CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for Gymnosporangium yamadae Miyabe ex G. Yamada 1904 Current Pest Rating: Q Proposed Pest Rating: A

Comment Period: 1/18/2019 – 3/4/2019

Initiating Event:

During August and September 2018, *Gymnosporangium yamadae* was identified by CDFA Plant Pathologists, from samples of three shipments of crabapples that originated in Massachusetts and were intercepted in California by the CDFA Dog Team. Currently, in California, *G. yamadae* has a quarantine actionable Q rating which consequently lead to the destruction of the intercepted shipments of infected crabapple. On September 28, 2018, the Plant Epidemiology and Risk Analysis Laboratory (PERAL) of the USDA APHIS PPQ released a document proposing a deregulation evaluation of *G. yamadae* to help individual states make their own quarantine decisions. Therefore, an assessment of the consequences of introduction of *G. yamadae* in California is presented here, and a permanent rating is proposed.

History & Status:

Background: *Gymnosporangium yamadae* is a fungal rust pathogen that causes Japanese apple rust disease. In Asia, *G. yamadae* is a serious pathogen of cultivated apples and junipers, especially if the host of its telial state, *Juniperus* spp. occurs close by (USDA APHIS PERAL, 2018; Yun et al., 2009b). The Japanese apple rust pathogen was originally named by Yamada in 1904, without a description, and was reported only from Japan, China and Korea, until 2009 when it was first reported in North America from crabapple in Wilmington, Delaware and nearby Media, Pennsylvania, USA (Yun et al., 2009a). A year later, the telial state of the rust pathogen was discovered in ornamental *Juniperus chinensis* growing near the original crabapples in Wilmington, Delaware (Gregory, et al., 2010).

Disease cycle: *Gymnosporangium yamadae* requires two taxonomically unrelated hosts, *Juniperus chinensis* (juniper) and *Malus* spp. (apple and crabapple) to complete its life cycle. This rust pathogen is macrocyclic with four distinct fruiting structures producing four different spore forms: spermatia, aeciospores, teliospores and basidiospores that appear in a definite sequence (Agrios, 2005; Gregory et al., 2010; Tao et al., 2018). The spermagonial (fruiting structures producing spermatia) and aecial (fruiting structures producing aeciospores) states appear in apple and crabapple, whereas the telial (fruiting structures producing teliospores) state is produced in juniper. The pathogen produces galls in the branches of infected juniper trees and overwinters in the form of mycelia within inconspicuous galls. The following spring, usually after a heavy rain, orange masses of telial horns extrude from the galls. Teliospores within the gelatinous horns produce basidiospores that are wind-blown to *Malus* spp. hosts and infect the leaves and twigs later in the summer (Gregory et al., 2010; Tao et al., 2017). After a successful infection, spermogonia develop in orange lesions on the upper surfaces of leaves, and after a period gray spikes or aecia develop in the same orange lesions or yellow and red spots, but on the lower surfaces of the leaves. Aeciospores are produced and are wind-blown to juniper trees from

early summer to fall. Following successful infections of juniper trees, galls are produced and during the following spring, telial horns form to produce basidiospores, thereby completing the life cycle (Tao et al., 2018). Generally, *Gymnosporangium* spp. complete only one disease cycle per year (Agrios, 2005).

Dispersal and spread: The pathogen is dispersed via wind and movement of infected plants and propagative plant parts as well as infected nursery stock (Agrios, 2005).

Hosts: Malus sp., *M. asiatica, M. baccata* (Siberian crabapple), *M. baccata* var. *baccata*, *M. baccata* var. *mandshurica*, *M. baccata* var. *nikkoensis*, *M. domestica, M. floribunda* var. *arnoldiana, M. halliana, M. halliana* var. *spontanea, M. honanensis, M. hupehensis* (hupeh crabapple), *M. kansuensis, M. manshurica, M. micromalus, M. platycarpa, M. prunifolia* (plum-leaved crabapple*), M. prunifolia* var. *ringo, M. prunifolia* var. *robusta*, *M. pumila* ( ), *M. pumila* var. *domestica*, *M. pumila* var. *dulcissima, M. sieboldii, M. sieboldii* var. *arborescens, M. sieboldii var. sargentii, M. spectabilis, M.scheideckeri, M. spontanea, M. theifera, M. toringo* (torringo crabapple), *M. transitoria, M. yunnanensis, J. chinensis* (Chinese juniper), *J. chinensis* var. *kaizuka*, *J. chinensis* var. *sargentii*, *J. sabina* (savin juniper) (CABI, 2018; EPPO, 2018; Farr and Rossman, 2018; Yun et al., 2009b).

Symptoms: On stems of *Juniperus chinensis*, *G. yamadae* causes fusiform swellings that can produce telial horns under wet conditions. However, infested *J. chinensis* may be asymptomatic and the pathogen can be latent during the winter. The swellings or galls form in the late fall, but the plants do not exhibit readily detectable symptoms until the spring. On apple, the pathogen produces aecia and pycnia on the leaves. Fruit is rarely infected and susceptible cultivars may be completely defoliated (CABI, 2018).

Damage Potential: Gymnosporangium yamadae is reported to be a serious rust pathogen of cultivated apple and junipers in Asia, especially when these hosts occur in proximity to each other. Infected fruit trees have resulted in delayed harvest and reduced fruit yields due to inhibition of photosynthesis and increased respiration, thereby threatening the economic development of local orchards (Yun et al., 2009b). The pathogen has also been reported to cause premature defoliation, reduction in plant vigor, dwarfing, and fruit deformation (Fukushi, 1926 *cited in* USDA APHIS PERAL, 2018).

Gymnosporangium yamadae is not known to be present in California. If introduced, the State has suitable climates and hosts (*Malus* spp. and *Juniperus chinensis*) for the Japanese apple rust pathogen to establish, survive and spread (USDA APHIS PERAL, 2018). Furthermore, because cultivated, landscape, and residential junipers and apple trees often exist in proximity to each other within California, disease development can be greatly enhanced and likely to significantly impact apple production. While there is no specific information on the distance between hosts that *G. yamadae* spores can traverse to infect either host, the pathogen is believed to behave similarly to a related species, *G. juniperi-virginianae,* that can infect a susceptible *Malus* host 3-5 km from a *Juniperus* host (USDA APHIS PERAL, 2018). *Juniper chinensis* is not native to California but it is present in natural environments and is commonly grown and sold as an ornamental plant in nurseries for public and private gardens and landscapes. It is possible that *G. yamadae* can survive and reproduce in greenhouse conditions (Yun et al., 2005), if both juniper and apple hosts are present. The increased movement of juniper nursery stock and cultivated apple as nursery stock and fruit from regions where

the Japanese apple rust pathogen is present, can increase the risk of its introduction to California. Furthermore, because of its latency period in junipers, *G. yamadae*-infected plants could be moved around for several months before being diagnosed (USDA APHIS PERAL, 2018). While fungicidal treatments may be used with varying efficiencies to control *Gymnosporangium* rusts that are already present in other U.S. states (USDA APHIS PERAL, 2018), *G. yamadae* is not known to be present in California, and quarantine actionable measures used to prevent its introduction and establishment in California are considered primary and likely to be more cost-effective than remedial control strategies.

Worldwide Distribution: *Asia*: China, Japan; Democratic People's Republic of Korea, Korea, Republic of Korea; *Europe*: Russian Federation; *North America*: USA(Connecticut, Delaware, Maine, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island) (CABI, 2018; EPPO, 2018; Gregory et al., 2010; USDA APHIS PERAL, 2018; Yun et al., 2009a, 2009b).

Official Control: Presently, *Gymnosporangium yamadae* is on the 'Harmful Organism' lists for Armenia, Belarus, Canada, Egypt, Honduras, Jordan, Kazakhstan, Kyrgystan, Morocco, Peru, Russian Federation, and Taiwan (USDA PCIT, 2018). It is listed as an A1 quarantine organism by the European and Mediterranean Plant Protection Organization and a quarantine pest in Canada, Jordan and Norway (EPPO, 2018). Presently, the USDA considers *G. yamadae* as reportable/actionable for port interceptions (USDA APHIS PERAL, 2018). In California, it is a quarantine actionable pathogen.

California Distribution: *Gymnosporangium yamadae* has not been reported from California. The pathogen is not known to be established in California.

California Interceptions: In August and September 2018, *G. yamadae* was detected in three separate shipments of crabapple (*Malus* sp.) that originated in Massachusetts and were intercepted in California by the CDFA Dog Team.

The risk *Gymnosporangium yamadae* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** California has suitable climate and hosts, apple, crabapple, and junipers, that would likely enable a widespread distribution in the State, particularly where junipers and apples are cultivated in close proximity. *Gymnosporangium yamadae* is reported to survive in Plant Hardiness Zones 4-9 (USDA APHIS PERAL, 2018), which includes most of 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 very specific and limited to several *Malus* spp. and *Juniperus chinensis*.

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 Dispersal Potential**: The Japanese apple rust pathogen has a high reproductive potential and spores are dispersed readily by wind currents and movement of infected plants and propagative plant parts as well as infected nursery stock.

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:** With suitable climate and available hosts, *Gymnosporangium yamadae* is likely to establish and spread within California, if introduced. Infected junipers may be asymptomatic during the winter months and thereby moved to non-infested regions before the pathogen is detectable. It is possible for *G. yamadae* to survive and reproduce in greenhouse conditions (Yun et al., 2005), if both juniper and apple hosts are present. If introduced and left uncontrolled, *G. yamadae* could affect commercial productions of apples, crabapples and junipers by lowering crop yields, lowering crop value and markets, increasing costs of production due to increased use of fungicidal treatments, and negatively changing normal cultural practices such as distancing apple trees from their alternate juniper host.

Evaluate the economic impact of the pest to California using the criteria below.
Economic Impact: A, B, C, D

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.

Score the pest for Environmental 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:** Juniper trees are present in natural environments and are also commonly grown in public and private gardens and landscapes. Their presence in proximity to apple and crabapple trees and their critical role in the Japanese apple rust disease cycle could increase the overall impact of *G. yamadae* in the environment. Subsequently, incidence of *G. yamadae* could trigger additional official or private treatment programs. Home/urban gardening and ornamental plantings of apple, crabapple, and junipers could also be impacted significantly.

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

Environment 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.

Score the pest for 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 *Gymnosporangium yamadae*:

Add up the total score and include it here. (Score)
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

Total points obtained on evaluation of consequences of introduction to California = **13**

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 'Not established'** in California.*

Score: (0)
-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.

Final Score:

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 =* ***13***

Uncertainty:

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Gymnosporangium yamadae* is A.**

References:

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