسیدگی میوه را داشت. پوسیدن میوه هایی که تیمار نشده بود زودتر از میوه های تیمار شده رخ داد.

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