cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Barley yellow dwarf luteovirus

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Viruses and viroids, Category: Riboviria,

Family: Luteoviridae, Genus: Luteovirus

Comment Period: 11/12/2020 through 12/27/2020

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 Barley yellow dwarf luteovirus (BYDV) is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Barley yellow dwarf (BYD) *sensu lato* is a viral disease of many of the most important grasses, including wheat, rice and maize. BYD viruses likely originated in grasses native to North America (Halbert and Voegtlin, 1998). BYDV has spread worldwide and causes sometimes serious disease epidemics in both crop and non-crop hosts. In the mid-1900s, the distinct yellowing symptoms, the transmission by aphids and the lack mechanical transmission, showed that BYDV was different from many other plant infecting viruses. BYDV has become a model for study of the "yellowing" viruses and for understanding the mechanisms of circulative or persistent virus transmission by aphids.

Luteoviruses are aphid transmitted, isometric, positive sense ss RNA viruses and BYDV is the type strain for the genus. They are restricted to the phloem of their hosts. Vesicles of infected plants will contain filaments and inclusions containing virus particles that can be seen with microscopy. Infection causes

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the death of phloem cells, inhibits translocation, slows plant growth, and induces loss of chlorophyll, resulting in dwarfing and yellowing symptoms (D'Arcy and Dormier, 2005).

The different strains that cause BYDV can be transmitted more efficiently by different species of aphids. Originally, Rochow and Muller (1971) identified five strains and they were named based the species of aphid that most efficiently transmitted each as follows: MAV (*Sitobion avenae*), PAV (*Rhopalosiphum padi*, *S. avenae*, and others), RMV (*R. maidis*), RPV (*R. padi*), and SGV (*Schizaphis graminum*). This nomenclature system has been adopted by nearly all researchers working on BYDV (CABI-CPC, 2020). California surveys by Gildow and Rochow in 1983, and Creamer and Falk in 1989, identified multiple strains of BYDV in small grains and showed that there were inconsistencies between transmission patterns by aphids and viral serotypes.

The viruses that cause BYD are transmitted from plant to plant by at least 25 different species of aphids (D'Arcy, 1995). After acquiring the virus through feeding on infecting plants, it must circulate through the hemocoel to the aphid's salivary glands, before being injected into a new host. This is called "circulative" transmission, or "persistent" transmission, because although the virus does not replicate inside the aphid, the aphid can retain the virus in its body for days or weeks. A single viruliferous aphid can spread virions to many new plants as it moves and feeds.

In 2002, Malmstrom showed native California grass species *Elymus glaucus*, *E. multisetus*, *Hordeum brachyantherum*, *Koeleria macrantha*, and *Nassella pulchra* were hosts of BYDV. In her surveys, BYDV incidence was as high as 40% and BYDV was shown to be contributing to the decline of remnant native grass populations. In a related study, Malmstrom et al. (2005) showed BYDV infection can stunt *E. glaucus* and other native bunchgrasses. Also, aphids consistently preferred exotic annuals as hosts (e.g. *Avena fatua*) and experienced higher fecundity on them, suggesting that the exotics can attract and amplify BYDV vectors, which increases disease in native grasses, sometimes to epidemic levels.

Hosts: BYDV has a host range restricted to the family Poaceae. However, cultivated hosts include major cereal crops: barley, maize, oat, rice, rye, and wheat. The known host range of BYDV includes more than 150 species of cultivated, lawn, weed, pasture and range grasses. Some infected hosts display no clear symptoms (CABI-CPC, 2020; D'Arcy and Dormier, 2005).

Symptoms: Symptoms of BYDV are most obvious on older leaves; the youngest leaves usually are not affected. Symptoms differ with the host species and cultivar, the viral strain and the environmental conditions, and can mimic nutritional and abiotic disorders. If seedlings are infected, leaves may emerge distorted, curled, and with serrations. Stems are shortened due to reduced internode length. The stunting may be so severe that heads fail to ever develop or so mild that it is overlooked without careful comparison with healthy plants. An uneven, blotchy leaf discoloration that can be yellow, red, or purple appears. The color change progresses from leaf tip to base and from the margin to the midrib. Barley plants usually turn yellowish, reddish, or purple areas along the margins, tips, or lamina of the older leaves. Oat leaves turn redder; wheat, rye and triticale are generally yellow and sometimes red. In maize, reddening occurs on the lower leaves primarily and in rice, infected leaves turn yellow to orange (D'Arcy, 1995). Other species may show reddening or yellowing, but many of them are symptomless. Plants can be severely stunted, especially if infected at an early stage. Tillering is reduced

in oat and wheat plants but is excessive in severely stunted barley plants. Severe early infections can kill young plants. Oats can have the additional symptom called blasting, which is sterility of florets in the panicle (Davis and Jackson, 2007). Inflorescences of diseased plants generally emerge later and are smaller. Flowers are often sterile, and the number and weight of kernels are reduced. The root systems of diseased plants are reduced drastically (D'Arcy and Dormier, 2005).

Transmission: BYDV is transmitted by many species of aphids in a persistent, circulative, but non-propagative manner. It can survive in most common grain aphids, including bird cherry-oat aphid (*Rhopalosiphum padi*), English grain aphid (*Sitobion avenae*), rose-grain aphid (*Metopolophium dirhodum*), corn leaf aphid (*Rhopalosiphum maidis*), and greenbug (*Schizaphis graminum*). The Russian wheat aphid (*Diuraphis noxia*), is not a vector of this virus. The aphids acquire the virus by feeding on infected host plants. A latent period of one to four days must pass before the aphid is able to transmit the virus during feeding, and at least four hours of feeding are required for transmission to occur.

Nonwinged (apterous) aphids can crawl to in a field and their feeding results in small patches of infected plants. Winged (alate) aphids often develop as host plants begin to deteriorate or when the aphid population is large. Long transmission periods allow alate aphids to carry the viruses over greater distances as they migrate, seeking new hosts. BYDV overseasons in a variety of grass hosts, such as in fall-sown cereals. Plants can be infected at any time and the spread of the virus depends on the populations of the aphid vectors. BYDV is not mechanically or seed transmissible, and the virus is not transmitted to aphid progeny. Vector transmission pattern corresponds to serotypes in most cases. However, as more BYDV isolates are being characterized, inconsistencies between transmission pattern and serotypes have been detected (Creamer and Falk, 1989).

Damage Potential: The virus interferes with the growth of infected plants, slowing the development of foliage and roots and sometimes preventing heading or even killing the host. Epidemics are most likely during cool, moist seasons that favor grass and cereal growth as well as aphid multiplication and migration The worst symptoms develop from virus brought into cereal fields in the spring by migrating, viruliferous aphids, moving from perennial grasses to cereal crops soon after the seedlings have emerged (Griesbach et al., 1990). BYDV infection can decrease the number of plants per row, the number of tillers per plant, the number of florets or seeds per head, and seed weight (McKirdy et al., 2002). In some cases, entire fields are destroyed, and the crops are not worth harvesting. Of the main grain crops, oats are the most severely affected and suffer serious losses annually. In years with BYDV outbreaks, oat yield losses may range from 30 to 50% while barley and wheat losses range between 5 and 30%. To these yield losses must be added losses in quality of the grain and losses in forage crops from the resulting failure or reduced productivity of pasture, range, and meadow grasses (McKirdy et al., 2007; Griesbach et al., 1990)

Worldwide Distribution: Africa: *Algeria, Egypt, Ethiopia, Kenya, Libya, Morocco, Mozambique, South Africa, Tanzania, Tunisia, Zimbabwe. Asia: Azerbaijan, China, India, Iran, Israel, Japan, Jordan, Lebanon, Nepal, Pakistan, Syria, Thailand, Turkey*. Europe: *Belgium, Czechia, Denmark, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden, Switzerland, Ukraine, United Kingdom*. North America: *Canada, Mexico, United States* (Alabama, California,

Colorado, Idaho, Illinois, Indiana, Louisiana, Missouri, Montana, New York, Pennsylvania, South Carolina, Washington). Oceania: *Australia, New Zealand*. South America: *Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay* (CABI-CPC, 2020).

Official Control: On the USDA APHIS Harmful Organisms list for French Polynesia, Georgia, India, Japan, Mexico, New Caledonia, Panama, and Taiwan (USDA- PCIT, 2020). It is on the EPPO A2 list for Jordan and the quarantine list for Mexico (EPPO, 2020).

California Distribution: CDFA PDR database has records in the following counties: Alameda, Calaveras, Del Norte, El Dorado, Fresno, Kern, Merced, Monterey, Placer, San Benito, San Mateo, Santa Clara, Sacramento, Shasta, Solano, Stanislaus, Tehama, Tuolumne, and Yolo

California Interceptions: none

The risk Barley yellow dwarf virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** The virus can survive species of grasses and in aphids that are widespread in California.

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

   Score: **3**
   - 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 is limited to members of the family Poaceae, but there are many susceptible genera.

   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:** The pathogen reproduces in the phloem of host plants. It disperses with winged aphids. Hosts and vectors are common and widespread.

   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:** This disease decreases the growth and yield of cereal and forage crops. It also damages non-agricultural grasses.

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

Economic Impact: A, B, 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:** This pathogen causes significant damage to native grasses, especially when planted in proximity to highly susceptible, non-native grasses.

Environmental Impact: A, B

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: 3
- 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 Barley yellow dwarf: High

Add up the total score and include it here. **14**
-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'. Barley yellow dwarf is widespread in California on multiple hosts.

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* **= 11**

Uncertainty: none

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for Barley yellow dwarf virus is C.

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Responsible Party:

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***Comment Period: 11/12/2020 through 12/27/2020**

***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
