

**California Pest Rating Proposal for
Venturia inaequalis (Cooke) G. Winter 1875**

Apple Scab

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Fungi; Division: Ascomycota;

Class: Dothideomycetes; Order: Pleosporales;

Family: Venturiaceae

Comment Period: 3/19/2020 through 5/3/2020

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 *Venturia inaequalis* is given herein and a permanent pest rating is proposed.

History & Status:

Background: Apple scab is considered a serious disease of apples in temperate climates with cool, wet springs and results in more losses than any other apple disease (Gauthier, 2018). In California, the disease is most severe along the coast and in the foothills in early spring and requires fungicide treatment (Gubler, 2015).

Venturia inaequalis was one of the first ascomycetes to be subjected to genetic research and analysis. In the 1930s, pathologists studied the heritability of pathogenicity and sexual compatibility in *V. inaequalis*. Since then it has become a valuable tool for basic genetic studies of pathogenicity. The fungus infects young tissues and lives in a close association with the host without causing damage for

an extended period. It can be cultured on artificial media, and matings can be made in vitro. The pathogen shows considerable diversity, with many pathotypes or races occurring in the population. The phenotypes and genotypes remain stable in culture over many years. There are multiple genes involved in pathogenicity to various apple species and cultivars (Agrios, 2005; Gauthier; 2018). The anamorph of *V. inaequalis* is *Fusicladium pomi* (Braun et al., 2002). Pear scab is caused by a closely related species, *Venturia pirini*, with similar symptoms, but *V. inaequalis* does not infect pears. *Pyracanthus* is a host to *V. inaequalis* sp.f. *pyracanthae* and *Eriobotrya japonica* is a host to both *V. pirini* and *V. inaequalis* (Sivanesan and Waller, 1974).

Hosts: Most reported hosts of *V. inaequalis* are in the family Rosaceae, including *Malus* (apple), *Amelanchier* (serviceberry), *Aronia* (chokeberry), *Cotoneaster*, *Docynia*, *Eriobotrya* (loquat), *Heteromeles* (toyon), *Kageneckia*, *Photinia* (red tip), *Prunus*, *Pyracantha* (fire thorn), *Pyralaria* (tan li), *Raphiolepis* (indian pink hawthorn), and *Sorbus* (mountain ash). An additional host is *Viburnum*, in the family Caprifoliaceae.

Symptoms: *Venturia inaequalis* attacks the leaves, petioles, blossoms, sepals, fruits, pedicels, young shoots, and bud scales. The most obvious symptoms are on leaves and fruits. The mycelium grows between the cuticle and the outer cell wall of the host epidermal cells. The epidermal cells and later the palisade and the mesophyll cells are depleted of their contents, eventually collapsing and dying. From this subcuticular position, the mycelium produces enormous numbers of olive-green conidia, which push outward, rupturing the cuticle. The conidia form velvety scab lesions that can be seen on the leaves and fruit (MacHardy, 1996; Sutton et al., 2014).

Infection on expanding leaves can lead to large scab lesions that distort the leaves. Lesions on young fruit are like those on leaves, but they usually enlarge more slowly, become darker in color, and are more sharply bordered. The lesions on fruit become brown and corky spots. Fruit infections early in the season can affect the meristematic tissues. When the fruits enlarge, they are misshapen around the fungal infections with cracks in the skin and in the flesh. If fruit are infected early, they may drop prematurely. Apple fruit becomes more resistant as they develop (Schwabe et al., 1984).

Transmission: *Venturia inaequalis* is a hemibiotroph; it must pass part of its life on the host as a parasite and part on dead tissues of the same host on the ground as a saprophyte to complete its life cycle. The pathogen overwinters in dead leaves on the ground as immature pseudothecia that complete their growth in late winter and spring. The ascospores mature as the weather becomes favorable for growth and development of the host. Each pseudothecium contains 50 to 100 asci, each with eight ascospores consisting of two cells of unequal sizes. When pseudothecia become thoroughly wet in the spring, the asci forcibly discharge their ascospores into the air. Air currents carry them to susceptible tissues. Conidia production occurs inside the leaves or fruit and during or after a rain. Conidia may be washed down or blown away to other leaves or fruit. Conidia continue to cause secondary cycles of infections during wet weather. After infected leaves fall to the ground, the mycelium invades the interior of the leaf and forms pseudothecia, which carries the fungus through the winter (Agrios, 2005; Machardy, 1996).

Damage Potential: Apple scab is one of the most serious diseases of apples worldwide and prevention of disease on susceptible apple varieties under favorable climatic conditions can require multiple fungicide applications. The initial inoculum of ascospores is usually large and is released over a period of 1 to 2 months following bud break. Infection must be prevented with fungicides during blossoming, early leafing, and fruit development. Without adequate and properly timed treatments, the entire annual crop can be lost. After primary inoculum comes as ascospores, secondary inoculum is available as conidia, which allows for exponential increase of disease (Machardy, 1996).

Parts of the country where environmental conditions are highly favorable for disease (eg. Northeast, Upper Midwest, Pacific Northwest) commonly utilize apple scab forecast systems that can predict when an infection period will occur, and if it will result in light, moderate, or severe levels of disease. Infection periods are more frequent, and disease is more severe during cool, wet periods of spring, early summer, and fall. Infection periods are infrequent or absent in dry, hot summer weather. Although these forecasting systems have been used for many years (MacHardy and Gadoury, 1989), they are under continual improvement as they increase the efficient and effective use of fungicides (Wrzesień et al., 2019). Long-term, extensive fungicide use has led to the selection of strains of *V. inaequalis* that are resistant to multiple fungicides (Chapman et al., 2011).

Worldwide Distribution: Worldwide in all temperate climates.

Official Control: *Venturia inaequalis* is on the EPPO A1 list for Egypt, and on USDA's Harmful organisms list for Bolivia, Canada, China, Egypt, India, and Nicaragua (EPPO, 2020; USDA PCIT, 2020).

California Distribution: Statewide

California Interceptions: Multiple interceptions on fruit at the border stations from other states and from Canada.

The risk *Venturia inaequalis* would pose to California is evaluated below.

Consequences of Introduction:

- 1) Climate/Host Interaction:** *Venturia inaequalis* requires leaf or fruit wetness in order to germinate and infect. Infection can occur at a range of temperatures from 6 to 28°C. These requirements are met in the spring in most areas of California, with the exception of the desert and the southern San Joaquin Valley where it is warmer and drier. However, apple production in warmer areas of the state is limited by lack of chill time needed for bud and fruit set.

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.
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- **High (3) likely to establish a widespread distribution in California.**

2) Known Pest Host Range: The host range is mainly apples, with some related ornamentals.

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: *Venturia inaequalis* produces multiple infectious spore stages and causes disease epidemics.

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: Apple scab is the most serious disease of apples in the world and without fungicides, whole crops can be lost. Consumers will reject fruit that is misshapen or scabbed. Because it is already widespread, quarantines are of minimal concern.

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: Repeated fungicide treatments are required when susceptible varieties are grown in climates that favor disease. Home gardeners routinely lose their apple crops to scab epidemics. Widely planted ornamentals such as toyon and hawthorn can suffer aesthetically.

Environmental Impact: D, 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: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 *Venturia inaequalis*: Medium

Add up the total score and include it here. **11**

- 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'. *Venturia inaequalis* is widespread in the apple growing regions of the state.

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 = 8*

Uncertainty:

None.

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Venturia inaequalis* is C.**

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Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, California Department of Food and Agriculture, 204 West Oak Ave, Lompoc, CA. Phone: 805-736-8050, [permits\[@\]cdfa.ca.gov](mailto:permits[@]cdfa.ca.gov).

***Comment Period: 3/19/2020 through 5/3/2020**

*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](mailto: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
