Epidemiological Studies of *Citrus tristeza virus* in Cuban Commercial Citrus Areas

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ABSTRACT. Tristeza is one of the most destructive diseases of citrus. Epidemiological studies were performed considering that epidemiological surveillance of this disease is the basis for defining its adequate management under Cuban conditions. In the evaluations carried out, a slow progress of the *Citrus tristeza virus* (CTV) was found for the grapefruit plot; the proportion of infected plants hardly rising during 12 mo, although it is located in the highest CTV incidence region among those evaluated. In orange groves, during the same period, there was no variation in the number of infected plants in areas with low virus incidence but it rose quickly where initial infection was higher. An increase in the proportion of CTV-infected plants was found in the commercial citrus areas of Ceiba del Agua and Ciego de Avila, but not in Contramaestre. Factors, such as citrus species and CTV incidence in each field possibly influenced CTV dissemination. The virus spatial dissemination pattern was characterized, resulting in aggregation in most of the spatial scales analyzed, except in one of the fields. The studies of isopath areas enabled visualization of the overall spatial pattern of CTV in each area.

Tristeza became a serious threat in Cuba after the introduction in 1993 of the brown citrus aphid (BCA), *Toxoptera citricida* Kirkaldy, the most efficient vector of *Citrus tristeza virus* (CTV), due to the widespread use of sour orange rootstock. The CTV spatio-temporal spread in orange and grapefruit groves was studied to establish management strategies on a solid basis under Cuban conditions. Samples were collected in three commercial citrus areas in the country: Ceiba del Agua (CEI), Ciego de Avila (CA) and Contramaestre (CTRE) which are in the western, central and eastern regions, respectively. Two fields were selected from each area and three evaluations were performed with intervals of approximately 6 mo. The varieties included were Washington Navel, China and Valencia sweet oranges and Marsh grapefruit, all grafted on sour orange rootstock.

In each field, all trees included in a 400-plant quadrant were sampled and the presence of aphids was assessed during each sampling. They were analyzed by DASI ELISA using the 3C1F10 monoclonal antibody (1). CTV incidence (as a proportion of infected plants) in the fields was calculated for each evaluation, and the virus spatial pattern was evaluated by ordinary runs analysis, Dispersion Index (2) and determination of isopath areas (Statistica 5.0). The fields with low numbers of positive plants were excluded from the spatial analysis.

As shown in Table 1, the proportion of CTV-infected plants in three orange fields (CEI 1, CEI 2 and CA 4) rapidly increased in a 12-mo period. Meanwhile, for CTRE-5 and CTRE-6, also planted with sweet orange, no new positive plants was recorded, and in the CA-3 grapefruit field, the presence of CTV hardly increased during the same period of time. Low aphid populations were observed in all cases with less than 10% of the shoots being infested.

The results of the ordinary runs analysis showed that in most cases there were no significant aggregated sequences of infected plants. Such results indicate that CTV transmission in the studied fields does not take place from one plant to the immediately adjacent one, which does not eliminate the possibility of detecting aggregation when larger areas of the field are analyzed.

TABLE 1
NATURAL *CITRUS TRISTEZA VIRUS* SPREAD IN FIELDS FROM THREE DIFFERENT CITRUS REGIONS OF CUBA

Fields[a]	Variety	Proportion of CTV-infected plants		
		1st evaluation	2nd evaluation	3rd evaluation
CEI 1	Navel sweet orange	0.0160	0.0588	0.1578
CEI 2	China sweet orange	0.1166	0.1603	0.2099
CA 3	Marsh grapefruit	0.0083	0.0083	0.0138
CA 4	Valencia sweet orange	0.4016	0.4987	0.7008
CTRE 5	Navel sweet orange	0.00	0.00	0.00
CTRE 6	Navel sweet orange	0.0030	0.0030	0.0030

[a]CEI = Ceiba del Agua; CA = Ciego de Avila; CTRE = Contramaestre.

The Dispersion Index values indicated the existence of an aggregation pattern for the CEI-2 and CA-4 fields. On the other hand, in the CEI-1 field, a random spread pattern was observed in all evaluations, and the CA-3 field, characterized by a low incidence of the virus, showed an intermediate behavior. The contour maps of the isopath areas for the fields are shown in Fig. 1, which allow visualizing the CTV spatial patterns. These areas indicate zones of similar incidence and in all cases reflect the viral spread from the initial foci.

The results indicate that factors such as citrus species and the initial infection percentage in the fields influence CTV spread in Cuba. The CTV infection percentages were found to increase during the period evaluated in Ceiba del Agua and Ciego de Avila, but not in Contramaestre. The viral spread in general was aggregated, except for one of the fields.

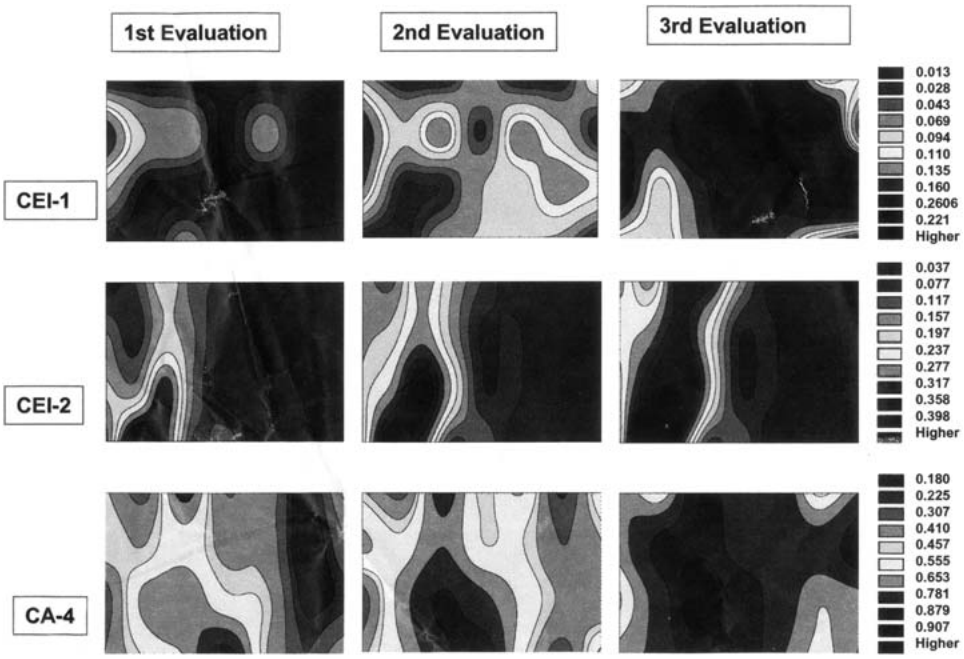

Fig. 1. Isopath areas in fields 1 and 2 from Ceiba del Agua and 4 from Ciego de Avila. The infection percentages are indicated by the color variation: from white (lower incidence) to black (higher incidence).

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