CARIBBEAN FOOD CROPS SOCIETY

46

Forty Sixth
Annual Meeting 2010

Boca Chica, Dominican Republic

Vol. XLVI – Number 2

T-STAR Invasive Species Symposium

PROCEEDINGS
OF THE
46th ANNUAL MEETING

Caribbean Food Crops Society
46th Annual Meeting
July 11-17, 2010

Hotel Oasis Hamaca
Boca Chica, Dominican Republic

“Protected agriculture: a technological option for competitiveness of the Caribbean”

“Agricultura bajo ambiente protegido: una opción tecnológica para la competitividad en el Caribe”

“Agriculture sous ambiance protégée: une option technologique pour la compétitivité de las Caraïbe”

United States Department of Agriculture,
T-STAR Sponsored Invasive Species Symposium

Toward a Collective Safeguarding System for the Greater Caribbean Region:
Assessing Accomplishments since the first Symposium in Grenada (2003)
and Coping with Current Threats to the Region

Special Symposium Edition
Edited by
Edward A. Evans, Waldemar Klassen and Carlton G. Davis

Published by the Caribbean Food Crops Society

ISSN 95-07-0410

Copies of this publication may be received from:

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USVI Cooperative Extension Service
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Isabella, Puerto Rico 00663

Proceedings of the Caribbean Food Crops Society. 46(1): 61-64. 2010

CITRUS LEPROSIS, A MAJOR THREAT TO PRODUCTION OF ORANGES

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ABSTRACT

The emergence of mites as vectors of plant viruses has serious implications and economic importance for the movement and spread of plant viruses such as citrus leprosis virus. This virus is the causal agent of citrus leprosis disease, a disease that has resulted in serious economic losses due primarily to issues of early detection and high production costs incurred to manage the mite vector. The importance of this disease and emergency management are discussed below.

INTRODUCTION

Mite-vectored viruses have grown in increasing importance, with mites belonging to the families Eriophyidae and Tenuipalpidae being implicated in virus spread. Eriophyid mites have been reported as vectors of several Rymo, Clostero, and possibly Nepo-viruses (Kitajima et al. 2003). Brevipalpus mites of the family Tenuipalpidae have emerged as virus vectors, primarily because of their association with the economically important citrus leprosies virus, the causal agent of citrus leprosis disease. Citrus leprosis, prior to its disappearance from Florida after 1960, almost decimated the Florida citrus industry, with estimated losses at 35–75% (Fawcett 1977). These figures were similar to that recorded in Brazil (Rodriguez et.al. 2003), where citrus leprosis disease is currently one of the most economically important disease (Bastianel et al. 2010). Brazil has recorded US$80 million each year for vector control. Severe economic losses occur when the mite vector is not effectively controlled, coupled with highly susceptible citrus cultivars (Rodrigues et al. 2003). This contributes to reduced yields and poor fruit quality. In the case of the latter, this can result in lower commercial value of spotted fruit, especially those earmarked for the fresh fruit market.

GEOGRAPHIC DISTRIBUTION

Citrus leprosis disease has been reported in South America, where it is endemic to Argentina (1930s), Paraguay and Uruguay (1950s), and Brazil (1940s). It was later detected in Venezuela (1999), Bolivia (2003), and Colombia (2006). The disease has spread northward to Central America, where it has been reported in Panama (2000), Costa Rica (2000), Nicaragua (2003), Guatemala (2003), Honduras (2003), and El Salvador (2003). The disease was recently detected in southern Mexico. The proximity of the disease to leprosis-free areas of the United States and the Caribbean islands is a cause for concern in light of the potential introduction / reintroduction (as is the case with Florida), spread, and damage. In addition, potential vectors are already present in the Pest Risk Areas. *Brevipalpus phoenicis* a known vector of the virus is present in Jamaica.

CITRUS LEPROSIS PATHOSYSTEM

Causal Agent

In Florida in the early 1900s, citrus leprosis disease was initially thought to be caused by fungi due to the association of certain fungi with scaly bark symptoms (Fawcett and Burger 1911). After its appearance in Brazil, it was thought be caused by a virus due to the presence of ringspot symptoms usually associated with viral pathogens. The disease can be caused by two completely distinct viruses (which do not share genomic sequences): Citrus Leprosis virus – Cytoplasmic type (CiLV-C) (prevalent form) and Citrus Leprosis virus – Nuclear type (CiLV-N) (little known). Both share similar morphology and vectors. CILV-C is currently under consideration as a full species. The virus is found localized only in conspicuous lesions (Bastianel et al. 2010); hence the infection is not systemic but localized.

Transmission

In Argentina around the 1940s, it was demonstrated that citrus leprosis virus was transmitted by a mite, identified later as *Brevipalpus obovatus Donnadieu* (Vergani 1945), which was later confirmed in the United States by Knorr (1950); in Florida and Guatemala, *B. californicus* was implicated in the transmission of the citrus leprosis virus. In Brazil, Musumecci and Rosetti (1963) associated *B. phoenicis* Giejskes with symptomatic plants.

The genus *Brevipalpus* is recognized as the most important group within the family Tenuipalpidae and is mostly found in tropical to subtropical climates (Childers et al. 2001). They are referred to as false spider mites, or flat mites, and several species are of economic importance on various crops including citrus, coffee, tea, pistachio, passion fruit, and numerous ornamental plants.

B. obovatus, B. phoenicis, and B. californicus are recognized as the most economically important as vectors involved in the citrus leprosis pathosystem. Only in the presence of citrus leprosis virus are these species considered key pests. All active stages of *Brevipalpus* spp. can acquire and transmit the virus. CiLV-C is not transovarially transmitted, but is circulative and not propagative in the vector (Bastianel et al. 2010).

Symptoms

The symptoms of citrus leprosis disease can take several weeks to months to appear. Symptoms can be observed on citrus leaves, stems, and fruits. Symptoms vary with the host species, the stage of development, and the pathogen isolates. Typical lesions can be described as follows: chlorotic, or necrotic, and circular, with a diameter ranging 5–12 mm. Lesions are localized where mites have fed. A darker central point in older lesions may also be observed, and symptoms such as ring spots may also occur. Trees affected by the disease show a decline in production due to a reduction in tree canopy development, premature fruit and leaf drop, dieback, and even death of young susceptible plants.

Host Range

The natural host range for citrus leprosis virus includes the *Citrus* spp. in grapefruit (*C. paradisi*) and oranges (*C. sinensis*). Lemons (*C. limon*) and mandarins (*C. reticulata*) are considered less susceptible. The first non-citrus host *Swinglea glutinosa* (Rutaceae) was reported from Columbia. The experimental host range includes transmission by viruliferous mites to *Solanum violaefolium*, *Phaseolus vulgaris*, and other species of plants that occur near citrus orchards (Rodrigues et al. 2005; Bastianel 2010). Although the list of alternative hosts for CiLV-C is growing, their role in the epidemiology of the disease is still to be elucidated.

The main means of spread of the virus is through feeding and movement of viruliferous mites. *Brevipalpus* mites have been found infesting more than 200 different plant species (Rodrigues et.al. 2003). However, known plant hosts of *B. californicus*, B. *obovatus*, and *B. phoenicis* include nearly 100 plant species (Rodrigues et.al. 2003).

INTERNATIONAL SPREAD

International movement of planting material is more likely to spread the pathogen on rooted symptomless plants harbouring viruliferous mites. This happens when plants are moved illegally from region to region. Little is known about the role of alternative natural hosts, so there may be a slight risk of introduction via other plant species. Other plant species could carry polyphagous viruliferous mites that have moved from citrus to these hosts (Rodrigues et.al. 2003).

Childers and Rodrigues (2005) found that plant shipments arriving via air cargo from Central America contained mites from 11 families recovered from a variety of ornamental plant genera. The mite species included *B. phoenicis*, a known vector of citrus leprosis virus. Childers and Rodrigues (2005) recommended the implementation of a special sampling program for mites on live plant material received at ports of entry, andnew legislation requiring that imported plant propagules be free of pest mites and that mandatory risk mitigation be implemented in nurseries abroad where shipments originate.

It is believed that the current spread of the virus in Central America may have occurred because the disease went unnoticed for some time. If the vector is not managed early, the disease will spread, though slowly at first, and damage will be evident in two to three years. Citrus leprosis is considered a polyetic disease in that the amount of infected tissue and initial inoculum increase yearly (Bastianel et al. 2010).

EMERGENCY RESPONSE AND MANAGEMENT

Attempts by countries to eradicate the pathogen after the first report began too late because the disease had already spread for some time before the symptoms were identified. Success in Costa Rica was due to a limited area being affected, but the country is still threatened by the presence of the pathogen in Nicaragua. Success in the United States in the early 1900s was attributed to use of sulphur acaricides and unfavourable climatic weather. It is also thought that the virus present in Florida was the CiLV-N, which may have shown low fitness (Bastianel et al. 2010).

Childers et. al. (2001) have recommended:

- Establishing quarantines for movement of citrus plant parts from affected countries
- Developomg a program for rapid detection and identification of disease symptoms and the pathogen via linkages with local universities
- Creating public awareness campaigns to sensitize growers/stakeholders
- Developing a monitoring program
- Establishing area-wide management zones to facilitate treatments

Those countries that are currently living with the disease, such as Brazil, are faced with increased production costs due to environmental factors that favor vector development and colonization of citrus orchards throughout the year. In addition, the presence of large contiguous areas of highly susceptible sweet orange varieties and the endemic presence of the virus in traditional citrus growing regions contribute to the epidemics that occur, especially during drought conditions. Growers in Brazil are faced with the cost of continued scouting of fields, applications of acaricides that must be timed using empirical thresholds based on documented incidences of mites on fruits and branches (Bastianel et al. 2010). Sampling challenges continue to be a problem because of low mite population densities and their uneven distribution in orchards. Investigations now show a low correlation between mites and disease foci in the field since only a percentage of the mite population vectors the virus. The economic and environmental impacts of pesticide use are also high (Bastianel et al. 2010)

The current challenges faced by the citrus industries of Florida and Jamaica in the presence of citrus greening will be further compounded with the introduction of the citrus leprosis virus. Such an incursion would contribute to the decimation of these industries.

RECOMMENDATION

It is hereby recommended that resources be committed to regional monitoring for the pathogen, medium-term investigations into the role of alternative hosts in the epidemiology of the disease, and the identification of environmentally yet efficacious field mite treatments. Long-term solutions should include the development of resistant varieties that must also have acceptable horticulture traits.

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