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Abstract. This paper summarizes the field status of citrus tristeza virus (CTV) in Lebanon. Based on the first virus survey conducted in citrus commercial groves and nurseries in autumn of 1996, CTV was reported officially in Lebanon with an overall infection rate of 1.43%. Another survey was undertaken between 1998 and 2000 in Mount Lebanon in addition to the adoption of four experimental plots in the South to assess the CTV incidence. CTV was only detected in the South with an increased infection rate from 1.2 to 3.8% in plot II, and from 2 to 5% in plot III whereas the CTV infection rate in plot I was stable (1.1%) with no concomitant infection in plot IV. The vectors *Aphis gossypii* and *Aphis citricola* were identified whereas *Toxoptera citricidus*, the most efficient CTV vector, was not encountered. With the aim to establishing a citrus mother block for the production of plant certified material, another field survey was carried out between 2003 and 2004 in the South and North of Lebanon close to LARI stations and CTV was found only in the South. Interestingly, no evidence of the disease was observed in the CTV-infected trees as ascertained by repeated observations in the field. Further work and preventive measures should be applied to secure the future of the citrus industry in Lebanon.

Keywords. Citrus – CTV – Lebanon – Vectors.

Situation actuelle du virus de la tristeza au Liban

Résumé. *Cette étude résume l'état du virus de la Tristeza des agrumes (CTV) au Liban. Sur la base d'une première prospection menée en automne 1996 dans les vergers commerciaux et pépinières des agrumes, le CTV a été signalé officiellement au Liban avec un pourcentage d'infection égal à 1.43 %. Une autre enquête a été réalisée entre 1998 et 2000 au Mont Liban, ainsi que dans quatre parcelles expérimentales au Sud afin d'estimer l'incidence du CTV. Le virus a été détecté uniquement au Sud où le pourcentage d'infection a évolué durant les trois années d'expérimentation en passant de 1,2 à 3,8 % dans la parcelle II, et de 2 à 5 % dans la parcelle III, tandis que le pourcentage d'infection dans la parcelle I est resté stable (1,1 %). Aucune infection n'a été signalée dans la parcelle IV. Les vecteurs Aphis gossypii et Aphis citricola ont été identifiés, tandis que Toxoptera citricidus n'a pas été retrouvé. Dans le but d'établir une parcelle de pieds mères destinée à la production de matériel certifié, une autre prospection a été effectuée aux alentours des stations de l'IRAL au Sud et au Nord du pays. Le virus a été trouvé seulement au Sud. Par ailleurs, les symptômes typiques n'ont pas été observés chez les arbres infectés. Des mesures préventives sont à appliquer dans l'avenir afin de préserver l'agrumiculture au Liban.*

Mots-clés. *Agrumes – CTV – Liban – Vecteurs.*

I – Introduction

With an area of about 16,940 ha, representing 6.3% of the total agricultural area, citrus ranks second among fruit trees grown in Lebanon (Anonymous, 2005). The average annual production is estimated at 395,000 tons (Anonymous, 2005). The main citrus growing areas in the country are located primarily in the South and North along the costal area. Currently, Washington Navel, Valencia and Shamouti sweet oranges, lemons, grapefruits, and mandarins are the main species grown in Lebanon. Little is known about the phytosanitary status of these species with respect to virus and virus-like diseases, the only available information stems from a limited survey conducted in 1996 (Saade, 1997; D'Onghia *et al.*, 1998). The lack of a certification program in the past, the exchange of citrus plant material of unknown sanitary status, and the lack of phytosanitary measures increased the incidence of viral problems, in particular the risk of citrus tristeza diffusion due to the alarming presence of CTV in Israel and recently in Syria (Abou Kubaa, 2006). This

situation urged local investigators to assess the occurrence of citrus tristeza virus in Lebanon. The current report summarizes the tristeza virus historical events in Lebanon.

II – Tristeza virus historical events in Lebanon

Citrus tristeza virus (CTV) is one of the major graft-transmissible pathogens limiting profitable citrus production worldwide (Garnsey and Lee, 1988; Bar-Joseph and Lee, 1989; Bar-Joseph *et al.*, 1989). It causes a decline of citrus on sour orange (*Citrus aurantium*) rootstock (CTV-decline) and stem pitting of many cultivars regardless to the rootstock. In Lebanon, more than 90% of citrus species are grafted onto sour orange; for this reason, a first investigation was carried out in 1996 to evaluate the incidence and distribution of CTV throughout the citrus-growing areas of the country (Saade, 1997).

1996. In autumn 1996 field surveys were carried out in commercial citrus groves and nurseries of the main Lebanese citrus-growing areas that included the districts of Akkar and Tripoli in the North and Wasta, Saida, Ghazieyyeh, Najjarieyyeh, Aakaibeh, Gibehit, Addousiyyeh, and Maamoura in the South. A total of 3427 samples from the orchards and other 1110 samples from the nurseries were collected and tested. The number of samples from each region was proportional to the area cultivated with citrus and to the economic importance of the species or varieties. DAS-ELISA was used for the detection of CTV (Clark and Adams, 1997). With respect to the groves, 62 samples representing 1.8% were infected with CTV whereas the virus was detected in most of the species monitored. The highest incidence of CTV was 2.4% in mandarin and mandarin-like (*C. reticulata*) species with a high prevalence in Ortanique variety (19%) followed by sweet orange (*C. sinensis*) species (2.3%) with the highest infection in Washington navel variety (5.3%). However, lemon (*C. limon*) had a low infection incidence of about 0.6% and that of Kumquat (*Fortunella margarita*) was 0.3% (D'Onghia *et al.*, 1998). For the nurseries, the incidence of infection was lower than that found in the groves (0.3%) and the species with the highest infection was mandarin-like (0.46%) followed by lemon (0.4%) trees (D'Onghia *et al.*, 1998). CTV was not detected in grapefruit, pummelo and lime species. Although grafted onto sour orange, none of the CTV infected trees showed decline symptoms. Moreover, different CTV sources were graft-inoculated for biological characterization to seedlings of Mexican lime.

1998-2000. In 1998, field surveys were undertaken in Mount Lebanon Iklim AlKharoub, Chouf and a total of 300 samples was randomly collected from 6 commercial fields of sweet oranges and mandarins representing 10% of the field trees (Jawhar and Choueiri, 2000). Four to five budsticks were sampled from the four sides of each tree and stored at 4ºC until analysis. ELISA test following Clark and Adams (1997) method was used for the detection of CTV. During that year, weekly visits were made to record the symptoms (stem pitting, decline, yellowing, wilting, etc.). Also, a "iodine test" field diagnosis was applied to detect starch depletion in the rootstock below the bud union. No symptoms were observed and all ELISA tests came out to be negative.

In the same year, four experimental citrus groves were selected to assess citrus tristeza virus incidence. Plot I was a grove of Clementine in LARI station, Tyre; plot II was a grove of sweet orange in the same location; plot III was a commercial grove of grapefruit in Tyre region; and plot IV was a commercial grove of sweet orange in Alman region. Each plot consisted of 100 trees in a grove containing 300 trees. Field inspections and collection of samples from all trees were carried out in these plots during three growing seasons (May-September 1998, 1999 and 2000). DAS-ELISA (Clark and Adams, 1997) was used for the detection of CTV. Monitoring of aphids was also taken in consideration. The infection rate of CTV increased from 1.2 to 3.8% in plot II, and from 2 to 5% in plot III during the three years of inspection; however, CTV infection rate was stable in plot I (1.1%) and no infection was encountered in plot IV. Moreover, *Aphis gossypii* and *A. citricola* were identified in all plots (Jawhar and Choueiri, 2000).

2003-2004. In the framework of cooperation between Lebanon and Italy regarding the certification project entitled "Project for the Production and Delivery of Certified Plant Material in Lebanon" and financed by the Italian Government through the Ministry of Foreign Affairs to upgrade the fruit sector, the Department of Plant Protection at Tal Amara station conducted two surveys: one in the south of Lebanon around Tyre station and the other in the North around Abde station in order to assess the presence of CTV and to establish the location of the citrus mother block. Around 500 samples from all locations were collected and tested by direct tissue blot immunoassay (DTBIA) (Garnsey *et al.*, 1993). CTV was detected in the South with an overall infection rate of 1.2%; however, no infection was found in the North (Choueiri, unpublished data). The infected trees found in the South were symptomless. These results prompted the establishment of a citrus mother block in Abde station.

III – Conclusion

The surveys carried out in Lebanon provided a relatively clear picture of the sanitary status of citrus, particularly citrus tristeza virus. An extremely low level of virus infection was detected in citrus samples from commercial groves and nurseries. The infection rate of CTV was low and there was no evidence of spreading although there was a limited increase in the rate of incidence in experimental trials. The most efficient CTV vector, the brown citrus aphid (*Toxoptera citricidus*), was not encountered in Lebanon; however, only *A. gossypii* and *A. citricola* were identified. It seems that the evidence of natural spread by *A. gossypii*, one of the most efficient CTV vectors in the Mediterranean region, is confined to Lebanon. The graft inoculation results and field observations had shown no apparent signs of decline in infected trees assuming that the CTV isolates present in Lebanon were not considered as severe strains. Furthermore, detailed monitoring of CTV is necessary to gather information on its development in Lebanon especially because the possibility of a sudden outbreak cannot be excluded as reported in other countries (Kyriakou *et al.*, 1996) as well as considering that the majority of citrus trees are grafted onto sour orange which is the most sensitive rootstock to CTV. The implementation of a national certification program for fruit trees and for citrus requires preventive measures aiming at the implementation of CTV eradication, at raising the awareness of citrus growers on CTV, on other virus and viroid disease risks, at introducing new rootstocks that are more tolerant or resistant to CTV, and at extending a continuing CTV monitoring survey.

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