GLADSTONE ROAD AGRICULTURAL CENTRE
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EVALUATION OF A HEAT TOLERANT TOMATO (*Lycopersicon esculentum* Mill.) VARIETY WITH RESISTANCE TO THE TOMATO YELLOW LEAF CURL VIRUS (TYLCV)

Kenneth VA Richardson
Gladstone Road Agricultural Centre
Department of Agriculture
Nassau, Bahamas
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ABSTRACT

The evaluation of a heat tolerant tomato variety, with resistance to the tomato yellow leaf curl virus (TYLCV), was conducted in a replicated small plot trial at the Gladstone Road Agricultural Centre during 2013. This study examined fruit quality and yield beyond the cooler growing season of September to March. The first harvest occurred on the 10th May, three months after planting, followed by harvests on the 17th and 28th of May. There were no significant differences observed for the total number of fruit per plant, total weight of fruit per plant, number of marketable fruit per plant or weight of marketable fruit per plant, over the three harvest dates. There was, however, a significant difference in the weight of a single tomato fruit. Based upon the results obtained from this study, the variety 'Inbar' proved to be very tolerant of the high temperature conditions during May, comparing favourably to other investigated tomato varieties evaluated during the cooler months of the year. The 'Inbar' tomato might be a useful variety to incorporate within the cropping systems of more local Bahamian farmers.

Heat tolerant 'Inbar' tomato variety with resistance to the tomato yellow leaf curl virus (TYLCV), grown at the Gladstone Road Agricultural Centre during 2013.

Introduction:

The tomato is a winter vegetable crop that prefers cool, dry growing conditions. It thrives best in moderate climates, but can adapt to a wide range of climatic conditions. The tomato can be grown in a variety of soil types, but does best on well-drained, fertile soils. It can be cultivated in the open under field conditions, or in a greenhouse under environmentally controlled conditions. In The Bahamas, production is restricted to the cooler months of September to March, due to several constraints which severely restrict production during the hot summer months. These constraints, which include heat,

heavy rains and humid conditions, result in poor flower development and low fruit set (Sato, *et. al.*, 2000). Most of the tomato varieties presently grown by farmers in The Bahamas are sensitive to the hot summer climate, so their availability is limited to the cool season. This inability to tolerate heat stress presents a major challenge for Bahamian farmers in their attempts to produce excellent quality tomatoes in sufficient quantities to satisfy the local market.

The vegetative and reproductive processes of the tomato are adversely affected by high temperature stress, resulting in a reduction in fruit quality and yield (Alsadon, *et al.*, 2006). Rick (1978) estimates that temperatures above 32^{o}C (90^{o}F) for more than three hours a day is sufficient to induce the abortion of flowers in the tomato. Several researchers (Abdul-Baki, 1991; Wessel-Beaver and Scott 1992; Sato, *et. al.*, 2000; Abdelmageed and Gruda, 2009; Elsharief *et. al.*, 2011) have identified heat tolerance in tomatoes by evaluating them for flowering and fruit set, since these two factors are sensitive to heat and relate directly to yield. High temperatures have been shown to affect not only the flowering and early fruiting stages, but also the later development and maturity of the fruit, resulting in reduced yields (Abdul-Baki, 1991; Wessel-Beaver and Scott 1992; Van Der Ploeg and Heuvelink, 2005; Abdelmageed and Gruda, 2009).

The tomato yellow leaf curl virus (TYLCV) is another limiting factor to tomato production in The Bahamas. Tomato plants infected by the tomato yellow leaf curl virus (Plate 1) exhibit symptoms such as a reduction in leaf size, the curling upward of leaves, severe stunting and the interveinal chlorosis of leaves (Martinez-Culebras *et al.*, 2001; Salati *et al.*, 2002). The tomato yellow leaf curl virus is not transmitted from plant to plant by handling, but is spread from infected solanaceous weed species to cultivated tomato plants by whiteflies (Ajlan, *et al.*, 2006; Al-Ani, *et al.*, 2011). Increased whitefly populations are associated with the tomato yellow leaf curl virus. This insect vector is controlled by limiting its numbers. Agronomic practices, such as weeding, the removal of vegetative matter and periodic spraying with insecticides are measures used to prevent the spread of the virus.

Plate 1. Tomato yellow leaf curl (TYLCV), observed in experimental plots at the Gladstone Road Agricultural Centre during 2012.

The tomato production season for farmers in The Bahamas could be extended beyond the cool season with improved flower and fruit set. Recently, farmers in North Andros have been using the heat tolerant, TYLCV resistant variety 'Inbar' in their cropping system with much success. For those farmers, the production season has now been extended beyond the month of May.

Objective:

This present study was conducted to evaluate the heat tolerant tomato variety 'Inbar' and document its performance under growing conditions of The Bahamas, beyond the winter vegetable growing season.

Materials and Methods:

Evaluation of the tomato variety 'Inbar' was conducted at the Gladstone Road Agricultural Centre from February to May of 2013. The 'Inbar' tomato is a product of the seed company Hazera Genetics Ltd. and is distributed by Hazera Seeds Inc. It is a determinate, heat tolerant variety producing a medium to large sized fruit and has very high resistance to tomato yellow leaf curl virus (TYLCV), tomato spotted wilt, Verticillium, Fusarium, and nematodes.

Tomato seeds were planted in a field seedbed during February, 2013. After seven days, close to 100% germination was achieved. Healthy tomato plantlets were selected from the seedbed and planted to field plots in early March. The experiment was set out in a completely randomised design with four replications. Each replicated plot consisted of seven plants with inter-row spacing of 1.5 m (5.0 ft), while within row spacing was 60 cm (2 ft) between plants. The plants were tied to stakes of approximately 1 m in length, placed at the side of each plant. Pruning treatment consisted of removing the lateral branches to retain a single stem and allowing it to climb along the stake support.

The usual cultural practices were observed to ensure that an even stand of plants was maintained in the field plots. A drip irrigation system supplied water throughout the experimental period. The plants were not treated with insecticides or fungicides, in order to determine their resistance or susceptibility to insect pests and diseases.

Tomatoes were harvested on the 10th, 17th and 28th of May 2013, when the first mature tomatoes, or crown set, were green ripened and of a marketable size. For this study, all observations and measurements were made on a set of three harvests of marketable tomatoes. A total of twenty-eight plants, seven plants for each of the four replications, were sampled for each harvest. Fruit displaying surface defects, uneven ripening, disease or insect damage were discarded.

The mean daily maximum and minimum temperatures for the trial period were 27.8^{o}C (82.1^{o}F) and 20.7^{o}C (69.2^{o}F), respectively. The total rainfall for the period was 568.7 mm (22.4 in). Mean monthly sunshine duration for the period was 8.7 h. Weather information (Table 1) was obtained from the Meteorological Department of The Bahamas.

Table 1. Weather data on rainfall, hours of sunshine and mean maximum and minimum temperatures for New Providence for the period of November 2012 to February 2013, courtesy of the Meteorological Department of The Bahamas.

Month	Total rainfall (mm/inches)	Mean monthly radiation (h)	Mean maximum temperature (°C/°F)	Mean minimum temperature (°C/°F)
February 2013	**50.8**/2.0	**8.7**	**27.2**/81.0	**19.6**/67.2
March 2013	**24.4**/1.0	**8.2**	**25.4**/77.8	**18.2**/64.8
April 2013	**66.8**/2.6	**9.4**	**29.2**/84.6	**22.6**/72.6
May 2013	**426.7**/16.8	**8.5**	**29.5**/85.1	**22.3**/72.1

Note: Monthly mean values have been rounded up to the nearest tenth.

Statistical Analyses:

All experimental results were analysed using Instat+™ v3.36 and ASSISTAT. Instat is an interactive statistical package, copyright © 2006, Statistical Services Centre, University of Reading, UK. All rights reserved. ASSISTAT, Version 7.6 beta (2013), website – http://www.assistat.com, by Fransisco de Assis Santos e Silva, Federal University of Campina-Grande City, Campina Grande, Brazil.

Results:

Over the three harvest dates there were no significant differences observed for the total number of fruit per plant, total weight of fruit per plant, number of marketable fruit per plant or weight of marketable

fruit per plant. There was, however, a significant difference in the weight of a single tomato fruit over the three harvest dates.

Table 2. Analysis of variance (ANOVA) for total number of fruit per plant, total weight of fruit per plant, weight of a single fruit, number of marketable fruit per plant and weight of marketable fruit per plant for the 'Inbar' tomato variety. Standard error is for each treatment mean. Error mean square has 83 df. *, ** and *** denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. NS indicates differences between means not significant.

		----------Significance levels----------				
Source	df	Total number of fruit per plant	Total weight of fruit per plant (g)	Weight of a single fruit (g)	Number of marketable fruit per plant	Weight of marketable fruit per plant (g)
Harvest date	2	NS	NS	*	NS	NS
Error	81					
Std. Err		0.3	62.7	5.7	0.3	60.2

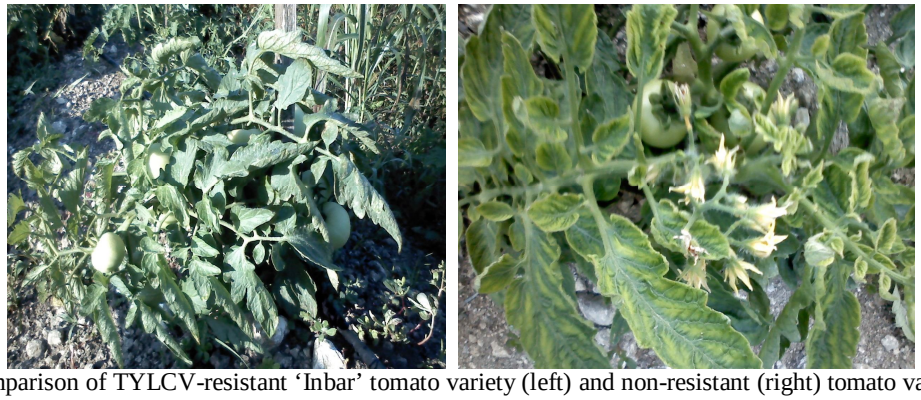
The mean values for the yield components of the 'Inbar' tomato variety, with respect to the total number of fruit per plant, total fruit weight per plant, average fruit weight, number of marketable fruit per plant and weight of marketable fruit per plant are presented in Table 3. These components are among the most important yield attributes in tomato (Pandey *et al*., 2006).

Table 3. Mean values of yield responses for the 'Inbar' tomato variety, assessed during May, 2013

Harvest date	Total number of fruit per plant	Total weight of fruit per plant (g)	Weight of a single fruit (g)	Number of marketable fruit per plant	Weight of marketable fruit per plant (g)
10 May, 2013	3.8b	768.0a	197.2a	3.4a	692.1a
17 May, 2013	5.3a	1008.1a	187.4a	4.5a	869.5a
28 May, 2013	4.9ab	822.3a	159.7b	4.8a	808.2a
Mean	**4.7**	**866.1**	**181.4**	**4.2**	**789.9**

The t-test at a level of 5% probability was applied. For each variety, means within columns bearing different lowercase letters differ significantly at 5% level of confidence.

The 'Inbar' tomato variety exhibited acceptable post-harvest quality characteristics, consistent with the basic requirements for the USDA standards for grades of fresh tomatoes (USDA-AMS, 1997). The tomatoes were medium to large in size, generally well formed and free of defects. No manifestation of the catface disorder occurred, nor was there any evidence of the tomato yellow leaf curl virus (TYLCV). Based on the results in Table 3 for the total yields per plant and marketable yields per plant, losses due to unmarketable quality tomatoes were less than ten percent.



Comparison of TYLCV-resistant 'Inbar' tomato variety (left) and non-resistant (right) tomato variety.

Discussion:

According to the results of a previous study (Richardson, 2013) on the quality and yield of five tomato varieties, the weight of marketable fruit per plant ranged from 449.1 g per plant to 2005.6 g per plant,

with a mean weight of 999.5 g per plant. At a mean weight of 789.9 g of marketable fruit per plant, the 'Inbar' tomato variety compared favourably to the five tomato varieties harvested in February, during the cooler season. Under high temperature conditions, the heat-tolerant 'Inbar' out yielded three of the five varieties of that study. It is clear that the higher temperatures during April and May, at the flowering and fruiting stages, did not have a negative impact on flowering and fruit set of this variety.

The results of this study suggest that the heat tolerant variety could be cultivated under conditions of The Bahamas during the warmer month of May and beyond. It can be used to extend the growing season. Its resistance to the TYLCV makes it an even more attractive tomato to incorporate within the cropping systems of local Bahamian farmers.

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