PP 206

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Southern Wilt of Geranium[1]

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Southern wilt, caused by the bacterium *Ralstonia solanacearum* (Rs), is currently an important disease for geranium producers. Different races of *R. solanacearum* affect hundreds of plant species around the world. However, some races are specific to given areas and are adapted to different climates. Race 1 biovar 1 is well adapted to tropical and warm-temperate areas and is common to the southeastern United States. Another race of *R. solanacearum*, race 3 biovar 2 (Rs3 2), has only been detected in a few greenhouses in the US and has been eradicated in each case.

Rs3 2 is not otherwise thought to be present in the US but is particularly troublesome for potato and tomato producers in temperate regions of much of the rest of the world where this particular pathogen is commonly found. Both race 1 and race 3 are capable of causing southern wilt disease on geranium. In an attempt to keep Rs3 2 from being introduced on imported geraniums and other susceptible crops, APHIS PPQ regulates potential introductions and has the authority to quarantine and destroy plants found to be infected. Geranium plants infected with the common *R. solanacearum* race 1 look identical to those infected with race 3. Geranium growers have a zero-tolerance for *R. solanacearum*, because it is likely that the discovery of any race on geranium will result in costly complications for the grower. This publication is meant to provide information to geranium producers that might help reduce their risks of substantial losses due to southern wilt disease.

Pathogen and Disease Information

Host Range

Plant species most susceptible to Rs3 2 include potato, tomato, geranium, and a few solanaceous weeds. Race 1 has a wide host range that includes potato, tomato, geranium, eggplant, pepper, tobacco, peanut, banana, and many others. Numerous solanaceous weed species associated with open irrigation systems or in close proximity to the production facility could potentially serve as a source of *R. solanacearum* inoculum. The exact host range of the pathogen is difficult to determine because of

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variation in virulence within races of *R. solanacearum* and variation in susceptibilities of host species. Some plant species may be asymptomatic but can still harbor the pathogen.

Figure 1. Initial symptoms of southern wilt include drought stress. Wilting and cupping generally occurs on the older leaves first and is apparent on younger growth as disease develops. Credits: Dave Norman

Disease symptoms

Symptom expression is favored by high temperatures (85-95°F). Symptoms of this disease may progress rapidly after infection, but plants may remain without symptoms for extended periods. After infection the pathogen may survive in and be spread from the infected plant.

Wilt and vascular symptoms

Symptoms of southern wilt on geranium (*Pelargonium* spp.) begin with wilting of the lower leaves, a condition that may improve overnight, but will occur again the next day (Figure 1). This wilt spreads up the plant, progressing from older leaves to newer ones, resulting in the eventual collapse and death of the plant. Wilted leaves often become chlorotic then necrotic in wedge-shaped patterns that expand towards the leaf margins (Figure 2), or leaf margins themselves may become chlorotic then necrotic (Figure 3). Leaf spots typically are not associated with the disease. Brown vascular discoloration is often apparent in and on stems (Figure 4), and stems may become soft and ooze a milky liquid (Figure 5). Roots may appear brown and rotten.

Figure 2. Wedge-shaped necrosis expanding from the midrib of the leaf to the margin with a distinct yellow (chlorotic) border is a typical symptom of southern wilt caused by *Ralstonia solanacearum.* Older leaves often show symptoms before the disease spreads to newer foliage. Credits: Dave Norman

Look-alikes

Similar wilt symptoms may be caused by general root rot, various nutrient imbalances, or water stress. Bacterial blight caused by *Xanthomonas campestris* pathovar *pelargonii* also may cause wilt symptoms. Generally, leaves affected with bacterial blight will become spotted, vascular discoloration will be less pronounced or absent, and roots will remain white and healthy.

Spread of the pathogen

R. solanacearum race 1 has been reported to survive in Florida soils. The pathogen was detected in irrigation ponds and surface water in Quincy Florida in 2004 (Tim Momol, personal communication). Rs has the potential to move into recycled irrigation water from infected weed species in close association with water collection or recovery areas. Plants brought into the facility from native soil plantings also could introduce the pathogen. Soil tracked into the facility on equipment, shoes, or supplies could contain the bacterium. Since Rs3 2 is a quarantinable pathogen in the US, pathogen introduction from

overseas production facilities in Central America and Kenya is the main concern for geranium producers. Once introduced into a production facility, Rs3 2 can be transmitted through contaminated irrigation water, on equipment, by personnel, or in soil similar to race 1.

Shared irrigation systems (i.e. flooded benches or floors) facilitate spread of the bacterium within a production facility. When contaminated irrigation water is used on geranium and other susceptible hosts, the pathogen moves with the water to the roots where it infects. The bacterium may be present in the water-conducting tissues (vascular tissue). If an infected plant is pruned with tools or pinched by hand, the bacterium can be spread to subsequent healthy plants. The pathogen also can be spread by splashing irrigation water. Though possible, the pathogen does not readily spread through leaf-to-leaf contact or through still water vapor in the air.

Figure 3. Marginal necrosis associated with a distinct yellow border are also common symptoms of southern wilt (*Ralstonia solanacearum*). However, distinct leaf spots are not generally associated with this disease. Credits: Tim Momol

Figure 4. As the bacterium spreads upward through the vascular tissues in the stem, yellow to brown stem discoloration may become apparent. The discoloration is a typical symptom of southern wilt (*Ralstonia*) but is generally not present with bacterial blight (*Xanthomonas*). Credits: Dave Norman

Figure 5. Brown and rotten roots and stems are associated with Geraniums with southern wilt (*Ralstonia*). While root rot symptoms can result from a number of other factors, roots typically remain white and healthy with bacterial blight (*Xanthomonas*). Credits: Dave Norman

Risk reduction and disease management

The introduction and discovery of this pathogen in a geranium production facility could have serious financial consequences. Some basic disease management strategies, including exclusion, sanitation, and eradication, can reduce the risk of pathogen introduction and spread. These practices can not only reduce the likelihood of many diseases

but can reduce the potential financial impact of an introduction.

Inspect offshore plant material

Rs3 2 is a regulated pathogen in the United States. Many geranium cuttings are produced in areas of the world where the pathogen is common. Movement of infected cuttings from these areas into US production facilities has occurred despite an APHIS-mandated testing and sampling plan for offshore facilities shipping geranium to the US. Careful producers will take additional precautions to ensure they receive clean material.

Rooted geranium cuttings imported from overseas initially should be isolated from the rest of the production facility for at least 48 hours if possible. Latent infections are difficult to detect, but plants should be carefully inspected for general wilting symptoms commonly associated with bacterial diseases (see Figures). If a shared irrigation system is used for the rest of the production facility, try to provide an alternate means of irrigation separate from the main system. If symptomatic plants are found, growers could test symptomatic plants themselves with a serological kit. They should also send samples to a UF/IFAS Extension Plant Disease Clinic for confirmation. UF/IFAS plant pathologists are required by law to report positive samples submitted to the appropriate regulatory agencies.

Serological kits for detecting *R. solanacearum* are available from a handful of companies. Agdia (http://www.agdia.com), for example, offers ImmunoStrip testing kits (catalog number: ISK 33900/0025). These kits cost from $3.60 to $10 per test depending on how many are purchased, take about 30 min to complete, and can be ordered by phone. Detailed information about the kits, how they should be used, and a copy of the instructions are available on the Agdia website. The kits also come with easy-to-follow instructions that include illustrations. Other companies with serological kits include: Adgen Ltd., Bioreba AG, Central Science Laboratory, and Loewe Biochemica GmbH. If a kit is used and a plant is found to be positive, submit a sample to a UF/FAS Extension Plant Disease Clinic and contact your state Division of Plant Industry inspector for further instruction. UF/IFAS plant pathologists are required to submit positive samples to regulatory agencies for confirmation of race and biovar. Several tests are used to confirm race and biovar of the pathogen (via PCR, carbohydrate utilization, etc.).

Reducing risk of spread

Most producers do not have a choice of irrigation systems. They use what they have. For those who do have a choice, avoid bottom-water (sub) irrigation that uses a continuous flow of water to irrigate many plants at the same time. Also avoid systems that collect excess water and return the used water to the system. Though these systems have their advantages, they do increase the likelihood of the spread of bacterial pathogens and in the case of Rs, increase the likelihood of substantial losses. When possible, use drip irrigation or mist irrigation instead.

If rain water is collected into holding tanks, if water is taken from collection or overflow ponds, or if water is recycled and reused, incorporate some type of water treatment that will help reduce bacterial pathogens. For example, ozonating sanitizers have been shown to remove Rs from contaminated irrigation water by 0.4 ppm residual O_3 for 4 minutes with UV light of at least 300 j/m^2 at >50% transmission. Various other filters and treatments are available to help remove pathogens from irrigation water. To prevent continued introduction of pathogens into the source, areas directly around collection ponds, open holding tanks, and greenhouses should be kept free of weeds. Plants or cuttings from plants that have been in contact with native soil also should be kept out of the greenhouse.

Plants found to be under the drip line of infected geraniums are typically discarded if Rs is detected. To be safe, don't place other plants under geraniums in the greenhouse. Keep geraniums on well-drained benches and off the ground or plastic sheeting where water may collect and pool. Keep plants from different sources and different varieties of geranium as separate as possible. When pruning, grooming, or making cuttings, workers should frequently sanitize hands and tools. This is especially important when moving between varieties, benches, and houses. Sanitizing hand gel dispensers and spray bottles with sanitizing cleaners are very useful. Locate sanitizing

shoe baths at the entrances of production facilities to reduce the likelihood of introducing pathogens in soil on shoes. Examples of cleansers commonly used to sanitize tools, pots, benches, shoes, and walkways include Physan 20, Green Shield, Maquat 615-HD or -LR, and ZeroTol. Follow the label instructions of these and other chemical disinfectants.

Hopefully no one reading this document will ever have to deal with an Rs3 2 introduction. Unfortunately, even if all these recommendations are followed, the risk of substantial losses may be reduced but cannot be eliminated completely. For additional information on Rs3 2, the regulatory actions associated with this pathogen, and other recommendations, visit the APHIS PPQ website for the latest *Ralstonia solanacearum* race 3 biovar 2 Pest Response Guidelines at:
http://www.aphis.usda.gov/ppq/ep/ralstonia/

Related Resources

Florida Cooperative Extension's Electronic Data Information Source (EDIS)
http://edis.ifas.ufl.edu/

APHIS PPQ Ralstonia pest response guidelines and website:
http://www.aphis.usda.gov/ppq/ep/ralstonia/

Bacterial wilt of pepper
http://edis.ifas.ufl.edu/PP103

Bacterial wilt of row crops in Florida:
http://plantpath.ifas.ufl.edu/takextpub/FactSheets/circ1207.pdf

First Report of Southern Wilt Caused by *Ralstonia solanacearum* on Geranium in Florida. P. Pradhanang, T. Momol, H. Dankers, E. Momol, and J. Jones.
http://www.plantmanagementnetwork.org/sub/php/brief/geranium/

Professional Disease Management Guide for Ornamental Plants
http://edis.ifas.ufl.edu/pdffiles/PP/PP12300.pdf

Southern Plant Disease Network (SPDN)
http://spdn.ifas.ufl.edu/

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UF/IFAS Pest Alerts:
http://extlab7.entnem.ufl.edu/pestalert/tmm-0607.htm
http://extlab7.entnem.ufl.edu/pestalert/tmm-0303.htm

UF/IFAS Extension Plant Disease Clinic:
http://edis.ifas.ufl.edu/SR007
http://plantpath.ifas.ufl.edu/pdc/

UF/IFAS Department of Plant Pathology Extension Publications:
http://plantpath.ifas.ufl.edu/takextpub/