CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Cucurbit Chlorotic Yellows Virus

Pest Rating: B

Comment Period CLOSED: 2/20/2019 – 4/6/2019

Initiating Event:

In September 2018, Dr. W. M. Wintermantel, Research Plant Pathologist, USDA ARS, Salinas, CA, notified Dr. Tongyan Tian CDFA of his detection of *Cucurbit chlorotic yellows virus* (CCYV) in melon for the first time in California. The risk of infestation of *Cucurbit chlorotic yellows virus* in California is evaluated and a permanent rating is herein proposed.

History & Status:

Background: In 2004, an unidentified disease that caused symptoms of severe leaf yellowing was observed in greenhouse-grown melon, cucumber, and watermelon plants in Southwestern Japan. Although viruses were suspected as causal agents of the disease, no known viruses were detected by reverse-transcription polymerase chain reaction (RT-PCR). At that same time, a strain of tobacco whiteflies (*Bemisia tabaci* biotype Q) was first reported from the same district in Japan. These whiteflies were collected from diseased melon plants, and when introduced to healthy melon seedlings, caused symptoms like those that were originally observed in the greenhouse-grown melons. Both *B. tabaci* MED (or Mediterranean, previously known as Q-biotype) and *B. tabaci* MEAM1 (or Middle East-Asia Minor 1, previously known as B-biotype) whiteflies were experimentally demonstrated to vector the new virus species which, in 2009, was named *Cucurbit chlorotic yellows virus* (Gyoutoku et al., 2009; Okuda et al. 2010). From 2009 to 2018, the virus has been reported from several countries only in the Eastern Hemisphere (see 'Worldwide Distribution'), often in coinfections with *Cucurbit yellow stunting disorder virus* (CYSDV). Both viruses belong to the same genus *Crinivirus* in the family Closteroviridae (Okuda et al., 2010), induce similar symptoms, and are transmitted by the same vector species (Gyoutoku et al., 2012; Wintermantel et al., 2018). However, mixed infections of CCYV and CYSDV in a cucurbit plant often results in reduced titers of both viruses (Abrahamian et al., 2013).

Cucurbit chlorotic yellows virus was first reported in the Western Hemisphere in 2018, from infected and symptomatic melon (*Cucumis melo*) plants growing in a field in Imperial Valley, California. Symptoms of interveinal yellowing and chlorotic spots that were observed in the CCYV-infected melon plants were similar to those caused by CYSDV, which is prevalent in the region, and was also present in most of the CCYV-infected plants observed in the field (Wintermantel et al., 2018). Furthermore, based on the analysis of archived and frozen total nucleic acid and RNA extracts from Imperial Valley melon plants that were collected between 2014 and 2018 and tested positive for CCYV, Wintermantel et al. (2018) suggested that CCYV was introduced to the Imperial Valley in 2014, at about the same time CYSDV was initially detected in California, but was not detected then due to its similarity with CYSDV in

symptomology and vector transmission. *Cucurbit chlorotic yellows virus* is transmitted by the whitefly, *Bemisia tabaci*. In the Imperial Valley and surrounding region, *B. tabaci* MEAM1 populations increase to high numbers beginning in the spring melon season, and consequently all cultivated melons are exposed to whitefly feeding from July through November, thereby facilitating virus transmission and disease development in the region (Wintermantel et al., 2018).

Hosts: The natural hosts of CCYV are cucurbits and include *Citrullus lanatus* (watermelon), *Cucumis melo* (melon), *C. sativus* (cucumber), *Cucurbita pepo* (zucchini) (Orfanidou et al., 2017a). In addition, several species of weed plants have been reported as hosts of CCYV.

Thirteen weeds species belonging to 11 families were found in several fields in Rhodes, Greece, and include *Amaranthus blitoides, A. retroflexus* (Amaranthaceae), *Sonchus oleraceus* (Asteraceae), *Heliotropium europaeum* (Boraginaceae), *Capsella bursa-pastoris, Sysibrium* sp. (Brassicaceae), *Capparis spinosa* (Caparaceae), *Chenopodium album* (Chenopoidaceae), *Convolvulus arvensis* (Convolvulaceae), *Echballium elaterium* (Cucurbitaceae), *Medicago sativa* (Fabaceae), *Malva sylvestris* (Malvaceae), and *Tribulus terrestris* (Zygophyllaceae) (Orfanidou et al., 2017a).

Symptoms: In general, symptoms induced by criniviruses initially develop on older leaves and then progress toward newer growth. Symptoms are similar to those caused by nutrition deficiencies and include interveinal chlorosis, and brittleness and thickening of leaves. Leaves of CCYV-infected plants initially exhibit symptoms of slight mottling which develop into severe yellowing after 2-3 weeks. Infected fruit does not show symptoms however the virus causes significant yield losses in cucumber and a significant decrease in sugar content of melons, thereby reducing their market value (Okuda et al., 2012). Symptoms induced by CCYV and other criniviruses are very similar, and the associated viruses can be detected and discriminated by sensitive, molecular technologies.

Transmission: Cucurbit chlorotic yellows virus is transmitted by the sweet potato whitefly, *Bemisia tabaci* (MED and MEAM1 species complexes) in a semipersistent manner (Abrahamian and Abou-Jawdah, 2014; Li et al., 2016). *Bemisia tabaci* MEAM1 is prevalent in the Imperial Valley, California (Wintermantel et al., 2018).

Research studies in Saudi Arabia have shown that a single whitefly (*B. tabaci* MEAM1) is able to transmit CCYV and that it requires a minimal acquisition time of one and a half hour and another one and a half hours of inoculation in plants to spread the disease. The vector can retain the virus for six days after acquisition. Infested weeds also serve as a reservoir for the virus inoculum during off-season (Shakeel et al., 2018). In contrast, Li et al., (2016) determined that *B. tabaci* MED required more than one hour of acquisition access to successfully acquire CCYV, and the proportion of CCYV positive whiteflies reached 100% at 48 hours of acquisition access. The virus could be retained within the vector for up to 12 days, but the proportion of CCYV-positive white flies dropped to 55% by the third day.

Damage Potential: The similarity of CCYV to CYSDV in symptomology and vector transmission that likely obscured detection of the former species in the Imperial Valley until recently, and the detection of CCYV alone in strongly symptomatic field-grown plants (Wintermantel et al., 2018), suggest a similar

damage potential for both viruses. Therefore, it is likely that CCYV can cause serious damage to cucurbit production similar to CYSDV, resulting in loss in fruit yield and quality and plant death, especially in regions where the whitefly vector is well established during the growing season.

Cucurbit chlorotic yellows virus is causing severe economic losses to cucurbit crops in many Asian countries (Li et al. 2016). The virus causes significant yield losses in cucumber and a significant decrease in sugar content of melons, thereby reducing their market value (Okuda et al., 2012). Losses in melon and watermelon production and reduction in Brix (sugar content) due to CCYV infestation were evaluated relative to the percentages of disease incidences encountered in Taiwan. Yield reductions of 12.4 to 32.8% in CCYV-infected cucurbit crops were also reported (Peng and Huang, 2011).

Worldwide Distribution: *Africa*: Egypt, Sudan; *Asia*: China, Iran, Japan, Lebanon, Saudi Arabia, Taiwan, Turkey; *Europe*: Greece; *North America*: USA (California) (Abrahamian et al., 2012; Bananej et al., 2013; Gu et al., 2011; Gyoutoku et al., 2009; Hamed et al., 2011; Huang et al., 2010; Orfanidou et al., 2014; Orfanidou et al., 2017b; Wintermantel et al., 2018).

Official Control: None reported.

California Distribution: Imperial Valley (Wintermantel et al., 2018).

California Interceptions: There are no reports of the detection of *Cucurbit chlorotic yellows virus* in shipments intercepted in California.

The risk *Cucurbit chlorotic yellows virus* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** CYSDV has already been reported to be established in the Imperial Valley, Southern California. Wintermantel et al. (2018) suggested that the virus has been in this region since 2014 but had not been detected due to its similarity in symptomology and vector transmission to CYSDV which is also established in the region. Further spread to CCYV to non-infected sites is limited by the distribution of its vector, *Bemisia tabaci* MEAM1, which has not been found in the cooler climates of Northern California counties.

   Evaluate if the pest would have suitable hosts and climate to establish in California.

   Score: **2**

   - Low (1) Not likely to establish in California; or likely to establish in very limited areas.
   - Medium (2) may be able to establish in a larger but limited part of California.
   - High (3) likely to establish a widespread distribution in California.

2) **Known Pest Host Range:** The natural host range is restricted to cucurbits in the family Cucurbitaceae (which are grown extensively in the lower Sacramento Valley and in limited production in the San

Joaquin and Imperial Valleys). Additional hosts include weed plants in families other than Cucurbitaceae, which can serve as virus reservoir plants for the whitefly vector, which then can carry the virus back to infect cucurbits during feeding.

Evaluate the host range of the pest.

Score: 2

- Low (1) has a very limited host range.
- **Medium (2) has a moderate host range.**
- High (3) has a wide host range.

3) **Pest Dispersal Potential:** The virus is able to thrive in climates that are favorable for its vector. Its potential for spread is always artificial being completely dependent on the distribution of its vector and infected plant materials. Therefore, factors that increase movement and activity of the vector and infected plants will also influence that of the virus.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 3

- Low (1) does not have high reproductive or dispersal potential.
- Medium (2) has either high reproductive or dispersal potential.
- **High (3) has both high reproduction and dispersal potential.**

4) **Economic Impact:** Although the epidemiology of the disease and losses in cucurbit crop production due to CCYV have not been reported for California, the virus is reported to cause notable economic losses in Asian countries. In those countries, significant yield losses in cucumber and a significant decrease in sugar content of melons have occurred resulting in reductions in market value (Okuda et al., 2012; Peng and Huang, 2011). Because of the similarity in symptomology and vector transmission of CCYV and CYSDV, it is likely that CCYV can also cause similar damage to cucurbit productions in California, resulting in loss in fruit yield and quality and plant death, especially in regions where the whitefly vector is well established during the growing season.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B, C, E

A. **The pest could lower crop yield.**
B. **The pest could lower crop value (includes increasing crop production costs).**
C. **The pest could trigger the loss of markets (includes quarantines).**
D. The pest could negatively change normal cultural practices.
E. **The pest can vector, or is vectored, by another pestiferous organism.**
F. The organism is injurious or poisonous to agriculturally important animals.
G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: **3**

- Low (1) causes 0 or 1 of these impacts.
- Medium (2) causes 2 of these impacts.
- **High (3) causes 3 or more of these impacts.**

5) **Environmental Impact:** Infestations of CCYV could significantly impact home/urban gardening of cucurbit host plants resulting in the imposition of additional official or private treatment programs in order to prevent spread of the virus and virus-carrying whitefly vector.

Environmental Impact: E

A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact Score: 2

- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.

Consequences of Introduction to California for *Cucurbit chlorotic yellows virus:*

Add up the total score and include it here. **12**
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

6) **Post Entry Distribution and Survey Information**: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

Evaluation is 'Low'. In California, *Cucurbit chlorotic yellows virus* is only known to be established in the Imperial Valley.

Score: -1

-Not established (0) Pest never detected in California or known only from incursions.
-Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
-Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
-High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) **The final score is** the consequences of introduction score minus the post entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 11***

Uncertainty:

Presently, the epidemiology of CCYV in the Southwestern United States desert crop production region and the impact of CCYV on *Crinivirus*-resistant melon cultivars in California needs further study (Wintermantel et al., 2018).

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Cucurbit chlorotic yellows virus* is B.**

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