CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Wheat streak mosaic virus

Current Pest Rating: None

Proposed Pest Rating: C

Realm: Riboviria; Kingdom: Orthornavirae

Phylum: Pisuviricota; Class: Stelpaviricetes

Order: Patatavirales; Family: Potyviridae

Genus: Tritimovirus

Comment Period: 7/29/2020 through 9/12/2020

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 Wheat streak mosaic virus is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Wheat streak mosaic virus (WSMV) infects both winter and spring wheat in parts of the United States, Canada, Mexico, Eastern Europe, Western Asia, and Australia. Depending on the environment, yield losses can surpass 60% (Langham et al. 2001) and it is a major limiting factor of wheat production in the Texas panhandle (Hunger, 2004).

Wheat streak mosaic virus is transmitted by the wheat curl mite, *Aceria tosichella* Keifer (Acari: Eriophyidae) (Brakke, 1987). Wheat is the preferred host for wheat curl mite and the plant most affected by WSMV. However, both the virus and the vector can be found on other crops such as corn,

barley, rye, oat, and sorghum. The virus and vector also infect wild grasses such as foxtails, needle grasses, goat grasses, crab-grass, ryegrass, brome, and cupgrass, but no dicotyledonous host plants. In wheat, WSMV is often found as a co-infection with two other mite-borne viruses of wheat, Wheat mosaic virus (syn. High Plains virus) and Triticum mosaic virus, both of which are also transmitted by wheat curl mite (Seifers et al., 1997, Seifers et al., 2009).

WSMV is a member of the plant virus family Potyviridae (Zagula et al., 1992). Historically, viruses of the family Potyviridae were classified into genera according to their vector taxa. Many are aphid-transmitted, including the type species Potato virus Y. The genus Rymovirus with the type species Ryegrass stripe mosaic virus was originally constructed to hold all mite-transmitted potyviruses. Salm et al. (1996) showed that the genus Rymovirus was not monophyletic (descended from a common evolutionary ancestor) and split it such that WSMV and Brome streak mosaic virus could be moved to a new genus. Also, transmission by eriophyid mites is not unique to Potyviruses; several Potex- and Carla viruses are vectored by eriophyid mites (Ryabov et al., 1996). Tritimovirus, which contains WSMV as the type species, was named as a new genus by Stenger et al. (1998). In the 21st century, additional mite-vectored, grass infecting viruses have been described and added to the genus. The Tritimoviruses resemble other potyviruses in having flexuous filamentous particles and the ability to induce the formation of "pinwheel" cytoplasmic inclusions in infected cells.

Hosts: Almost 90 grass species worldwide have been reported as hosts for the mites including cereals (including wheat, oats, barley, pearl millet, corn, and rye), grasses grown for pasture for animals, and uncultivated grasses (Navia et al., 2013).

Symptoms: In individual leaves, the symptoms start as small chlorotic interveinal lines. As the disease progresses, these chlorotic lines elongate to form discontinuous yellow to pale green streaks, forming a mosaic pattern in the leaves. In severe cases, the stripes may coalesce, forming large chlorotic patches that commonly progress into leaf tissue necrosis and plant death. Stunting and yellowing are also prominent symptoms of the disease (Hadi et al., 2011).

Plants on the field margins are often infected first, as the mites migrate into newly planted areas from weedy grasses or bordering crops (Hunger, 2010). In fields with heavy growth of volunteer wheat, symptoms may be scattered throughout the field. Wheat curl mites will colonize volunteer wheat that sprouts up after hail or heavy rain and may serve as a source of wheat curl mite and WSMV for next wheat crop (Hadi et al., 2011).

More severe symptoms are observed when winter wheat becomes infected under mild winter conditions compared to wheat infected in the spring or summer (Hunger et al., 1992). During severe infections, the wheat heads do not produce grain, especially on the side tiller, or contain non-viable, small, shriveled seeds (CABI- CPC, 2020).

Transmission: Studies have shown a low 0.2-5% seed transmission of WSMV in wheat and maize lines, which is likely the route for virus introduction to new areas (Hill et al., 1974). The main method of transmission is vectoring by the wheat curl mite. The mites are very small and inhabit protected areas

of the wheat plant. They do not have wings and are spread by wind. Although wheat is a primary host, these mites have a large host range which can serve as bridge between wheat crops (CABI-CPC, 2020).

Damage Potential: On average, WSMV is estimated to reduce annual wheat yields about 2% per year throughout the central and great plains, but localized yield losses of up to 100% can occur. Severe disease outbreaks are often associated with the presence of volunteer wheat, which serves as an over-summering reservoir for both WSMV and the wheat curl mite. Some outbreaks of WSMV occurred in the absence of volunteer wheat, and it is possible that annual grass species are acting as hosts (McNeil et al., 1996). Wheat is grown in multiple climates in California. The host range of WSMV is not restricted to wheat, but economic damage has not been reported on any hosts in California.

Worldwide Distribution: Africa: *Zambia*; Asia: *China, Iran, Jordan, Kazakhstan, Syria, Turkey, Uzbekistan*; Europe: *Bulgaria, Croatia, Czechia, Germany, Hungary, Italy, Moldova, Poland, Romania, Russia, Serbia*, *Montenegro, Slovakia, Ukraine*; North America: *Canada, Mexico, United States* (Alabama, Arkansas, California, Colorado, Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, Wyoming; Oceania: *Australia, New Zealand*; South America: *Argentina, Brazil* (CABI-CPC, 2020).

Official Control: Wheat streak mosaic virus is on the USDA's harmful organism list for: Argentina, Australia, Chile, China, Colombia, Ecuador, Egypt, Georgia, Guatemala, India, Japan, Korea, Republic of Mexico, Nauru, New Zealand, Panama, Peru, and Taiwan (USDA PCIT, 2020). It is a quarantine pest in Mexico, on the A1 list for Chile and Jordan, and on the A2 list for Egypt (EPPO, 2020).

California Distribution: Detections in 1993 in Yolo County on oats, barley, and wheat. The vector has also been detected in Yolo County in 2002.

California Interceptions: None

The risk Wheat streak mosaic virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** WSMV can survive in a variety of environments and it is distributed worldwide in a variety of climates. The lack of detections of the virus and/or its vector on susceptible hosts in the absence of phytosanitary controls could indicate that California does not have a highly conducive climate, and climate could be a limiting factor.

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

   Score: **1**

   - 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 grasses but include important species that are widely distributed.

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:** WSMV is an obligate pathogen that must have a living host to survive. It does not replicate inside its vector. The vector, *Aceria tosichella*, has only been found in Yolo County.

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:** Worldwide this virus causes chronic yield loss and occasional crop failure. However, losses have not been reported in California. Resistant varieties are available.

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:** California ranks 21st in the nation in wheat production with a reported 425,000 acres planted (147,000 acres for grain) in 2018/19. Although WSMV and its vector mite are presumed to be widespread, infecting wheat and other hosts, no economic impacts have been reported in California (California Agricultural Statistics Review 2018-2019).

Environmental Impact:

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: 1
- 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 Wheat streak mosaic virus is Low:

Add up the total score and include it here. **8**
-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'. Very few official records are available of the virus (1993) and the vector mite (2002), only from Yolo County. It could be established there or have been eradicated but without negative survey data.

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* **= 7**

Uncertainty:

There are no recent reports of WSMV or the wheat curl mite in California. It is not known if they are widely distrubuted but causing minimal damage, present but are not being detected, or largely absent from wheat producing areas.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Wheat streak mosaic virus* is C.

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Responsible Party:

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***Comment Period: 7/29/2020 through 9/12/2020**

***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
