Original article

Yield of eight tomato (*Solanum lycopersicum* L.) cultivars in Granma province and their performance against Begomovirus

Elio Lescay-Batista[1*]

Dariel Molinet-Salas[1]

[1]Instituto de Investigaciones Agropecuarias “Jorge Dimitrov”, carretera Bayamo a Manzanillo km 16½, Gaveta Postal 2140, Bayamo 85 100, Granma, Cuba

[*]Author for correspondence: lescaybatistaelio@gmail.com

ABSTRACT

Two experiments were developed in the 2016-2017 and 2017-2019 seasons on a Fluvisol soil at the Agricultural Experimental Station, belonging to the "Jorge Dimitrov" Agricultural Research Institute, to determine the yield in eight tomato cultivars in Granma province and their behavior against begomovirus. These were planted in individual furrows 10 m long, in a randomized block design with three replications. The planting distance was 1.40x0.25 m per treatment. A factorial analysis of variance was applied for whitefly incidence and virus severity, and a two-way analysis of variance was applied for yield. Multiple comparison of means was performed by Tukey's test for $P \leq 0.05$. The results showed that both whitefly incidence and virus severity expressed low values, between 3.0 and 10.2 insects per plant in the former and between 1.02 and 1.31 % of plants affected in the latter. The cultivars showing the highest yields were HC-2580, HC-7880 and Rilia with values of 31.4, 31.0 and 29.6 t ha^{-1}, respectively.

Key words: geminivirus, whitefly, damage, virosis, TYLCV

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is the most economically important vegetable worldwide and one of the most consumed vegetables in the world (1). Its fruit is an essential component of the diet of millions of people (2). Fresh consumption and industry are the two main production destinations (3). Its demand is continuously increasing and with it its cultivation, production and trade (4).

Yields achieved in tomato cultivation in Cuba are low, as in most tropical countries. This is due to the negative effect of climatic factors and the high incidence of pests in the crop [(5)].

Among the main pests that affect tomato in Cuba and that cause yield losses of up to 100 %, are the commonly called "geminivirus" [(6)]. These constitute one of the families of viruses that infect vegetables, with DNA as genetic material. Among the genera that make up the Geminiviridae family, the one that causes the most damage is the begomovirus, transmitted by the whitefly *Bemisia tabacci* (Genn.) [(7)].

In tropical and subtropical zones of Mesoamerica and the Caribbean, infections by more than one geminivirus generally occur. Some begomoviruses have gained importance due to the insect vector and can produce losses in fields of 80-90 % [(8)].

This subject has been little studied in the territory that is why the present work was developed with the aim of determining the yield in eight tomato cultivars in Granma province and to evaluate their behavior against begomovirus in field conditions.

MATERIALS AND METHODS

The research was carried out in the period November-March in the 2016-2017 and 2017-2018 seasons, on a fluffy Vertisol soil [(9)], at the Agricultural Experimental Station belonging to the "Jorge Dimitrov" Agricultural Research Institute, in Bayamo municipality, Granma province.

The following cultivars were evaluated: HC-3880, FL-5, L-316, HC-2580, Rilia, Selección 1, Buena Ventura and I-10-7.

The data of the main climatic variables during the period in which the experiment was developed, were obtained from the record of Veguita Meteorological Station, belonging to the Ministry of Science, Technology and Environment, which are shown in Table 1.

Table 1. Behavior of the main climatic factors during the experimental period

Season	Months	Temperature (º C)			Relative Humidity (%)	Precipitacions (mm)
		Maximum	Minimum	Mean		
2016-2017	November	34.0	13.3	24.1	79.9	7.7
	December	35.2	15.3	25.3	77.7	3.1
	January	35.5	12.6	23.6	76.0	9.2
	February	36.9	14.4	25.5	72.5	9.5
	March	37.5	15.2	24.6	78.4	47.8
2017-2018	November	35.1	19.0	25.2	90.3	9.8
	December	34.9	16.2	24.0	87.9	23.4
	January	33.7	17.0	23.5	90.1	14.3
	February	33.6	14.9	24.0	80.8	2.5
	March	36.4	12.8	24.7	84.8	34.8

The seedbed was planted in the last week of October, in beds 10 m long and 1 m wide. Soil from the arable layer and organic matter from sheep in a 3:1 ratio were used as substrate. The conduction of this was carried out by means of technical indications for cultivation [10].

High quality seeds were used, coming from the working collection of the Agricultural Research Institute "Jorge Dimitrov".

Ten days after plant emergence, thinning was carried out to prevent the seedlings from becoming thin and weak for transplanting. Irrigation was done daily, by hand, in the afternoon and the beds were kept free of weeds until transplanting.

The seedlings were extracted 25 days after seed germination, when they were between 10 and 12 cm high, had three to four healthy and developed leaves, stem thickness of about 3 mm, bright green color and developed roots.

Fertilization was organic with sheep manure, applied manually at the bottom of the furrow at the time of transplanting, at a rate of 5 t ha^{-1}. Transplanting was carried out in a planting frame of 1.40 m between rows and 0.25 m between plants. Weed control was carried out manually with a hoe, keeping the experiment free of undesirable plants during its execution.

Individual furrows of 10 m length were used for each cultivar, distributed in a randomized block design with three replications.

On both sides of the experiment, two additional furrows were planted to counteract the edge effect. Also at harvest time, two plants were discarded from the ends of the furrows for the same purpose.

Irrigation was manual at the time of transplanting, flowering and fruiting. The rest of the cultural attentions were carried out according to the technical instructions for Organoponics and Intensive Orchards, established for tomato [11].

Ten plants were evaluated at random for each plot. The incidence of B. tobacco (number of adults per plant) and the severity of the disease (% of necrotic leaf area per plant) were determined in four samplings carried out every seven days after transplanting. To determine pest incidence, the number of *B. tabaci* adults on each plant was recorded and the data were processed using the following formula:

$$I = n/N$$

where:

N: is the number of adults

N: the number of plants observed

To evaluate the severity of the disease in the eight cultivars studied, we used the severity scale proposed by Lapidot et al. (2006) cited by other authors [12], where 0: plants without symptoms; 1: plants with light yellowing symptoms on the margin of the leaflets of apical leaves; 2: plants with yellowing symptoms and minor curling of apical leaflets; 3: plants with wide range of symptoms of leaf yellowing, curling and stabbing, with some reduction in size, but plants continue to grow; 4: plants with symptoms of severe yellowing and stunting, curling and stabbing, plant growth is stopped. With the data obtained, severity was calculated using the formula:

$$S = \Sigma a.b/X.N$$ [13]

where:

S= severity

a=number of plants in each grade

b= scale value

X= highest scale value

N= total number of plants

At the end of the harvests, the yield of each plot was estimated using the following formula:

$$Y = \frac{MFP}{AP} x\ 10000$$

where:

Y: yield (t ha^{-1})

MFP: mass of fruit per plot (t)

PA: plot area (m^2)

For the data corresponding to *Bemisia tabaci* incidence and disease severity, $log\ (X + 1)$ and $\sqrt(x + 1)$ transformations were used, respectively. Data for pest incidence and virus severity were processed by factorial analysis of variance (cultivars and samplings) and yield was estimated by double ranked analysis of variance. Multiple Range Tests of Means were performed by Tukey's test (p0.05), using the program statgraphics centurion on Windows, version xv [14].

RESULTS AND DISCUSSION

The results of the factorial analysis of variance are presented in Table 2. In the number of adults per plant, significant differences were observed between cultivars, between samples and in the interaction between both factors. In the percentage of affected plants, statistical differences were found between cultivars and samples, while in agricultural yield only significant differences were observed between cultivars.

None of the variables evaluated showed significant differences between years, nor in any of the interactions where these intervened, which indicates that the existing variations between both periods did not influence the behavior of these variables in any of the cultivars under study.

Table 2. Results of the factorial analysis of variance

Sources of variation	Mean squares		
	Number of adults per plant	**Affected plants (%)**	**Agricultural yield (t ha^{-1})**
Year (A)	0.301 ns	0.0011 ns	1.056 ns
Cultivar (C)	53.62*	0.2500*	489.6*
Sampling (M)	60.14*	0.019*	2.3151 ns
A x C	0.031 ns	0.0009 ns	1.8456 ns
A x M	0.083 ns	0.0018 ns	2.5410 ns
C x M	16.32*	0.0016 ns	2.6613 ns
A x C x M	0.045 ns	0.0021 ns	1.0992 ns
Error	0.144	0.002	1.2

Regarding the number of adults per plant (Table 3), treatments with the lowest incidence of the insect were FL-5-sample 1, FL-5-sample 4, L-316-sample 2, L-316-sample 4 and Rilia-sample 1. The last four treatments had no significant differences with HC-7880-sample 1.

Table 3. Behavior of cultivar x sampling interaction on whitefly incidence in eight tomato cultivars

Cultivars	Sampling				SE
	1	**2**	**3**	**4**	
HC-7880	3.9 (1.89) lm	6.0 (2.44) fghi	5.1 (2.19) jk	4.6 (2.09) kl	
FL-5	3.0 (1.64) n	5.8 (2.40) ghij	5.5 (2.31) hij	3.4 (2.12) mn	
L-316	7.5 (2.71) cd	3.3 (1.78) mn	6.3 (2.42) fgh	3.5 (1.76) mn	
HC-2580	9.9 (3.12) a	5.8 (2.39) ghij	9.5 (3.12) ab	5.3 (2.19) ijk	
Rilia	3.1 (1.76) mn	5.1 (2.78) jk	10.0 (3.12) a	6.6 (2.51) ef	
Selección 1	9.5 (3.07) ab	6.5 (2.48) efg	8.3 (2.81) c	5.8 (2.31) ghij	
Buena Ventura	8.1 (2.87) c	8.1 (2.81) c	9.7 (3.06) ab	7.2 (2.57) de	
I-10-7	6.0 (2.35) fghi	9.3 (2.96) b	10.2 (3.23) a	6.2 (2.42 fghl	0.026

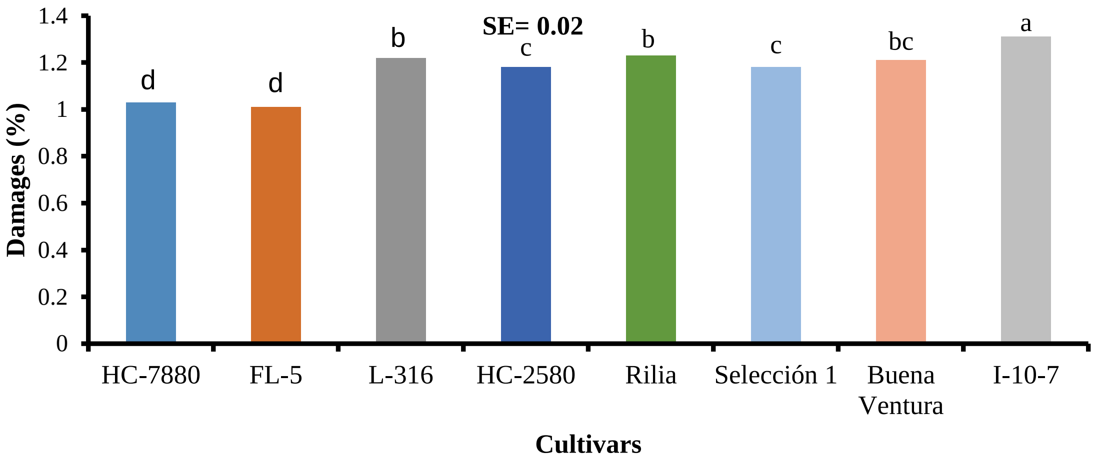
Means with equal letters show no significant differences between them in rows and columns for P≤0.05.
Data in parentheses refer to the means of the transformed data

The highest incidence was recorded in treatments HC-2580-sample 1, Rilia-sample 3 and I-10-7-sample 3 with averages between 9.9 and 10.2 adults per plant, with no significant differences with treatments HC-2580-sample 3, Selección 1-sample 1 and Buena Ventura in sample 3.

In general, the incidence of the pest was low, which may be due to the favorable climatic conditions in the area where the research was carried out, since it was carried out during the optimum period of the crop, which may have influenced the low population of the insect.

There are authors that point out that the incidence of this pest can be due to differences in plant structures such as hardness of tissues, pubescence, glandular and non-glandular trichomes (uni or pluri cellular structures that cover the surfaces of leaves and stems of plants and that differ in their morphology and functionality), which serve as an obstacle to phytophagous [(15)]. This last author also includes repellency as an example of plant defense mechanism, which is given by a set of characteristics such as color, smell, taste of the plant, by which a cultivar is less preferred by the herbivore for the oviposition and feeding process. It is also noted that the species *B. tabaci* is divided into different biotypes, which may have influenced in this sense [(16)].

The cultivars evaluated and the samplings carried out showed different responses to the severity of the virus. The values of affected plants were low (Figure 1), with averages ranging between 1.04 and 1.31 %, which shows some similarity with the low incidence mentioned above.



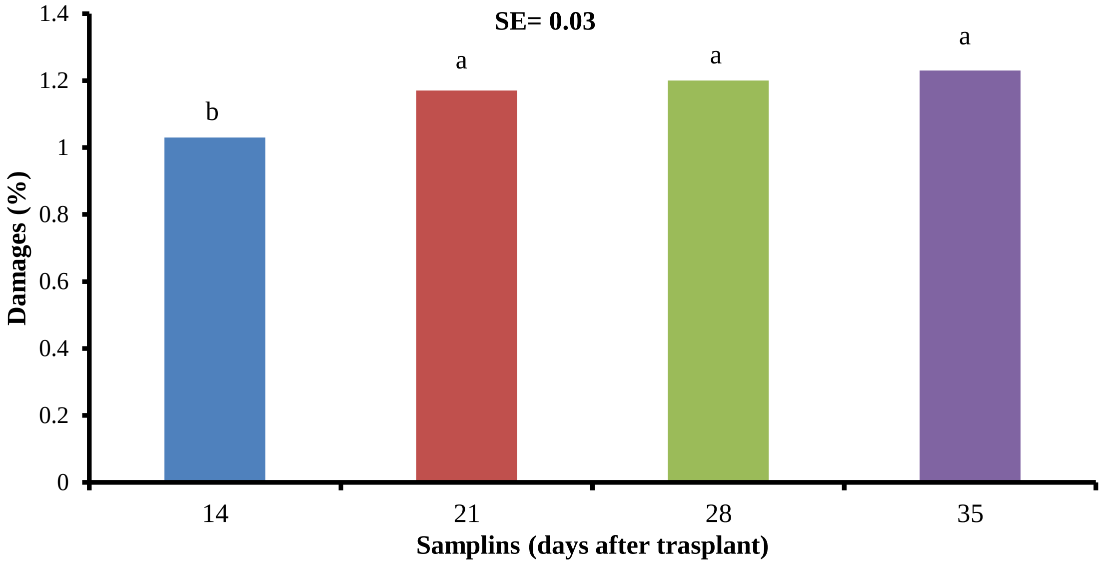
Bars with equal letters do not show significant differences between them for P≤0.05

Figure 1. Behavior of virus severity in eight tomato cultivars

Regardless of the low severity of the virus, it was observed that cultivars AC-7880 and FL-5 were the least affected and cultivar I-10-7 presented the highest percentage of affected plants, followed by cultivars L-316 and Rilia, the latter without significant differences with cultivar Buena Ventura.

The lowest number of virus-affected plants was observed in the first sampling, that is, in the second week after transplanting the seedlings (Figure 2). The appearance of symptoms at this stage does not coincide with the criterion of other authors, who point out that the symptoms of this disease appear several weeks after the infection occurs [(2)].

In a study carried out in seven industrial tomato cultivars in the Dominican Republic, it was found that the lowest incidence of virus appeared 25 days after transplanting, but increased 40 and 60 days after transplanting the plants; that is, the incidence of the virus increased as the dates of sampling increased [17].



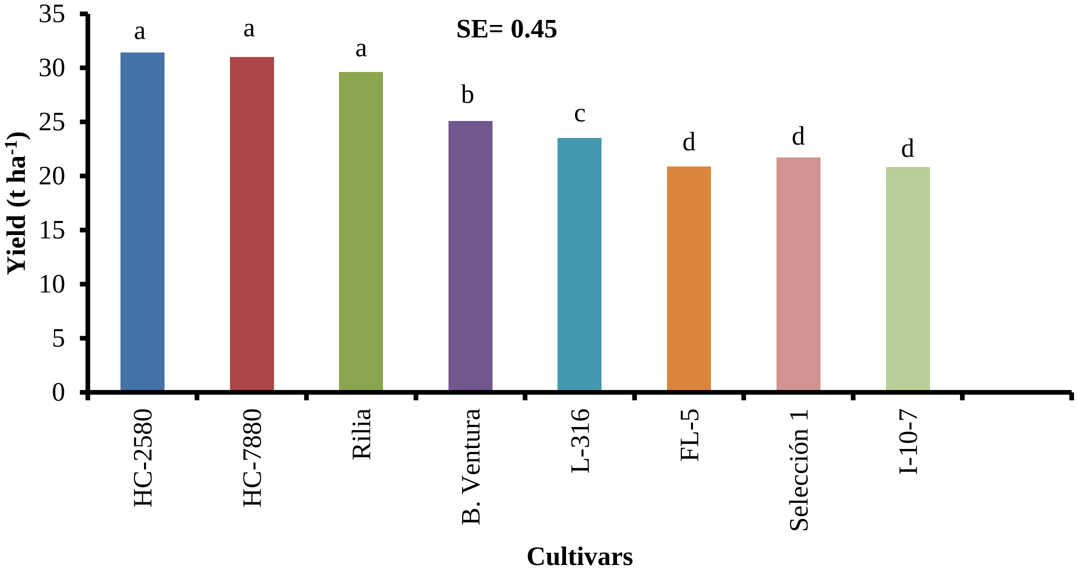
Bars with equal letters do not show significant differences for P≤0.05

Figure 2. Behavior of virus severity in different samplings in tomato cultivars under field conditions

Yield values ranged between 20.8 and 31.4 t ha^{-1} (Figure 3), which are higher than the 12.6 t ha^{-1}, average yield in Granma province [18]. The highest averages were obtained by the cultivars HC-2580, HC-7880 and Rilia with values of 31.4; 31.0; 29.6 t ha^{-1}, respectively, which statistically exceeded the rest of the cultivars.

The significant differences among the cultivars cannot be attributed to the presence of virus, since the severity was low, but may rather be due to the productive potential of the cultivars under these conditions.

All cultivars expressed yield values higher than 20 t ha^{-1}, thus exceeding the average yield of Granma province, which is around 12.6 t ha^{-1} [19], which is logical since the experimental results are generally higher than the production data.



Bars with different letters show significant differences for P≤0.05

Figure 3. Agricultural yield in eight tomato cultivars

It should be noted that the temperature and relative humidity conditions during the execution of the research (Table 1), can be considered favorable, since the optimum temperature and relative humidity for the crop oscillate between 18-30 °C and 60-80 %, respectively [3]. Other authors place the optimum temperature between 21 and 27 °C [20].

CONCLUSIONS

- The tomato cultivars evaluated showed low values for whitefly incidence and virus severity.
- Yield values ranged from 20.8 to 31.4 t ha^{-1}, with cultivars HC-2580, HC-7880 and Rilia standing out with yields of 31.4; 31.0 and 29.6 t ha^{-1}, respectively.

RECOMMENDATIONS

It is recommended to evaluate the performance of these cultivars in the non-optimal period.

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