SURVEYS, CERTIFICATION AND OTHER TOPICS

Current Situation on Citrus Virus and Virus-like Diseases and their Vectors in Mexico

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ABSTRACT. The available information on citrus virus and virus-like pathogens in Mexico is presented here. *Citrus exocortis viroid* (CEVd) is common in old plantations of sweet-fruited species grafted on the predominant sour orange rootstock. CEVd occurs commonly in mixed infections with either *Hop stunt viroid* variants or *Citrus viroid III* on Tahiti lime plantations from different locations. *Citrus tristeza virus* has been reported to occur in symptomless infections in 17 states of the country. Psorosis-like symptoms are common in some old groves, but occur at relatively low incidence throughout the country. Citrus blight has been identified in some particular groves grafted on rough lemon in the Yucatan Peninsula. No information is available on the occurrence of other viral pathogens such as vein enation virus and tatter leaf virus.

Citrus in Mexico is of major economic and social importance and is a permanent source of income. Currently the citrus industry consists of more than five hundred thousand hectares distributed in different ecological regions around the country. There are approximately 67,000 citrus growers and more than 138 packinghouses and 19 fruit processing plants nationwide. Annual production is 5.5 million tons of fruit, of which 75% is for fresh market, 15% for fruit processing and 10% for export.

Citrus viroids. Surveys conducted in selected groves in the northeastern states of Nuevo León and Tamaulipas showed a 50% incidence of *Citrus exocortis viroid* (CEVd), as determined by inoculation into citron indicator plants. Infections of CEVd were symptomless and hence overlooked by citrus growers, because of the predominance of sour orange rootstock in most citrus plantations (26, 33). When fruit production and tree growth were evaluated in a grove of sweet orange on Troyer citrange rootstock affected by CEVd, the results showed that infected trees produced only one third of the fruit that was produced on the CEVd-free trees. Trunk diameter and canopy volume of infected trees also showed values reduced by close to one-third (33). The occurrence CEVd along with other citrus viroids is presumed to be widespread in old line cultivars of sweet-fruited citrus species (orange, grapefruit, mandarin and mandarin hybrids) around the country, mostly because of the predominance of sour orange as a rootstock (28). In Tahiti lime groves from several parts of the country, CEVd occurs commonly in mixed infections with Citrus viroid II (CVdII) (*Hop stunt viroid* variants), and *Citrus viroid III* (CVdIII) (1, 2). The typical symptoms of cachexia disease caused by CVdIIb or CVdIIc (25) occur commonly on trees grafted on alemow rootstock (2). These trees commonly show stunting and

reduced trunk diameter below the bud union, along with brownish lesions on the wood which are noticeable when a portion of bark is removed at the bud union (2). The presence of citrus viroids in either sweet citrus species or Tahiti lime samples collected from diverse locations indicates the continuing use of infected budwood sources for the establishment of new plantations.

Tristeza. *Citrus tristeza virus* (CTV) was reported in Mexico as early as 1982 in a foundation block in the northeastern state of Tamaulipas (36). CTV was found later in several other parts of the country (29, 37), and this subsequently led to the establishment of a nationwide campaign conducted by the federal government for a serological survey for CTV (31). Currently, the presence of symptomless CTV-infected trees has been reported in 17 of the citrus growing states of the country (32).

Relatively limited research has been conducted on the serological and molecular characterization of CTV isolates. Both mild and decline-inducing CTV isolates were reported in the state of Nuevo Leon (29, 34) as identified by tests using the strain specific monoclonal antibody MCA 13 (23). Further studies of these isolates using single stranded conformational polymorphism analysis (17) and molecular cloning and sequencing (11), revealed the presence of mild, decline-inducing and stem-pitting CTV isolates. Some additional information on the molecular characterization of some CTV isolates from Tamaulipas and Veracruz is also available (9, 13).

To assess the distribution and dissemination of CTV in the field, a survey conducted twice a year during 1996-1998 which looked for CTV in individual trees in three commercial groves in the state of Nuevo Leon, showed an increase in CTV occurrence of 0.27 and 0.18%, in the groves of Montemorelos and Linares, respectively. No CTV spread was detected in the grove of Hualahuises (34). Even though some samples were reactive with the decline strain discriminating MCA-13 monoclonal antibody (23), no disease symptoms were observed under field conditions (29, 34). Similar studies conducted in the neighboring state of Tamaulipas during 2001-2002 showed some increase in the CTV incidence as measured from initial infected foci, showing the relative spread of CTV in the groves (13).

The aphid species that vector CTV and which are prevalent in most of the citrus groves are *Aphis gossypii* Glover, *A. spiraecola* Patch and *Toxoptera aurantii* Boyer de Fonscolombe (7, 18, 22, 24, 34). The presence of *Toxoptera citricida* (Kirkaldy) (the brown citrus aphid or BrCA), the most efficient CTV vector (27) was first reported in February of 2000 in the Peninsula of Yucatan (38), and in the following four years, this vector moved into the neighboring states of Campeche, Tabasco and Veracruz on the Gulf of Mexico (32). Upon discovery of the BrCA infestations in the Yucatan Peninsula in 2000, the federal government jointly with local Citrus Plant Protection Boards established a campaign for the permanent release of aphid predators. These predators included the coccinellid beetles *Harmonia axyridis* (Pallas), *Cycloneda sanguinea* L., and *Olla v-nigrum* (Hagen), and the chrysopid lacewings *Ceraeochrysa claveri* (Navás), and *C. cubana*, (Mulsant) (14, 16). The aphid predators have not prevented significant long distance moving of BrCA. In addition these insect predators, some field and laboratory experiments have been conducted with entomopathogenic fungi. *Beauveria bassiana* (Balsamo) Vuillemin, *Paecilomyces fumoroseus* (Wize) Brown & Smith and *Verticillium lecanii* (Zimmermann) Viégas, have shown variable infection rates in BrCA populations (3). The long distance movement of the BrCA has been mostly associated with incidental movement by people and/or trans-

portation vehicles, rather than natural spread of the insect. Therefore, the effectiveness of natural enemies has not been fully assessed.

Citrus psorosis. Symptoms of bark scaling typical of citrus psorosis are commonly found in some old groves in different regions of the country, particularly on old line cultivars of sweet-fruited species (19). Positive identification of *Citrus psorosis virus* has been documented in the northeastern state of Nuevo Leon (12).

Disorders of unknown etiology. Citrus blight has been identified in some groves on rough lemon rootstock in the Yucatan Peninsula (39). There are other virus-like disorders named "Amachamiento" in sweet orange in Veracruz and Tamaulipas (20), and "Lethal yellowing of Tahiti Lime" in the state of Veracruz (5). The plants affected by these two disorders show poor growth and reduced fruit set and production (5, 20). While "Amachamiento" is of unknown etiology (20), "Lethal yellowing of Tahiti Lime" has been associated with the presence of citrus viroids and phytoplasmas (35). However, proof of their role in causing the disease symptoms remains to be determined.

Other insect vectors. The presence of the Asiatic citrus psyllid (ACP) (*Diaphorina citri* Kawasaki), the vector of the Huanglongbing disease bacteria (6), was reported in the Peninsula of Yucatan in 2001, and its presence has been subsequently recorded in several other citrus growing states of the country (15). In addition, the presence of several mite species of the genus *Brevipalpus*, which are known vectors of Citrus leprosis virus, has been reported to occur in several citrus growing states (10). The presence of both the ACP and mites warrants attention because of the recent reports of Huanglongbing disease in Brazil (4) and Citrus leprosis virus in Central America (21, 30).

Citrus certification program. In 2000, the federal government established some specific regulatory actions and published federal guidelines and policies regarding the nationwide campaign against CTV and the brown citrus aphid, as well as the establishment and maintenance of the Citrus Budwood Certification Program. Currently there are ten certified foundation blocks that provide clean budwood of diverse citrus cultivars and rootstock seed nationwide (8).

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