cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Zucchini yellow mosaic virus

Realm: Riboviria; Kingdom: Orthornavirae
Phylum: Pisuviricota; Class: Stelpaviricetes
Order: Patatavirales; Family: Potyviridae
Genus: Potyvirus

Current Pest Rating: C

Proposed Pest Rating: C

Comment Period: 9/22/2020 through 11/6/2020

Initiating Event:

On August 9, 2019, USDA-APHIS published a list of "Native and Naturalized Plant Pests Permitted by Regulation". Interstate movement of these plant pests is no longer federally regulated within the 48 contiguous United States. There are 49 plant pathogens (bacteria, fungi, viruses, and nematodes) on this list. California may choose to continue to regulate movement of some or all these pathogens into and within the state. In order to assess the needs and potential requirements to issue a state permit, a formal risk analysis for Zucchini yellow mosaic virus (ZYMV) is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Zucchini yellow mosaic is a positive sense ssRNA virus in the family Potyviridae and in the genus Potyvirus. Named after potato virus Y, this is a large genus of plant viruses and includes many of the most severe viral diseases of crop plants. Potyvirus virions are flexuous filaments and the infection produces cylindrical inclusion bodies that look like pinwheels and scrolls in infected plant cells. These cytoplasmic inclusions appear as fibrillar masses using the orange-green stain for light microscopic detection of viral inclusions (Christie & Edwardson, 1986). Potyviruses are transmitted mainly by aphids in a nonpersistent manner, and some are transmitted through the seed.

ZYMV is probably one of the best examples of damage that is possible from an 'emerging' plant virus. First described in Europe in 1973, it was associated with severe symptoms on zucchini in Italy with increasingly frequent and destructive epidemics of squash and melon in Europe in its first decade (Lisa et al., 1981). By the spring of 1982, it was causing severe mosaic disease in Imperial, California (Nameth et al., 1985). Within 5 years, the virus was reported worldwide in cucurbit growing areas (Desbiez and Lecoq, 1997).

ZYMV is one of the most economically important viruses of cucurbits worldwide, especially in areas with hot climates in the tropics, sub-tropical areas, and southern Mediterranean regions of Europe, in addition to the Middle East, Central America, Mexico, and the southern United States. In more northern areas, epidemics are more erratic or limited geographically (CABI- CPC, 2020). In general, early season infections are more likely to lead to high or complete crop losses (Blua and Perring, 1989) and mild winters that favor the survival of high numbers of aphids also lead to high incidence and severity (Nameth et al., 1985).

Hosts: Alcea rosea (hollyhock), *Begonia cucullata* (wax begonia), *Begonia cucullata* var. *hookeri* (perpetual begonia), *Benincasa fistulosa* (round gourd), *Citrullus lanatus* (watermelon), *Cucumis anguria* (West Indian gherkin), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita maxima* (mammoth pumpkin/large winter squash), *Cucurbita moschata* (crookneck pumpkin/small winter squash), *Cucurbita pepo* (zucchini squash/common pumpkin/small gourd/acorn squash/summer squash), *Fevillea trilobata* (javillo), *Lagenaria siceraria* (bottle gourd), *Luffa aegyptiaca* (loofah), *Momordica charantia* (bitter gourd), *Phaseolus vulgaris* (common bean), *Sesamum indicum* (sesame), *Siraitia grosvenorii* (luohan guo), *Solanum lycopersicum* (tomato), *Trichosanthes cucumerina* (snake gourd), and *Tripleurospermum maritimum* subsp. *inodorum* (false mayweed) (CABI-CPC, 2020; Brunt et al., 1996).

Symptoms: Symptoms of ZYMV can be very severe and cause significant yield reductions. Fruits that exhibit severe deformations and color alterations are unmarketable. Symptoms can be diverse, depending on the host species and the cultivar. In zucchini squash, leaves develop a yellow mosaic and become severely blistered and leaves grow divided into deep narrow irregular segments. Green variety fruits develop into distorted forms with prominent lumps; yellow variety fruits may stay green with glossy yellow knobs. In other squash types, leaf symptoms may vary from mild mottles to severe mosaics. Fruits may also be severely distorted. In melons, early leaf symptoms are vein clearing and yellow mosaics. Leaves are reduced in size, deformed, often with serrated edges and dark green blisters or enations. Vines develop short internodes and usually exhibit an erect habit. Discolorations and raised patches are observed on fruits, occasionally associated with internal marbling and hardening of the flesh or superficial cracks with corky edges. Seeds can be deformed and have low germination rates. Some ZYMV isolates infecting melons cause a sudden wilting followed by a general necrosis of the plant (Lecoq and Pitrat, 1984). In cucumbers, severe mosaic and deformations are observed on leaves and on fruit. In watermelon, mottles, mosaics, and leaf filiformism are common. Fruits may have irregular coloration and slight to severe deformations (Desbiez and Lecoq, 1997; Nameth et al., 1985).

Transmission: ZYMV is spread from plant to plant by several species of aphids in a non-persistent manner. Primarily in California it is spread by the cotton-melon aphid, *Aphis gossypii*, and the green peach aphid, *Myzus persicae*. These aphids are widespread in the state and can transmit ZYMV in seconds simply by probing or sampling a plant. California research shows that that low numbers of aphids can cause a high level of disease if a source of virus inoculum is nearby (Umesh et al., 1995).

Reports of seed transmission are inconsistent but generally low with published rates ranging from 0.05% to 15.3% in cucurbits (CABI-CPC, 2020). Tóbiás et al. (2003) found no correlation between symptom severity in fruit and virus transmission by seed.

Damage Potential: There are other potyviruses that attack cucurbits in California with similar symptoms including Watermelon mosaic virus and Papaya ringspot virus. Mixed infections of these and others with ZYMV are common. Symptoms can be more severe in mixed infections with another virus or viruses, particularly when the others are Cucumber mosaic virus or Squash mosaic virus.

ZYMV occurrence is high and regular in regions with hot climatic conditions. Imperial and Riverside counties are major melon-producing areas and losses have reached 50% (Nameth et al., 1985). Epidemics occur when aphid vector populations are large early in the year, especially in spring melons. In areas with cooler spring temperatures, when infection occurs after fruit set, or where aphid populations are lower, infection rates and economic losses can occur but are more erratic and less frequent (Blua and Perring, 1989). There is no tolerance level for virus infection in seed fields and detections can result in the loss of seed markets.

Worldwide Distribution: Africa: *Algeria, Côte d'Ivoire, Egypt, Eswatini, Libya, Madagascar, Mali, Mauritius, Mayotte, Morocco, Nigeria, Réunion, South Africa, Sudan, Tunisia, and Zimbabwe.* Asia: *Azerbaijan, China, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Lebanon, Malaysia, Nepal, Oman, Pakistan, Saudi Arabia, Singapore, South Korea, Syria, Taiwan, Turkey, United Arab Emirates, Vietnam, Yemen*. Europe: *Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Cyprus, Czechia, France, Germany, Greece, Hungary, Italy, Jersey, Netherlands, Norway, Poland, Portugal, Serbia, Slovakia, Slovenia, Spain, United Kingdom*. North America: *Canada, Costa Rica, Dominican Republic, Guadeloupe, Honduras, Martinique, Mexico, Panama, Puerto Rico, United States* (Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, and Wisconsin). Oceania: *Australia, Guam, New Caledonia, New Zealand, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste*, and *Tonga*. South America: *Argentina, Brazil, Chile, Paraguay*, and *Venezuela* (CABI-CPC, 2020).

Official Control: ZYMV is on USDA-PCIT's Harmful Organisms list for: Ecuador, Georgia, Guatemala, India, Japan, Nicaragua, and Syrian Arab Republic (USDA-PCIT 2020). EPPO lists it as an A2 pest for Bahrain and Jordan (EPPO, 2020). ZYMV is included with any/all significant viruses for cucurbits in CDFA's Phytosanitary field inspection manual.

California Distribution: Official detection records have been made in Colusa, Fresno, Glenn, Imperial, Kern, Kings, Riverside, San Joaquin, Solano, Sutter, Tehama, and Yolo counties (French, 1989; CDFA PDR Database).

California Interceptions: None

The risk Zucchini yellow mosaic virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:**

ZYMV is already widespread warmer parts of California where cucurbit production is done for fruit, and in northern counties where it is grown for export seed. There have not been detections in cooler areas i.e. along the north coast.

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 host range includes cucurbits plus plants in a few other families.

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 Reproductive Potential:** This virus multiplies in the sap of infected hosts. It can be moved easily but in a nonpersistent method by aphids. No overwintering hosts have been identified but it can be seedborne, although generally at very low levels.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 2
- 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:** ZYMV is controlled with resistant varieties and by preventing large populations of vectors. It is far more impactful when there are multiple viruses co-infecting plants (Umesh et al., 1995; Davis et al., 2020).

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

Economic Impact: A, 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: **2**
- 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:** No significant environmental impacts have been described from ZYMV in California, but native cucurbits could be minor hosts.

Environmental Impact: A

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 Zucchini yellow mosaic virus: Medium

Add up the total score and include it here. **10**
-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 'high'. ZYMV has been detected in 12 counties in the desert, San Joaquin and Sacramento valleys

Score: -3
-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* ***= 7***

Uncertainty:

There are multiple of species in the family Cucurbitaceae that are native and naturalized in California including *Brandegea bigelovii* (desert star-vine), which is native in the deserts of southern California and Arizona, and three wild *Cucurbita* species (*C. digitata, C. foetidissima*, and *C. palmata*). The latter two occur in both the deserts and Central Valley. Species of *Marah* (man-root), such as *M. fabacea* and *M. watsonii*, are also native in the Central Valley, and *M. macrocarpa* is found in the deserts of southern California. Cultivated plants of *Citrullus* (watermelon), *Cucumis* (cucumber, melon), and *Cucurbita* (squashes, pumpkins, and gourds) are widely present in California including the Central Valley and desert and known to escape locally in disturbed/agricultural habitats, and the small-fruited feral dudaim melon (*C. melo* var. *dudaim*) is present in Imperial County (Dr. R. Price, CDFA Primary Botanist, pers. comm.). These should be assumed to be potential hosts of ZYMV and/or aphid vectors. They could be negatively impacted by virus infection or serve as resevoir hosts for agronomic hosts.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for Zucchini yellow mosaic virus is C.

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***Comment Period: 9/22/2020 through 11/6/2020**

***NOTE:**

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

  Example Comment:

  Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.
- Comments may not be posted if they:

  Contain inappropriate language which is not germane to the pest rating proposal;

  Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

  Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

  Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Proposed Pest Rating: C