# Bacterial Wilt of Solanaceous Crops and Other Host Plants
# *Ralstonia solanacearum*

**Hosts:** This pathogen has a broad host range of at least 33 families. Different pathogenic populations have been divided into five races, based primarily on their pathogenicity to various hosts, and biovars, based on metabolic activity with different carbon sources. Genetic analyses have resulted in a new classification of strains into phylotypes and sequevars, which may replace the older classifications into races and biovars. Race 1 (see below under Disease Cycle) has a wide host range covering plant species that occur in warm climates, including solanaceous hosts, such as tobacco (*Nicotiana* spp.), tomato (*Lycopersicon* spp., 144 wild species and crosses), and eggplant (*Solanum melongena*), and nonsolanaceous species, such as peanut (*Arachis hypogaea*). Race 2 affects banana and heliconia. Although tomatoes, when inoculated with race 2 in the greenhouse, develop wilt symptoms, there is no evidence that it causes the disease naturally in the field. Race 3, biovar 2 primarily infects potato (*Solanum tuberosum*) and was first reported in high-elevation tropics (hence, cooler conditions). It now has become established in cool potato-growing regions of Europe. Geranium (*Pelargonium ×hortorum*), tomato, eggplant, and some additional weed and ornamental hosts are also susceptible to race 3, biovar 2. Race 4 primarily affects ginger (*Zingiber officinale*) and other hosts in the family Zingiberaceae. It also wilts tomato following greenhouse inoculation, but it is not known to cause disease in the field. Race 5 is specific to mulberry (*Morus alba*).

**Disease common names:** Bacterial wilt and southern bacterial wilt.

**Pathogen:** *Ralstonia solanacearum*; syn.: *Pseudomonas solanacearum* and *Burkholderia solanacearum*. Different pathogenic populations have been divided into five races, based primarily on their pathogenicity to various hosts, and biovars, based on metabolic activity with different carbon sources. Genetic analyses have resulted in a new classification of strains into phylotypes and sequevars, which may replace the older classifications of races and biovars.

## Disease Cycle

The following descriptions focus on bacterial wilt caused by race 1.

**Inoculum:** Inoculum is found in soil, irrigation water, plant debris, and alternate hosts that harbor the pathogen without producing symptoms.

**Transmission:** The pathogen is disseminated on contaminated farming equipment, in soil, and on footwear. Drainage water from diseased plants carries inoculum to distant fields. Cultural operations, such as pruning, create wounds that provide infection sites. There is little evidence for seed transmission, with a few exceptions, such as with peanut (groundnut).

**Infection:** Bacteria are attracted to root exudates and gain entry through wounds and natural openings. They multiply rapidly in xylem elements and produce abundant extracellular polysaccharides, causing plugging of the xylem and leaf wilting. There often is an association between root-knot nematode infection and bacterial wilt, since nematodes create wounds, allowing sites of entry for the bacteria. High temperatures and moist soils favor disease development. Thus, disease is most serious in tropical, subtropical, and warm temperate regions where the mean soil temperature is above 15°C.

**Symptoms and signs:** Initial symptoms on tomato are wilting of upper leaves on hot days, followed by recovery during the evening and early morning hours. The wilted leaves maintain a green color and do not dehisce as disease progresses (Fig. 1). High temperatures have a pronounced effect on symptoms, causing wilt to occur rapidly. Figures 2–6 show plants at different stages of wilt with some dying. Vascular tissues in the lower stem of wilted plants may exhibit a dark brown discoloration. With custard apple, a brown discoloration of the

vascular system is a characteristic symptom (Fig. 5). Figure 7 shows discolored vascular bundles in bird-of-paradise. There are other symptoms of bacterial wilt and they vary among plant species, such as anthurium (Figs. 8 and 9). When cut stems from infected plants are placed into tubes of clear water, white, milky strands of bacterial cells exude from the cut ends. The “ooze test” distinguishes a wilt caused by *Ralstonia solanacearum* from that caused by fungal pathogens (e.g., *Fusarium* spp.) or other vascular bacterial pathogens of tomato, such as *Pseudomonas corrugata* and *Clavibacter michiganensis* subsp. *michiganensis*.

**Survival:** The bacteria survive in soil and can maintain infectious populations for several years. Bacteria may enter a viable but nonculturable state, which is considered a form of long-term survival. Weed hosts that harbor the pathogen without producing symptoms also play a role in survival.

## Disease Management

Crop rotation is essential since continuous cropping of susceptible plants produces high levels of soilborne inoculum. Rotation with maize or rice for 2 years or more is recommended for some areas. Irrigation water and drainage patterns should be monitored since water can carry and disseminate inoculum from diseased plants in nearby fields. Other cultural practices include use of certified transplants or vegetative planting stocks stored under dry, cool conditions. Planting in the cooler seasons of the year and cleaning and disinfesting machinery helps to minimize disease spread. Deep plowing to bury inoculum or repeated disking of soil to expose inoculum to the sun and heat appears to be an effective method to reduce or eliminate inoculum in some areas. Use of resistant germplasm is recommended, when available. In the tropics, susceptible cultivars are grafted onto resistant rootstocks. Biological control with bacteriophages has been effective under greenhouse and controlled field conditions. Chemical control is generally not feasible.

## References

Bradbury, J. F. 1986. Guide to Plant Pathogenic Bacteria. CAB International, Slough, U.K.

Jones, J. B., Jones, J. P., Stall, R. E., and Zitter, T. A., eds. 1991. Compendium of Tomato Diseases. American Phytopathological Society, St. Paul, MN.

Figure 1. Wilted tomato foliage. (Courtesy M. Goto)

Figure 2. Wilted tobacco plant. (Courtesy K. W. Liew)

Figure 3. Wilt of eggplant, late stage. (Courtesy H. Valenzuela)

Figure 4. Strawberry with advanced stage of wilt. (Courtesy M. Goto)

Figure 5. Longitudinally cut trunk of custard apple exposing brown discoloration of the vascular system. (Courtesy A. Hayward)

Figure 6. Wilted and dead leaves of bird-of-paradise. (Courtesy T. Saito/M. Goto)

Figure 7. Rotted stele of infected rhizome and discolored vascular bundles of leaf petioles of bird-of-paradise. (Courtesy T. Saito/M. Goto)

Figure 8. Anthurium with pale yellow areas on wilted leaf. (Courtesy D. Norman)

Figure 9. Anthurium with a wilted and discolored leaf. (Courtesy D. Norman)