

**California Pest Rating Proposal for**  
***Ralstonia solanacearum* Race 3 biovar 2 (Smith 1896) Yabuuchi et al. 1996**  
**Brown rot of potato/ Southern wilt of geranium**

**Current Pest Rating: Q**

**Proposed Pest Rating: A**

Domain: Bacteria; Phylum: Proteobacteria  
Class: Betaproteobacteria; Order: Burkholderiales  
Family: Burkholderiaceae

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**Comment Period: 6/1/2020 through 7/16/2020**

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**Initiating Event:**

On April 21, 2020, The U.S. Department of Agriculture identified *Ralstonia solanacearum* Race 3 biovar 2 (*Rs-R3bv2*) in a symptomatic geranium plant (*Pelargonium* sp.) in a commercial greenhouse in Michigan. The geranium that tested positive was a Fantasia 'Pink Flare' variety imported from a production facility in Guatemala. This is the first introduction of the pathogen into the United States since 2004, when this disease was similarly introduced in 27 states. USDA Plant Protection and Quarantine officials issued an Emergency Action Notification to the Michigan greenhouse to immediately prohibit the sale or movement of all geraniums and any other suspect plant material on the property. The USDA determined an additional 288 plant growers in 39 states had received affected shipments from the Guatemalan facility, including a nursery in Placer County, California. USDA and CDFA are inspecting all greenhouses that received cuttings, collecting trace-forward information, and destroying all Fantasia 'Pink Flare' geraniums and any co-mingled or exposed hosts and non-host plants. Cleaning and disinfecting the greenhouses will follow USDA approved methods. The risk to California from *Rs-R3bv2* is described herein and a permanent rating is proposed.

**History & Status:**

**Background:** Bacterial wilt diseases caused by *R. solanacearum* sensu lato generally occur in the lowlands in tropical or subtropical areas and have been reported in more than 30 countries around the world. Historically, strains of *R. solanacearum* have been differentiated into five races according to host range and geographic distribution, and six biovars based on biochemical tests (Denny, 2006).

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There is no correlation between races and biovars; however, biovar 2 strains are usually in race 3. A system based on phylogenetic relationships has been proposed by Fegan and Prior (2005) and classifies *R. solanacearum* into four phylotypes (genetic variants) that can be further separated into 23 sequevars (sequence variants). These phylotypes reflect the geographical origin and ancestral relationships between strains, and *Rs-R3bv2* belongs to Phylotype II (sequevars 1 and 2).

*Ralstonia solanacearum* R1 is endemic to the southeastern United States, where it causes bacterial wilt on a range of cultivated crops, such as pepper, tobacco, tomato, and rarely potato. Bacterial wilt caused by this group has not spread to potato elsewhere in the United States because the seed potato system is isolated from the potato production system and also (it is thought) because the southeastern strains cannot survive in colder, potato-producing areas of the United States.

*Ralstonia solanacearum*, R3bv2, is unique in its ability to infect plants growing in temperate zones or at higher altitudes, such as the temperate highland tropics of Africa, Asia, and Latin America, where it is established. It is an extremely destructive potato pathogen, causing brown rot of tubers and causing southern wilt of geranium and bacterial wilt of tomato. It has also been found multiple times in Europe, where it has caused serious quarantine-related losses of seed potatoes (Jance, 1996).

In the United States, several introductions of *Rs-R3bv2* have already occurred as a result of importation of infested geranium cuttings from off-shore production sites in Kenya (2003) and Guatemala (2003 and 2004), but the pathogen was apparently eradicated from the US. In 2007, a *Ralstonia* work plan was developed by USDA that includes the minimum sanitation protocols necessary for off-shore production of geranium cuttings (Evens-Goldner, 2007). Despite the application of strict biosecurity measures, the re-introduction of this pathogen through importation of infected geranium planting material has occurred again. Because of its potential to affect potato production in cold-temperate areas in the northern United States, *Rs-R3bv2* is considered a serious threat to American agriculture and is listed as a Select Agent plant pathogen (Lambert, 2002).

Management of brown rot caused by R3b2 is difficult due to lack of effective control measures or resistant potato cultivars. Chemical control, such as soil fumigation, is of limited efficacy. Additionally, detection of the pathogen can be difficult due to occurrence of latent infections in potato tubers or in geranium cuttings.

*Hosts: Capsicum annuum* (bell pepper), *Cosmos bipinnatus* (garden cosmos), *Cyphomandra betacea* (tree tomato), *Datura stramonium* (jimsonweed), *Pelargonium hortorum* (pelargonium), *Physalis* spp. (groundcherry), *Portulaca oleracea* (purslane), *Solanum cinereum* (Narrawa burr), *Solanum dulcamara* (bittersweet nightshade), *Solanum lycopersicum* (tomato), *Solanum melongena* (eggplant), *Solanum nigrum* (black nightshade), *Solanum tuberosum* (potato), *Urtica dioica* (stinging nettle).

*Symptoms:* On geranium, the early symptoms of *Rs-R3bv2* can be subtle and easily overlooked. Symptoms include leaf scorching that appears in sectors, yellowing of lower leaves (not associated with senescence), and upward curling of leaf margins. Soon after the leaf symptoms manifest, geranium plants begin to wilt even with adequate soil moisture. Southern wilt can look like wilting symptoms caused by other pathogens such as *Xanthomonas campestris* pv. *pelargonii*, which causes bacterial

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blight. Unlike bacterial wilt, bacterial blight produces leaf spots and is favored by high temperatures (29-35°C) (Champoiseau et al., 2009). Bacterial streaming can be a diagnostic sign of *Rs-R3bv2*. When cut geranium stem sections are suspended in water, threads of a viscous white slime can be observed streaming from the cut end of the stem. This is bacterial ooze released from the infected xylem vascular bundles (Allen et al., 2001). Occlusion of the vascular bundles is the cause of the wilting.

On infected potatoes, plants may be stunted, and foliage yellowed, and wilted. Early in disease development, leaf wilting may be limited to the top portion of plants, and to only an individual branch or leaflet. The plants may appear to recover at night when temperatures are cooler. As wilting becomes more extensive and irreversible, plants collapse. The stems may collapse and/or exhibit narrow dark streaks of vascular discoloration, with bacterial ooze present. Inside the potato tubers, the vascular ring will have grey-brown discoloration, and bacteria may ooze from cut tuber pieces when they are squeezed. Ooze from intact tubers at eyes or where the stolons attach can cause dirt to adhere to the ooze. If the vascular tissue inside the tuber has collapsed, sunken skin lesions can result (Champoiseau et al., 2009). Symptoms can be confused with those of *Verticillium* wilt.

On tomatoes, symptoms of bacterial wilt caused by *Rs-R3bv2* are the same as those caused by strains of other biovars. Wilting is the first symptom and begins at the top portions of plants as a flagging of one or two leaves. Under favorable conditions, the disease develops rapidly on tomatoes and may collapse plants as quickly as 4-7 days after appearance of the first symptoms. *Fusarium* wilt, caused by *Fusarium oxysporum* f. sp. *lycopersici*, causes similar symptoms (McCarter, 1991).

*Transmission:* This disease can be transmitted by contaminated soil, water, equipment, and personnel or by transplantation of infected plants, tubers, or cuttings. The bacterium does not spread through the air and bacteria can remain viable in soil for more than a year in the absence of a host.

Transmission can occur from plant to plant with contaminated shared irrigation water systems (e.g., “ebb and flow”), and in geraniums, transmission occurs primarily through water movement in recirculating subirrigation systems. Sap transmission when taking geranium cuttings without proper sanitation also can spread the pathogen. Latently infected plants can shed large numbers of bacteria through their roots, making runoff water an important source of new infections. Strict sanitation practices are necessary reduce transmission in geranium cuttings (Evans-Goldner, 2007).

Movement of infected seed potatoes greatly enhances the transmission of the disease over long distances. Transmission in potato occurs from plant to plant in the soil, usually by water movement. *Ralstonia*-contaminated water used for irrigation can also transmit the disease. In cool conditions, infected potato plants may harbor the bacterium without exhibiting symptoms and transmit the disease to progeny tubers, resulting in severe outbreaks if grown under warmer conditions (Janse, 1996).

*Damage Potential:* Latent infections are common in both potato and geranium (Swanson et al., 2005) and are of major importance in spread of *R. solanacearum* and in the epidemiology of the disease. It was shown that latently infected geranium cuttings were responsible for introductions of *Rs-R3bv2* to the United States in 2003 and 2004. The economic impact to offshore geranium producers can be high

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with the burden of quarantine-related testing and record keeping, plus the cost of crop destruction when *Rs-R3bv2* is detected.

Brown rot is one of the most damaging pathogens on potato worldwide (Hayward, 1991; Janse, 1996). It has been estimated to affect one million acres in approximately 30 countries with global damage estimates exceeding one billion dollars per year (Floyd, 2007). The bacterium is adapted to cooler temperatures and could be particularly damaging to potato production regions of the northern United States. Yield reductions in potato fields in the United Kingdom, the Netherlands, and Sweden have been limited due to quarantine and eradication efforts (Priou et al., 2006). If *Rs-R3bv2* became established in California, seed potato production and export would come under quarantine from other states and countries.

**Worldwide Distribution:** Widespread in Central and South America, Asia, and Africa, and present but under eradication in the United Kingdom, Netherlands, and Sweden.

**Official Control:** *Ralstonia solanacearum* Race 3 biovar 2 is a Federal Quarantine pest and on the Select Agent plant pathogen list. It is on USDA's Harmful organism list for Canada, Chile, Colombia, Egypt, and Panama.

**California Distribution:** *Ralstonia solanacearum* Race 3 biovar 2 is not known to occur in California. Its presence anywhere in the United States is transient: actionable, under eradication

**California Interceptions:** Potentially infected geranium plants originating in Guatemala were sent to California in April 2020.

The risk *Ralstonia solanacearum* Race 3 biovar 2 would pose to California is evaluated below.

## **Consequences of Introduction:**

- 1) Climate/Host Interaction:** Although many strains of *Ralstonia solanacearum* are associated with tropical or subtropical locations, strains classified as Race 3 biovar 2 are more cold-tolerant and have been found in cooler areas higher in latitude or higher in elevation.

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 contains plants from multiple families, including agronomic hosts and weeds.
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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:** This pathogen spreads with contaminated water and infected planting material. It does not spread through the air or have an insect vector.

**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 pathogen causes direct damage to hosts causing wilt and death. It is also a quarantine pathogen, restricting the movement of seed potatoes and geranium cuttings. When detections are made in California, actions taken include extensive traces and crop destruction of exposed or potentially exposed hosts. It can remain viable in water and soil, necessitating long crop rotations to break the life cycle, extensive cleaning of greenhouses, and it can also survive on weeds.

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

**Economic Impact: A, B, C, D, G**

- 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:** Extensive biosecurity is required to grow geraniums or seed potatoes for export because of this pathogen. It potential for long latency, can lead to extensive spread before detection. Its hosts include weeds; if accidentally introduced, it could survive in the absence of an agronomic host. In Europe, after accidental introduction on potatoes used for processing, *Rs-R3bv2* has persisted in the environment.

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**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 *Ralstonia solanacearum* Race 3 biovar 2: High**

Add up the total score and include it here. **13**

- 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 'not established'***: there have only been incursions of this pathogen in California with infected geraniums from offshore.

**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.

- 7) The final score is the consequences of introduction score minus the post entry distribution and survey information score: (Score)**
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**Final Score:** *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information = 13*

### Uncertainty:

Additional weed hosts might be added as *Rs-R3bv2* is introduced into new areas.

### Conclusion and Rating Justification:

Based on the evidence provided above, the proposed rating for *Ralstonia solanacearum* R3bv2 is A.

### References:

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Priou, S., Gutarra, L., and Aley, P. 2006. Sensitive detection of *Ralstonia solanacearum* in soil: a comparison of different detection techniques. Plant Pathology 49:414-422.

Swanson, J. K., Yao, J., Tans-Kersten, J. K., and Allen, C. 2005. Behavior of *Ralstonia solanacearum* race 3 biovar 2 during latent and active infection of geranium. Phytopathology 95:136-143.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PEXD) Harmful Organisms Database Report. *Ralstonia solanacearum*. Accessed 5/4/2020

### 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[[@](mailto:permits@cdfa.ca.gov)]cdfa.ca.gov.

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**\*Comment Period: 6/1/2020 through 7/16/2020**

**\*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\[\[@\]\(mailto:permits@cdfa.ca.gov\)\]cdfa.ca.gov](mailto:permits@cdfa.ca.gov).

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### Comment Format:

- ❖ Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

**Example Comment:**

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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.
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**Proposed Pest Rating: A**

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