Figure 1: Wasabi mottle tobamovirus leaf symptoms. Photo by Nancy Poss, San Mateo County Agricultural Commissioner's Office

California Pest Rating Proposal for

Wasabi Mottle Tobamovirus

Current Pest Rating: Q

Proposed Pest Rating: C

Comment Period: 11/27/2019 through 1/11/2020

Initiating Event:

On October 2, 2019, a San Mateo County agricultural official submitted a sample of wasabi (*Wasabia japonica*) from a commercial greenhouse to CDFA's Plant Pest Diagnostics Center. The inspector reported that approximately 400 plants (30% of the planting) were showing viral symptoms in a scattered distribution. CDFA plant pathologist Tongyan Tian detected Wasabi mottle virus (WMoV) from the sample using transmission electron microscopy, RT-PCR, and sequence analysis. As a first detection in the United States, the sample was forwarded to the Domestic Diagnostic Coordinator of the National Identification Services for USDA APHIS PPQ in Beltsville, Maryland. A temporary Q rating was assigned. The risk of this pathogen to California is evaluated herein, and a permanent rating is proposed.

History & Status:

Background: Wasabi or Japanese horseradish is a member of the brassica family and is primarily grown in Japan, Korea, and Taiwan, with expanding production in Australia, New Zealand, and on the west coast of North America (British Columbia to California). The rhizomes, roots, leaves, and flower stalks are used as a botanical spice in cooking. The pungent flavor is provided by isothiocyanate. In addition, wasabi has biomedical and cosmetic uses. It is credited with providing health benefits against allergies, cancer, ulcers, inflammatory diseases, and heart disease, and for boosting the immune system, acting as an anti-coagulant, improving weight loss, enhansing collagen synthesis, and improving bone calcification (Van De Walle, 2019).

Wasabi is usually vegetatively propagated, which carries a high risk of transmitting viruses from a mother plant to her daughters. A "wasabi-strain" of Tobacco mosaic virus was first observed in Japan in 1985 (Kashiwazaki et al., 1990). Tobacco Mosaic Virus is the type strain for the genus Tobamovirus, a large and important group of pathogens that commonly infect tobacco, potato, tomato, and squash. They are not vector trasmitted but can be seed transmitted. Their genomes consist of a single molecule of linear, positive-sense, single-stranded RNA. The virions often form large crystalline arrays that are visible by light microscopy. The virus particles are very stable and can survive in plant sap for many years (Agrios, 2005). Further genomic sequencing and the naming of Wasabi Mottle Virus beyond a strain of Tobacco Mosaic Virus was done by Shimamoto et al. in 1998.

Hosts: Wasabi (*Wasabia japonica* = *Eutrema japonicum*)

Symptoms: The original detection in Japan was described by Kashiwazaki et al. (1990) as a severe leaf rugose (wrinkling). This was similar to the symptoms seen in Taiwan: rugose and yellow mosaic (Deng et al., 2016). Symptoms on naturally infected *W. japonica* in Canada (McDonald et al, 2018) included bleach spots, vein clearing, and ringspots. The progression of symptoms they most commonly observed was bleach spots followed by vein-clearing and then leaf spots. On rare occasions necrotic symptoms were observed in severely diseased plants.

Transmission: Tobamoviruses like Wasabi mottle virus are transmitted mechanically with no known insect vectors. They can be seedborne and plants infected as seedlings can be stunted and generally chlorotic. Leaves develop a subtle mosaic or mottle, can be crinkled or wrinkled, and remain small (Agrios, 2005). Symptomatic plants and adjacent plants should be rogued and planting stock should be tested and found free from all virus titer. Heat treatment with meristem tip culture can eliminate virus from desirable clonal materials. Tobamoviruses are very stable and extensive spread can occur through handling and contaminated tools, trays, pots, stakes, twine, and clothing, as well as pollination, pruning, and other cultural practices. The virus can remain viable for several years in plant debris.

Damage Potential: When wasabi is clonally propagated with rhizomes, the virus can be passed from infected mother plants to daughter plants. There are no curative treatments. Infection levels in Canadian greenhouses were 38% and damage was more severe at higher temperatures (>30°C) than cooler temperatures (21-24°C) (Macdonald et al., 2018).

Worldwide Distribution: Japan, Taiwan, Korea, Canada (Deng et al., 2016; Kashiwazaki et al., 1990; Kim et al., 1999; Macdonald et al., 2018).

Official Control: None.

California Distribution: Wasabi mottle virus has been found at one production greenhouse in San Mateo County (see 'Initiating Event').

California Interceptions: None.

The risk **Wasabi Mottle Virus** would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Wasabi generally requires a cool summer climate (45°F -70°F) with high humidity and it needs full shade. It's likely to be limited to greenhouse production in the cooler parts of California.

   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 of Wasabi mottle virus is limited to wasabi.

Evaluate the host range of the pest.

Score: 1

- 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:** Tobamoviruses spread easily with clonal propagation material, mechanically, and with seed. The virus particles can remain infective in dried plant sap.

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:** This virus is damaging to wasabi, which is clonally propagated. There are no curative or eradicative treatments for adult plants. This disease could be controlled through clean stock techniques and adoption of proper sanitary practices to minimize virus spread.

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

Economic Impact: A, B

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:** The pathogen could significantly impact cultural practices or home garden plantings.

Evaluate the environmental impact of the pest on California using the criteria below.

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 Wasabi mottle tobamovirus:

Add up the total score and include it here. **Low (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'. One detection has been made in San Mateo County.

Score: -1 (score followed by bolded bullet)
-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:

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 7***

Uncertainty:

None.

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Wasabi mottle tobamovirus* is C.**

References:

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Responsible Party:

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***Comment Period: 11/27/2019 through 1/11/2020**

***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 plant.health[@]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
