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Performance of Some Tomato (*Lycopersicon esculentum* Mill.) Varieties under Heat Period in Northern Nigeria

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Abstract: An experiment to evaluate the performance of five different varieties of tomato (*Lycopersicon esculentum* Mill.) under heat period was carried out at Maiduguri, Nigeria. The 5 varieties used were, Dan-Syria, Roma VFN, UTC, Dan-Baga and Tandino which were arranged in a Randomized Complete Block Design (RCBD), with three replications. The varieties varied in their yield characteristics. The varieties Roma VFN and Tandino started flowering 40 Days After Transplanting (DAT) earlier than the other varieties used. The Roma VFN, generally, produced significantly ($p < 0.05$) greater number of fruits/plant and fresh weight of fruits/plant than the other varieties used. Consequently, the Roma VFN, produced the highest fresh fruit yield of 6.1 mt ha⁻¹. The variety Dan-Baga produced the lowest fruit yield ha⁻¹, which was 2.6 mt ha⁻¹. The results of the study suggest that among the varieties used in the experiment, Roma VFN was more tolerant to heat followed by Tandino which surpassed the rest.

Key words: Tomato varieties, *Lycopersicon esculentum* Mill., dry season tomato, heat tolerance, tomato yield

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family Solanaceae and the genus *Lycopersicon*. It is one of the most widely used vegetable in the world. Ecologically, tomato requires relatively cool weather for optimum yield (Abdelmageed *et al.*, 2003; Ploeg and Heuvelink, 2005; Rodriguez, 2007). In Nigeria, yields of upto 32.70-53.98 mt ha⁻¹ are obtained during the cool harmattan period in the northern area (Ahmad and Singh, 2005). Similarly, a report from the Horticultural Unit of Borno State Ministry of Agriculture (Nigeria) in 1980-1981 showed that yield of 20-23 mt ha⁻¹ was obtained during the cool harmattan period.

The production of tomato in relation to demand is generally low in Nigeria and this could be particularly attributed to the prevailing high temperature in most parts of Nigeria. Even where the cool temperature is obtained (mostly in the Northern Nigeria) such temperature prevails only during the harmattan period, November to February. Outside the short cool period, fresh tomato is very scarce and expensive in the whole country. There is the need to increase the availability of fresh tomato to meet up with the high demand for this commodity, particularly during the hot season in Northern Nigeria. Thus, the present study attempted to compare the performance of some popular tomato varieties in Nigeria during the heat period from March to July, when the mean minimum and

maximum temperatures range from 29 to 38°C. It is expected that identification of heat tolerant tomato varieties would be a major asset towards greater food supply among the resource poor farmers in hot climates of the tropics.

MATERIALS AND METHODS

The experiment was conducted during the heat period of March to July of 2006 and 2007 on the Faculty of Agriculture Research Farm, University of Maiduguri, Maiduguri, Nigeria. The experimental site was basically a sandy loam, having 69.74% sand, 18.23% silt and 12.03% clay (Chiroma *et al.*, 2006), which was supplied with the fertilizer NPK (15:15:15) at the rate of 330 kg ha⁻¹ during land preparation. Urea was later on applied at the rate of 100 kg ha⁻¹ in 2 equal split doses, the first dose at 3 Weeks After Transplanting (WAT) and the remaining at 6 WAT.

The mean minimum and maximum temperatures during the period of the experiment were 25/41°C and mean relative humidity during morning and afternoon were 41.1 and 31.3 mm, respectively (Meteorological Department, Nigerian Airport Authority, Maiduguri) (Table 1). Seedlings of 5 varieties of tomato, Roma VFN, Tandino, Dan-Baga, UTC and Dan-Syria were transplanted (one seedling per hole) at the spacing of 60×60 cm in 4 m² plots. According to Borno Ministry of

Agriculture, Roma VFN is known to produce medium sized fruits with excellent flavor. The fruits are good for slicing and in salad. Tandino gives medium sized reddish fruits that are solid and well flavored. Dan-Baga produces relatively small fruits that have very good flavor. UTC fruits are stripped reddish and yellow. Dan-Syria gives good sized red fruits, which are solid and full of flavor. The treatments were arranged in a Randomized Complete Block Design (RCBD) and replicated three times. Yield and yield parameters were measured as well as the relative percentage yield of the present experiment to the expected yield of 32.70-53.98 mt ha⁻¹ of tomato under the normal growing season in Northern Nigeria (Ahmad and Singh, 2005).

The four centre plants in each treatment were chosen for the parameter measurements, except for percentage of plants that flowered with time, number of flowers produced per plant and percentage of plants that developed fruits with time where all plants within each plot were considered. In the present study, the cultivar Dan-Baga was assumed as more heat tolerant (control) than any other available tomato cultivar in the country. This is because its fresh fruits are more available in the market than any other tomato cultivar during the heat period.

Data collected from the two years trial were similar and were therefore combined and subjected to analysis of variance. Differences among treatments were identified using the Duncan's Multiple Range Test (DMRT).

RESULTS

Table 2 indicates that Roma VFN and Tandino tomato varieties achieved 10 and 7% flowering, respectively, at 40 DAT when all the other varietal entries had not started flowering. A week later (47 DAT), all the varieties bloomed with variety Tandino leading with 64.3% flowering. Subsequent observations showed that Tandino consistently maintained the lead until 100% flowering was recorded at 75 DAT. There was however no significant difference ($p \leq 0.05$) in the extent of flowering between Tandino and Roma VFN at 75 DAT and all the varieties attained full bloom at 82 DAT.

The number of flowers produced by the various varieties was quantitatively greater in Tandino and Roma VFN at 47 DAT with 24.5 and 18.0 flowers, respectively (Table 3). The total number of flowers produced by Tandino was consistently and significantly more than the number of flowers produced by each of the other varieties at successive days after transplanting up to 82 DAT. Statistically similar and highest number of flowers were produced by the two varieties, Tandino and Roma VFN (which produced the earliest flowers) by the end of the observation period.

The consideration of fruit development showed that fruit formation was earliest in Roma VFN at 54 DAT while UTC and Tandino varieties did not commence fruit production until 68 DAT (Table 4). The least earliness to fruiting was recorded by Dan-Syria and Dan-Baga.

Table 1: Mean temperatures and mean relative humidity during the period of the trials

Months	Temperature (°C)		Mean relative humidity (%)	
	Mean minimum	Mean maximum	Morning	Afternoon
2006				
March	22.3	40.6	12	9
April	25.6	40.8	17	12
May	26.0	42.4	45	30
June	26.7	41.9	58	45
July	24.9	38.7	67	53
2007				
March	24.0	39.8	13	8
April	25.4	41.0	28	17
May	26.3	41.5	42	25
June	27.1	43.7	57	44
July	25.3	41.1	72	60

Source: Meteorological department, Nigerian airport authority, Maiduguri

Table 2: Flowering percentage of tomato varieties with time of days after transplanting (DAT)*

Varieties	Flowering percentage							
	Days after transplanting							
	40	47	54	61	68	75	82	89
Dan-Syria	0.0 ^c	30.9 ^{bc}	45.0 ^d	75.0 ^b	78.3 ^c	89.7 ^c	100 ^a	100 ^a
Roma VFN	10.0 ^a	42.9 ^b	68.7 ^b	92.4 ^{ab}	96.4 ^{ab}	97.9 ^{ab}	100 ^a	100 ^a
UTC	0.0 ^c	42.1 ^b	58.2 ^c	61.5 ^c	64.6 ^d	81.1 ^d	100 ^a	100 ^a
Dan-Baga	0.0 ^c	14.3 ^c	28.6 ^c	35.7 ^d	92.9 ^b	95.7 ^b	100 ^a	100 ^a
Tandino	7.0 ^b	64.3 ^a	78.6 ^b	92.9 ^a	95.7 ^{ab}	100.0 ^a	100 ^a	100 ^a

With in a column, values followed by the same letter do not differ significantly at $p \leq 0.05$, according to DMRT; * Data is average of 2 years

Table 3: Number of flowers produced per plant with time*

Varieties	No. of flowers produced per plant							
	Days after transplanting							
	40	47	54	61	68	75	82	89
Dan-Syria	0.0 ^c	7.2 ^c	15.3 ^c	27.0 ^c	32.0 ^c	39.0 ^c	40.5 ^c	67.3 ^b
Roma VFN	5.0 ^b	18.0 ^b	28.0 ^b	36.3 ^b	41.3 ^b	49.0 ^b	53.3 ^b	78.0 ^a
UTC	0.0 ^c	5.0 ^d	9.0 ^d	11.5 ^d	18.0 ^d	22.0 ^d	29.5 ^d	30.5 ^c
Dan-Baga	0.0 ^c	3.0 ^e	7.5 ^{ab}	13.0 ^d	18.5 ^d	24.0 ^d	31.3 ^d	35.5 ^c
Tandino	15.0 ^a	24.5 ^a	33.2 ^a	40.5 ^a	51.5 ^a	62.0 ^a	75.0 ^a	80.0 ^a

With in a column, values followed by the same letter do not differ significantly at $p \leq 0.05$, according to DMRT; * Data is average of 2 years

Table 4: Percentage of plants that had developed fruits with time*

Varieties	Percentage of plants that had developed fruits with time							
	Days after transplanting							
	54	61	68	75	82	89	96	103
Dan-Syria	0.0 ^b	0.0 ^b	0.0 ^d	0.0 ^c	12.2 ^b	20.5 ^b	67.8 ^b	100 ^a
Roma VFN	20.0 ^a	21.0 ^a	23.2 ^a	30.1 ^a	40.2 ^a	50.0 ^a	100.0 ^a	100 ^a
UTC	0.0 ^b	0.0 ^b	5.0 ^c	12.2 ^b	15.0 ^b	22.0 ^b	100.0 ^a	100 ^a
Dan-Baga	0.0 ^b	0.0 ^b	0.0 ^d	0.0 ^c	10.2 ^b	20.6 ^b	100.0 ^a	100 ^a
Tandino	0.0 ^b	0.0 ^b	12.6 ^b	12.6 ^b	12.9 ^b	20.2 ^b	100.0 ^a	100 ^a

With in a column, values followed by the same letter do not differ significantly at $p \leq 0.05$, according to DMRT; * Data is average of 2 years

Table 5: Total number of fruits/plant, total fresh weight of fruit/plant and fresh fruit yield ha⁻¹ *

Varieties	Total No. of fruits/plant	Total fresh weight of fruits/plant (kg)	Fresh fruit yield ha ⁻¹ (mt)
Dan-Syria	11.0 ^d	0.12 ^{c,d}	3.4 ^d
Roma VFN	40.0 ^a	0.21 ^a	6.1 ^a
UTC	16.3 ^c	0.14 ^{b,c}	4.1 ^{b,c}
Dan-Baga	10.3 ^d	0.09 ^d	2.6 ^d
Tandino	31.7 ^b	0.19 ^{ab}	5.2 ^{ab}

With in a column, values followed by the same letter do not differ significantly at $p \leq 0.05$, according to DMRT; * Data is average of 2 years

At 82 DAT. All the varieties achieved 100% fruiting at 96 DAT with the exception of Dan-Syria which had 67.8% fruiting within the same period. However, 100% of the Dan-Syria plants had bore fruits by 103 DAT.

The greatest number of marketable fruits/plant was produced by Roma VFN (40 fruits/plant) followed by Tandino which produced 31.7 fruits/plant (Table 5). The variety UTC had the next highest number of fruits/plant while Dan-Syria and Dan-Baga significantly traded behind with 10.7 and 11.0 fruits/plant, respectively. The fruit weight produced/plant indicated that Roma VFN (0.21 kg/plant) and Tandino (0.19 kg/plant) were the top leading varieties among the 5 varieties considered. The next leading variety was UTC which had 0.14 kg/plant. Both Dan-Syria and Dan-Baga produced the least weight of total fresh fruits/plant with 0.12 and 0.09 kg of fresh fruits/plant, respectively (Table 5). The fresh fruit yield ha⁻¹ maintained a similar trend with total fresh weight of fruits/plant. Consequently, Roma VFN and Tandino produced the highest yield of fresh fruit weight/ha with 6.1 and 5.2 mt ha⁻¹. UTC had 4.1 mt ha⁻¹ while Dan-Syria and Dan-Baga yielded 3.4 and 2.6 mt ha⁻¹ of fresh fruits, respectively (Table 5).

DISCUSSION

Earliness to flowering was positively related with fresh fruit yield given that both Roma VFN and Tondino which started flowering as early as 40 DAT, became the two leading varieties in total fresh fruit production. Similarly, the other varieties which bloomed later, produced fewer number and quantity of fruits. The profile of weather data, indicated that higher temperature manifested over time from March to July (Table 1) as heat stress escalated. This implied that early bloomers made better use of cooler temperature which eluded the late bloom varieties. Consequently, the late bloomers experienced greater heat stress at the time of flowering. This situation could have also led to greater total number of flowers produced per plant ($p \leq 0.05$) for Roma VFN and Tandino.

Contrary to the local assumption that Dan-Baga is a heat tolerant variety, the results of the present study suggests that it is not. The relative abundance of its fresh fruits in the market during the heat period in Northern Nigeria is probably because the variety is normally grown around the Lake Chad water, which has influence on the

microclimate (relatively high humidity and cool temperature in the area). This environmentally related adaptation of Dan-Baga within the Lake Chad Basin area could not stand the hot temperature experienced in Maiduguri, where the current study was sited.

In the interim, the two leading varieties, Roma VFN and Tandino are recommended to solve the problem of food security during the off season period. Even though the current yield of the leading varieties (6.1 and 5.2 mt ha⁻¹ for Roma VFN and Tandino, respectively) is far below the yield during the normal growing (harmattan) season (32.70-53.98 mt ha⁻¹), the varieties can palliate the dear need for fresh tomato during the scarce period. The poor performance of tomatoes during heat period has been largely attributed to reduced net assimilation rate at the higher temperatures (<http://www.search.gov.on.ca:8002/compass>; Rivero *et al.*, 2004; Dong *et al.*, 2005).

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