

Population survey of leafhopper vectors of *Xylella fastidiosa* in citrus nurseries, in Brazil

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ABSTRACT

INTRODUCTION. Citrus variegated chlorosis (CVC), a severe disease of citrus in Brazil, is caused by the bacterium *Xylella fastidiosa*. Apparently, the fast spread of CVC to distant geographic regions of Brazil took place through infected nursery plants. A monitoring of the population of sharpshooters, vectors of *X. fastidiosa*, in citrus nurseries of Northwestern São Paulo State was designed for developing strategies to control CVC at the nursery stage and to reduce dissemination of the disease through infected nursery trees. **MATERIALS AND METHODS.** Four nurseries located at different elevations, with or without irrigation, were surveyed. From October 1995 to September 1996, the number of adults of three sharpshooter species, known vectors of *X. fastidiosa* in Brazil, was counted, every 15 days, on 100 plants, selected at random in each of the four nurseries. **RESULTS AND DISCUSSION.** In general, the number of individuals started increasing at the onset of summer, peaked in late summer and autumn, and dropped in winter and spring. The vector population was higher and more persistent in the lowlands near a stream than in higher elevations far from water sources. Irrigation extended the period of occurrence of the sharpshooters and increased their population levels. **CONCLUSION.** To minimize early infection and spread of CVC among young trees, nurseries should be sprayed with insecticides during the period of sharpshooter occurrence. Special care should be taken in irrigated nurseries, which show higher numbers of sharpshooters over a prolonged period of time.

KEYWORDS

Brazil, *Citrus*, chlorosis, vectors, population dynamics, plant nurseries.

Étude des populations d'insectes vecteurs de *Xylella fastidiosa* dans les pépinières d'agrumes au Brésil.

RÉSUMÉ

INTRODUCTION. La chlorose variée des agrumes (CVC), sévère au Brésil, est causée par la bactérie *Xylella fastidiosa*. Apparemment, la rapide dissémination de la CVC au travers de régions géographiquement éloignées du pays s'expliquerait par la plantation d'arbustes contaminés. Une étude des populations d'insectes vecteurs de *X. fastidiosa* a été effectuée en pépinières d'agrumes localisées au nord de l'État de São Paulo, afin d'envisager un contrôle de la maladie dès le stade pépinière et, ainsi, réduire sa propagation due aux jeunes plants infectés. **MATÉRIEL ET MÉTHODES.** Quatre pépinières situées à différentes altitudes, irriguées ou non, ont été suivies. D'octobre 1995 à septembre 1996, les insectes adultes de trois espèces connues pour être des vecteurs de *X. fastidiosa* au Brésil ont été comptés, tous les quinze jours, sur cent plants choisis au hasard dans chacune des pépinières. **RÉSULTATS ET DISCUSSION.** En général, le nombre d'individus a commencé à croître au début de l'été, a culminé en fin d'été et en automne, et a baissé en hiver et au printemps. La population du vecteur a été plus forte et plus durable dans les basses terres proches d'un ruisseau qu'en zones plus élevées, éloignées d'un point d'eau. L'irrigation a rallongé la période de présence des insectes vecteurs et a favorisé leur multiplication. **CONCLUSION.** Pour réduire la contamination précoce des arbustes et la dissémination de la CVC, il est recommandé d'appliquer des traitements insecticides aux pépinières pendant la période propice au développement des insectes et d'apporter une attention particulière à leur irrigation, puisque cela favorise le développement des insectes et leur maintien.

MOTS CLÉS

Brésil, *Citrus*, chlorose, vecteur, dynamique des populations, pépinière.

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● introduction

Citrus variegated chlorosis (CVC), a severe disease of citrus in Brazil, is caused by the bacterium *Xylella fastidiosa* (LEE et al, 1993; HARTUNG et al, 1994). This disease was first observed in 1987 (ROSSETI et al, 1990). A survey carried out by Fundecitrus in 1995 showed that 26% of the citrus trees in the State of São Paulo are affected by CVC (SALVA et al, 1995). This disease is more severe in sweet orange [*Citrus sinensis* (L) Osbeck], resulting in fruits of smaller size and with a hard ring that damages the juicing machines.

The bacterium that causes CVC is limited to the xylem and cannot be cultivated on artificial media, commonly used for most plant pathogenic bacteria. All known vectors of *X. fastidiosa* are xylem sap-sucking leafhoppers (Hemiptera: Cicadellidae), also called sharpshooters, and spittlebugs (Hemiptera: Cercopidae). The fast spread of CVC in Brazil suggests that the bacterium is easily transmitted by vectors. Three species of sharpshooters commonly found on citrus trees in the State of São Paulo, *Dilobopterus costalimai* Young, *Acrogonia terminalis* (Young) and *Oncometopia facialis* (Signoret), have been confirmed as vectors of *X. fastidiosa* to citrus (LOPES et al, 1996; ROBERTO et al, 1996).

Apparently, the fast spread of CVC to distant geographic regions of Brazil took place through infected nursery plants. It is likely that the vectors play an important role in the inoculation and infection of young nursery plants with *X. fastidiosa*. However, very little is known about the incidence and population dynamics of sharpshooter vectors in nurseries. This study was designed to monitor the population of sharpshooters in citrus nurseries of Northwestern São Paulo State, in order to developing strategies to

control CVC at the nursery stage and to reduce dissemination of the disease through infected nursery trees.

● materials and methods

The population of three species of sharpshooters commonly found on citrus trees, *D. costalimai*, *A. terminalis* and *O. facialis* was monitored in citrus nurseries in the Northwest part of the State of São Paulo, where CVC incidence is very high. Four nurseries located at different elevations, with or without irrigation, were surveyed (table I).

In each nursery, the population of the three sharpshooter species was surveyed every 15 days in five points selected at random, by counting the number of adults, all species combined, on plants per point. Each point was represented by two rows of 10 plants (area = 2 m²). Surveys were carried out from October 1995 to September 1996.

● results and discussion

The population of sharpshooters in the citrus nurseries was markedly influenced by elevation, relating to water proximity, and by irrigation. In general, the numbers of individuals started increasing in December – the onset of summer –, peaked in February to June – late summer and autumn –, and dropped during the winter, which is the dry season, and from July to November, the spring months (figure 1). However, the overall population was higher and more persistent in the nursery located in lowland, near a stream (figure 1D) than in nurseries located at higher elevations, far from water sources (figure 1A, B, C). For both high and low elevations, the practice of irrigation extended the period of occurrence of the sharpshooters and increased their population levels.

In the non-irrigated highland nursery, the occurrence of sharpshooters was restricted to the period of December to June (figure 1A), while in the non-irrigated nursery located at medium elevation the insects were recorded throughout the year except in Septem-

Table I
Locality and characteristics of the citrus nurseries surveyed in the State of São Paulo, Brazil.

Nursery	Locality	Irrigation	Elevation
Faz Pirajá	Neves Paulista	No	Highland
Faz Córrego Azul	Neves Paulista	No	Medium elevation
Faz Tanquinho	José Bonifácio	Yes	Highland
Faz Água Limpa	Neves Paulista	Yes	Lowland (near water)

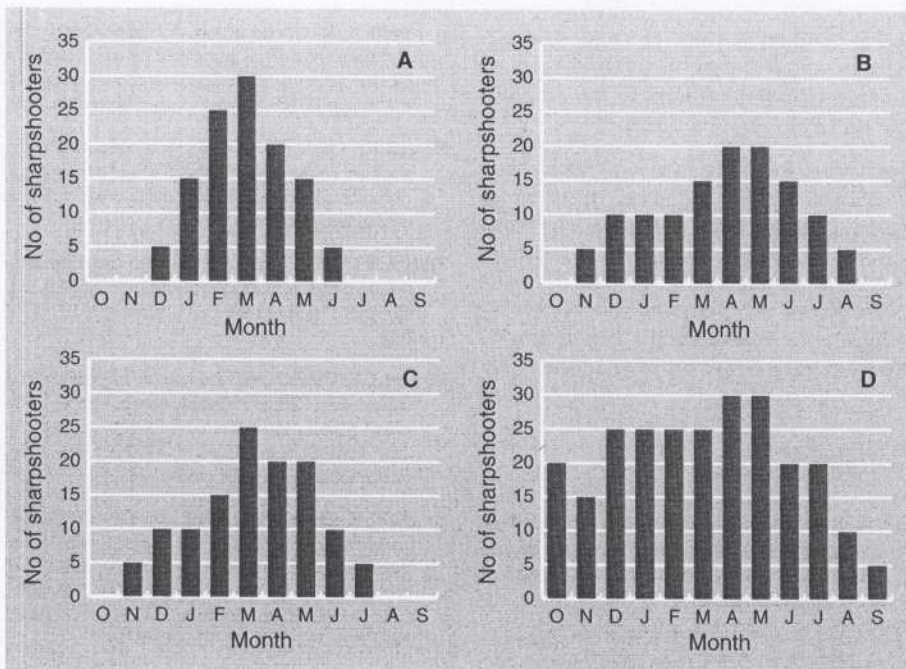


Figure 1
Total number of sharpshooters sampled per month, two sampling dates combined, in four citrus nurseries located at: A) high elevation, without irrigation; B) medium elevation, without irrigation; C) high elevation, with irrigation; D) low elevation, with irrigation.

ber and October (figure 1B). With irrigation, the occurrence of sharpshooters in highland extended over a longer period – from November to July (figure 1C) –, but the population levels were considerably lower than those observed in the irrigated nursery located in lowland (figure 1D). A high population of sharpshooters was observed almost the whole year in the irrigated lowland nursery, with a decline, but without disappearance, only at the end of the dry season – from August to September (figure 1D).

These results suggest that water availability is a major factor conditioning the perpetuation of sharpshooter populations during the winter – the dry season – and the spring in citrus nurseries. Water deficiency in non-irrigated areas usually results in lower production of young shoots by the citrus trees and, probably, alters nutrient levels and the tension in the xylem, which, in turn, might affect sharpshooter feeding and preference. The rate of feeding of the sharpshooter *Homaladisca coagulata* (Say), for example, was found to be significantly correlated with xylem tension and concentration of amides and total amino acids in the natural host plant, *Lagerstroemia indica* L (ANDERSEN et al, 1992). Therefore, during the dry season, these insects probably move to irrigated

citrus groves/nurseries or search for alternative hosts in more humid habitats such as shrubs or woods located in lowlands near rivers, streams or swamps. In the Southern United States, the most efficient sharpshooter vector of *X. fastidiosa* in grapevines (Pierce's disease), *Graphocephala atropunctata* (Signoret), overwinters as adults (SEVERIN, 1949) and feed early in the spring on wild blackberry, elderberry, mugwort and other plants located along streams where shade and soil moisture are available for succulent growth (PURCELL, 1975, 1979).

● conclusion

Considering that many nurseries in the State of São Paulo are close to CVC-infected groves, it is likely that significant vector transmission of *X. fastidiosa* starts at the nursery stage, particularly during the summer and autumn when high numbers of sharpshooters visit the nurseries. To minimize early infection and spread of CVC among young trees, nurseries should be sprayed with insecticides during the period of sharpshooter occurrence. Monitoring for sharpshooters by placing yellow sticky cards along the nursery's borders could be useful to indi-

cate the correct timing of insecticide application. In addition, spraying could be effected in an approximately 30 m border around the nursery to reduce immigration of sharpshooters from adjacent areas.

Special care should be taken in irrigated nurseries located in low and humid areas, which show higher numbers of sharpshooters over a prolonged period of time. New nurseries should be installed as far as possible from CVC-infected citrus groves and preferably in highlands where vector population is expected to be lower for most of the year.

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Estudio de las poblaciones de insectos vectores de *Xylella fastidiosa* en los viveros de cítricos de Brasil.

RESUMEN

INTRODUCCIÓN. La clorosis variegada de los cítricos o amarilleamiento (CVA) rigurosa en Brasil, es causada por la bacteria *Xylella fastidiosa*. La rápida diseminación de la CVA a través de regiones geográficamente alejadas del país se explicaría, aparentemente, por la plantación de arbustos contaminados. Se efectuó un estudio de las poblaciones de insectos vectores de *X. fastidiosa* en viveros de cítricos, situados al norte del estado de São Paulo, para programar un control de la enfermedad desde la fase vivero y, de esta forma, reducir su propagación por plántones infectados. **MATERIAL Y MÉTODOS.** Seguimiento de cuatro viveros, con o sin irrigación, situados en distintas altitudes. De octubre 1995 a septiembre 1996 se contaron, cada quince días y en cien plantas escogidas al azar en cada vivero, los insectos adultos de tres especies, conocidas por ser vectores de *X. fastidiosa* en Brasil. **RESULTADOS Y DISCUSIÓN.** En general, el número de individuos comenzó a crecer el principio del verano y en otoño, y bajó en invierno y primavera. La población del vector fue más densa y duradera en las tierras bajas, próximas de un arroyo, que en zonas más elevadas, alejadas de puestos de agua. La irrigación prolongó el periodo de presencia de los insectos vectores y favoreció su multiplicación. **CONCLUSIÓN.** Para reducir la contaminación precoz de los arbustos y la diseminación de la CVA, se aconseja la aplicación de tratamientos insecticidas en los viveros, durante el periodo propicio para el desarrollo de los insectos, y prestar una especial atención a su irrigación, ya que ésta favorece el desarrollo y persistencia de los insectos.

PALABRAS CLAVES

Brasil, *Citrus*, chlorosis, vectores, dinámica de la población, viveros.