California Pest Rating Proposal for

Impatiens necrotic spot virus

Current Pest Rating: Z

Proposed Pest Rating: C

Realm: Riboviria, Kingdom: Orthornavirae,
Phylum: Negarnaviricota, Class: Ellioviricetes
Order: Bunyavirales, Family: Tospoviridae
Genus: Orthotospovirus

Romaine lettuce infected with INSV

Comment Period: 02/12/2021 through 03/29/2021

Initiating Event:

Impatiens necrotic spot virus (INSV) is a thrips-transmitted virus capable of infecting a wide range of host plants in California. 1998, CDFA plant pathologist Dennis Mayhew detected INSV by ELISA from four different species of ornamental plants in 5 different counties. In October 2005, a University of California Cooperative Extension Farm Advisor submitted a plant sample from a wholesale ornamental nursery in Salinas, Monterey County. INSV was identified by CDFA plant pathologist Tongyan Tian using ELISA.

In 2006, INSV first began to cause damage to lettuce crops in Monterey County (Koike et al., 2008). Since that time, INSV has occurred to a greater or lesser degree every season with significant INSV outbreaks beginning in late May or early June. 2019 and 2020 were years with very significant lettuce crop losses in the Salinas Valley, and in Hollister, Gilroy and Watsonville. The Grower-Shipper Association of Central California has formed a taskforce with industry, researchers, and state and county agencies to seek solutions to INSV and thrips problems. The risk to California from INSV is described herein and a permanent rating is proposed.

History & Status:

Background:

The genus name Tospovirus was derived from **To**mato **spo**tted wilt virus (TSWV), the first member that was described in Australia in 1915. Tospovirus fits within the Bunyaviridae family (currently the order of Bunyavirales), a large group of predominantly animal-infecting viruses, and TSWV was thought to be the sole member of the genus. In the late 1980s, a significant new virus disease problem began to develop in the greenhouse floriculture industry (Daughtrey et al., 1997). Symptoms were very typical for TSWV: stunting, necrotic and chlorotic spotting, stem cankers, line patterns, and ring spots. Initially, it was designated TSWV-I (Impatiens strain) but later characterized as a separate virus and named Impatiens necrotic spot virus (INSV) (Law and Moyer, 1990). Both TWSV and INSV are vectored primarily by western flower thrips in California and have a wide host range. Today the genus Orthotospovirus continues to add new members, and there are more than a dozen species that cause significant, worldwide, crop losses.

Beginning in 2006 and continuing through today, severe outbreaks of disease caused by INSV have affected the coastal lettuce crop in Monterey, San Benito, Santa Cruz, San Luis Obispo and Santa Barbara counties. Lettuce growers suffered substantial economic losses and populations of western flower thrips are large and difficult to control (Koike et al., 2008; Kuo et al., 2014). All types of lettuce are susceptible including iceberg, butterhead, romaine and leaf lettuces. Spinach grown in Salinas is also affected (Liu et al., 2009).

Hosts: Ageratum sp. (floss flower), *Amaranthus retroflexus* (pigweed), *Aster* sp. (asters), *Arachis hypogaea* (peanut), *Begonia* sp. (begonia), *Begonia tuberhybrida* (tuberous begonia), *Calathea makoyana* (peacock plant), *Calendula* sp. (pot marigold), *Capsella bursa-pastoris* (shepherd's-purse), *Capsicum* sp. (pepper), *Capsicum annuum* (bell pepper), *Cichorium intybus* (radicchio), *Chrysanthemum* sp. (daisy), *Chrysanthemum morifolium* (florist's chrysanthemum), Claytonia perfoliata (miner's lettuce), *Convolvulus* sp. (bindweed), *Coreopsis* sp. (coreopsis), *Cosmos* sp. (garden cosmos), *Cucumis sativus* (cucumber), *Cyclamen persicum* (cyclamen), *Cyperus esculentus* (yellow nutsedge), *Cyperus rotundus* (purple nutsedge), *Dahlia* sp. (dahlia), *Datura stramonium* (jimsonweed), *Dendrobium* sp. (dendrobium orchid), *Emilia* sp. (lilac tasselbrush), *Exacum affine* (exacum), *Fatsia japonica* (Japanese aralia), *Gerbera* sp. (Transvaal daisy), *Gladiolus* sp. (sword lily), *Gloxinia* sp. (gloxinia), *Gypsophila* sp. (baby's breath), *Hippeastrum* sp. (amaryllis), *Hoya kerrii* (sweetheart plant), *Hymenocallis* sp. (spider lily), *Impatiens wallerana* (touch me not), *Impatiens* hybrids (New Guinea impatiens), *Kalanchoe* sp.

(kalanchoe), *Lactuca sativa* (lettuce), *Lathyrus odoratus* (sweet pea), *Lupinus* sp. (lupine), *Lillium* sp. (lily), *Malva* sp. (cheeseweed), *Matthiola incana* (stock), *Mesembryanthemum* sp. (ice plant), *Myosotis* sp. (forget-me-not), *Nemesia* sp. (nemesia), *Nicotiana tabacum* (tobacco), *Ocimum basilicum* (basil), *Papaver* sp. (poppy), *Pericallis × hybrida* (cineraria), *Petunia* sp. (petunia), *Phalaenopsis* sp. (moth orchid), *Phlox* sp. (phlox), *Physalis* sp. *(Chinese lantern), Physalis ixocarpa* (tomatillo), *Peperomia* sp. (radiator plant), *Polygonium* sp. (knotweed), *Primula obconica* (top primrose), *Primula* spp. and hybrids (primula), *Ranunculus asiaticus* (Persian buttercup), *Ranunculus* sp. (buttercup), *Rubus* spp. (blackberry, raspberry), *Salvia* sp. (salvia), *Sinningia speciosa* (gloxinia), *Solanum* sp. (nightshade), *Solanum lycopersicum* (tomato), *Solanum tuberosum* (potato), *Spathiphyllum* sp. (peace lily), *Spinacia oleracea* (spinach), *Stephanotis floribunda*, *Stellaria media* (chickweed), *Tagetes* sp. (marigold), *Tropaeolum* sp. (nasturtium), *Verbena* sp. (verbena), *Vicia faba* (faba bean), *Zantedeschia aethiopica* (calla) and *Zinnia* sp. (zinnia) (CABI-CPC, 2021; Daughtrey et al., 1997; Kuo et al., 2014).

Symptoms: On lettuce, symptoms include stunted plant growth, chlorosis, and leaves with irregular-shaped, tan to dark brown, necrotic spots or ringspots. Older leaves show extensive marginal necrosis and wilting. Leaf ribs show extensive spotting and browning. Lettuce plants infected at the seedling through rosette stage were severely stunted and did not form marketable heads (Kuo et al., 2014).

On many hosts including ornamentals, symptoms can include overall yellowing or patchy chlorosis, dead necrotic spots on leaves or terminal shoots, and general stunting. Sometimes ringspots are present. Peppers show discontinuous and irregular necrotic or blackened streaks on stems and petioles, with water-soaked leaf lesions that expand into irregular-shaped necrotic patches. Infected leaves show necrosis along the veins and petioles and will defoliate. If plants are infected when young, they can be severely stunted and produce very few fruits. The fruits will have uneven ripening with necrotic and concentric green rings, or chlorotic spots, red or green areas surrounded by yellow halos. The rings that may become necrotic (Koike et al, 2009; Naidu et al., 2005; González-Pacheco and Silva-Rosales, 2013). Spinach plants infected with INSV exhibit severe stunting and leaves with interveinal yellowing, thickening, and deformation (Liu et al., 2009). Symptoms are similar enough to TSWV that testing is required to accurately diagnose each virus.

Transmission: The primary mode of transmission is vectoring by thrips. The virus is acquired through feeding on infected plants when the thrips are in a larval stage. After pupation when they become adults, the virus can multiply inside the thrips, but the virus is not transmitted to the eggs. Once a larva has the virus, it will retain the virus through molting, pupation, and emergence, so that adult thrips will be viruliferous and can transmit it to healthy plants.

In California, INSV is transmitted by western flower thrips (*Frankliniella occidentalis*). *Frankliniella occidentalis* is a polyphagous and widespread pest of vegetables and ornamentals in fields and greenhouses, often building up to very large population sizes in the summer and fall. This thrips can feed and reproduce on many types of weeds. Orthotospoviruses survive year-to-year in perennial or biennial hosts, and in mild winters, inside overwintering adult thrips. In spring, the thrips fly from overwintering hosts and transmit INSV to annual hosts. Thrips can also be blown longer distances with strong winds (Kuo et al., 2014).

Although it is not seed borne, INSV can be easily spread by the movement of infected but asymptomatic, vegetatively propagated plants. Spread with infected ornamentals is most likely responsible for the movement of INSV between countries and continents (CABI-CPC, 2021).

Damage Potential: INSV causes significant crop losses for growers of major flower crops, including cineraria, ranunculus, impatiens, New Guinea impatiens, cyclamen, exacum, begonia, primula and gloxinia, along with dozens of minor crop species. If seedlings are infected early, they can be killed outright. Older plants show varying degrees of crown rot, line patterns, mosaic, brown leaf spots and stem necrosis, with the potential to cause 100% losses (Daughtrey et al., 1997).

In peppers and spinach, incidences ranging from a few percent of the crop to nearly 40% has been reported, sometimes with severe stunting and damage to leaves and fruits (Liu et al., 2009; González-Pacheco and Silva-Rosales, 2013; Naidu et al., 2005).

In California, coastal lettuce crops have periodically sustained huge losses due to INSV. Entire crops can be infected when thrips populations are high. Damage is most severe when the plants are infected early, and if there are additional pathogens such as *Pythium uncinulatum*, which causes Pythium wilt, or *Sclerotinia* spp., which cause white rot, in the fields. Reducing weeds that can serve as a reservoir for the virus during the winter fallow months, and then as the source of the virus and thrips for the coming lettuce production season is important in controlling epidemics (Smith and Hasegawa, 2020).

Worldwide Distribution: Africa: *Egypt, Uganda*; Americas: *Canada, Chile, Colombia, Costa Rica, Mexico, United States of America* (Alabama, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Texas, Vermont, Virginia, Washington); Asia: *China, Iran, Japan*; Europe: *Belgium, Bosnia and Herzegovina, Bulgaria, Czech Republic, Finland, France, Germany, Greece, Guernsey, Hungary, Italy, Italy, Lithuania, Netherlands, North Macedonia, Poland, Portugal, Slovenia, Spain, United Kingdom*; Oceania: *Australia, New Zealand.*

Official Control: The EPPO lists INSV as a quarantine pest for Israel, Mexico, Morocco, Norway, and Tunisia, on the A1 list for Bahrain, Brazil, Georgia, Jordan, Kazakhstan, Turkey, and Ukraine and on the A2 list for Russia (EPPO, 2021). USDA PCIT includes INSV on the harmful organism list for the following countries: Brazil, Ecuador, Eurasian Customs Union, French Polynesia, Georgia, Guatemala, Honduras, India, Japan, Republic of Korea, New Zealand, Panama, Peru, and Taiwan (USDA, 2021)

California Distribution: From official samples, INSV is in Imperial, Monterey, San Diego, San Luis Obispo, and Santa Barbara counties. From published literature, it is also in San Benito and Santa Cruz counties (Kuo et al., 2014).

California Interceptions: In 2016, San Diego County agricultural officials detected INSV in an incoming shipment of *Peperomia* sp. (radiator plant) from Guatemala.

The risk Impatiens necrotic spot virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:**

   There are abundant and diverse hosts throughout the state. In some areas, cold winter weather reduces adult thrips populations.

   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 of this virus is large including important flower and vegetable crops for California.

   Evaluate the host range of the pest.

   Score: 3

   - 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:**

   Thrips vectors are common in vegetable fields and greenhouses where many important INSV hosts are grown. Thrips adults can fly and infect new hosts.

   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:**

   INSV can be a major problem for lettuce growers in coastal California. Economic losses can be up to 100% when there are large populations of western flower thrips vectoring the virus. Other important crops affected include peppers and spinach, and many greenhouse grown cut flowers and potted ornamentals including impatiens, gladiolus, and ranunculus (Daughtrey et al.). INSV is a quarantine pest for some trading partners (USDA PCIT).

   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.

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: The host range of INSV is large and includes weeds that can be directly affected and serve as a reservoir for virus and thrips that move onto healthy plants. Greenhouses may need screens to keep out thrips or apply insecticides for thrips control.

Environmental Impact: A, 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 Impatiens necrotic spot virus*:* High

Add up the total score and include it here. **15**
-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.

INSV has been detected in multiple counties in California and is well established in coastal areas

Evaluation is "high'.

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* ***= 12***

Uncertainty:

When INSV first emerged in floriculture and nursery crops, it was thought to have a restricted host range compared to TSWV. However, INSV has been detected in additional California crops including lettuce, spinach, basil, and peppers, ornamentals, and in many weed species. With large and uncontrolled populations of western flower thrips, there is greater risk of inoculation of more potential hosts.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for **Impatiens necrotic spot virus is C.**

References:

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Responsible Party:

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***Comment Period: 02/12/2021 through 03/29/2021**

***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
