Southern Bacterial Wilt of Geranium Caused by *Pseudomonas solanacearum*

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ABSTRACT

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The cause of wilting and death of florists' geranium (*Pelargonium hortorum*) in a garden in Raleigh, NC, was determined to be *Pseudomonas solanacearum*. This geranium isolate of *P. solanacearum* was also pathogenic on marigold, tomato, and zinnia, but not on tobacco. A marigold isolate reacted similarly, but tobacco and tomato isolates were pathogenic on all five crops. This is believed to be the first report of *P. solanacearum* on geranium.

Southern bacterial wilt caused by *Pseudomonas solanacearum* E. F. Sm. is a widespread and destructive disease in warm climates. The host range of the pathogen is extensive, including members of 33 different families (5). While not major, economically important hosts, several herbaceous ornamental plants, including dahlia, marigold, nasturtium, and zinnia, are hosts.

Florists' geranium, *Pelargonium hortorum* Bailey, has not previously been reported as a host of *P. solanacearum*. Smith (10) reported that *Pelargonium zonale* was not susceptible. Natural infection of *Pelargonium* sp. was reported from West Australia in 1933 (9) and from Tanganyika in 1934 (12). Also, Hayward (3) in 1964 reported using the culture CMI No. B509 (NC PPB) of *P. solanacearum* isolated from *Pelargonium capitatum* from the West Indian ocean island of Réunion in 1961. Southern bacterial wilt is not listed as a disease of florists' geranium in any of the standard references (1,2,4–6,8,11).

In Raleigh, NC, in July 1979, half of a planting of about 110 'Sprinter' geraniums were wilting and dying. Plants were large, about 30–40 cm in diameter, and otherwise in good condition. Vascular necrosis could be traced 15–20 cm from the soil line in the succulent stem tissue. Isolations at these extremities as well as from tissue at the soil line and below yielded bacterial colonies on nutrient agar and tetrazolium agar typical of *P. solanacearum*.

Tests of Koch's postulates were performed with 'Yours Truly' geranium and 'Manapal' tomato. Inoculations were made by dipping roots in a dense suspension, by puncturing stems at the junction of petiole and leaf with contaminated toothpicks, and by pouring a dense suspension over cut roots (13). Symptoms developed in 5–7 days with each method, but disease development was most uniform in the severed-root method.

Initial symptoms in 10-cm-tall geraniums appeared 5 days after root inoculations in warm (24–40 C) greenhouse conditions. Wilting of lower leaves was followed in a few days by chlorosis and finally necrosis of affected leaves. Most leaves were necrotic after 2 wk, but the terminal growth usually remained green until the stem turned black at the soil line and the plant collapsed. Expanded leaves that were not fully necrotic by this time usually showed marginal chlorosis and necrosis. Flowers failed to open normally. Stem sections revealed vascular necrosis 5 days after root inoculations (Fig. 1). Ten to 14 days after root inoculation, portions of stems at the soil line began turning brown, then black. The plant usually collapsed after 1–2 cm of the basal stem became necrotic.

Physiologic and morphological characteristics of isolates from geranium (NC 437), tomato (K 60), and tobacco (NC 446) were compared. All isolates were rod-shaped and contained poly-B-hydroxybutyrate crystals. They were aerobic, gram-negative, catalase-positive, arginine dihydrolase-negative, and nonfluorescent on King's B medium.

Four isolates of *P. solanacearum* from geranium, marigold, tobacco, and tomato were tested for pathogenicity to those four crops and to zinnia. Culture isolates, maintained in sterile distilled water at room temperature, were grown 48 hr on nutrient agar at 28 C. Ten milliliters of an aqueous suspension of 10^7 colony-forming units per milliliter was

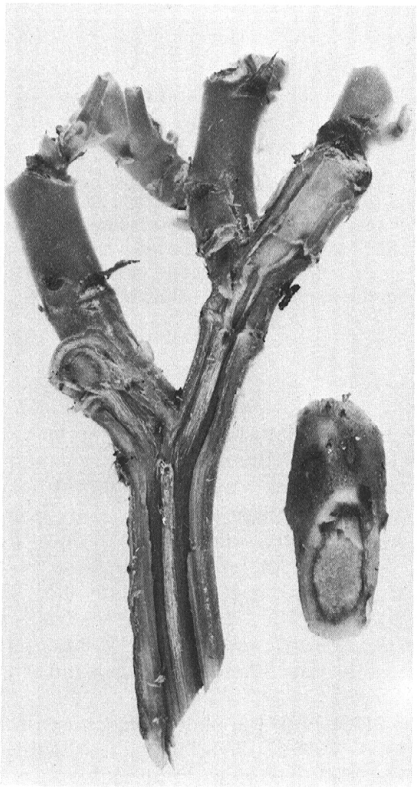

Fig. 1. Vascular necrosis of geranium infected with *Pseudomonas solanacearum*.

Table 1. Disease development[a] in geranium, marigold, tobacco, tomato, and zinnia after root inoculation with four isolates of *Pseudomonas solanacearum* from North Carolina

P. solanacearum NC isolate/source	Weeks after inoculation	Crop				
		Geranium	Marigold	Tobacco	Tomato	Zinnia
407/marigold	1	1.0	2.2	1.0	3.6	1.0
	3	3.4	4.8	1.0	3.2	4.2
437/geranium	1	1.8	2.9	1.0	3.8	1.9
	3	4.5	5.0	1.0	4.8	4.1
445/tomato	1	2.2	2.3	4.3	4.9	2.4
	3	4.6	4.0	5.0	5.0	4.4
446/tobacco	1	2.0	3.7	4.1	5.0	2.4
	3	4.6	4.6	4.5	5.0	4.2
Uninoculated control	1	1.0	1.0	1.0	1.0	1.0
	3	1.0	1.0	1.3	1.0	1.0

[a] Disease was rated on a scale of 1 to 5, where 1 = no symptoms, 2 = stunting, 3 = chlorosis and necrosis of leaves, 4 = wilting of leaves, and 5 = dead plant. Each value is an average of ratings for 10 plants in one experiment.

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poured on roots severed on one side, 1 cm from the base of stems. Ten plants were inoculated with each isolate, and 10 plants served as uninoculated controls. Roots of control plants were severed as above, and sterile water was poured over them.

Plant size varied somewhat among species, but seedlings used were 4–6 wk old at inoculation. Rooted cuttings of 'Yours Truly' geranium were 4 wk out of the rooting bed. Other plants used were 'Dwarf French Petite' marigold, 'Hicks' tobacco, 'Manapal' tomato, and 'Peter Pan Scarlet' zinnia. Plants were incubated in a warm greenhouse (24–40 C) and kept moist with overhead irrigation.

Disease development was rated weekly on a scale of 1 to 5, where 1 = no symptoms, 2 = stunting, 3 = chlorotic or necrotic leaves, 4 = wilted leaves, and 5 = dead plant. Results are summarized in Table 1. All isolates were pathogenic on geranium, marigold, tomato, and zinnia. The isolates from geranium and marigold did not cause symptoms in tobacco, indicating that they are different from the tomato and tobacco isolates.

Because the tobacco isolate caused the most rapid symptom development in all hosts, it is surprising that geranium has not been previously recognized as a host of *P. solanacearum* in North Carolina. The potential importance of this disease in geranium in the South, and in North Carolina specifically, is obvious: this soilborne pathogen limits the production of its hosts wherever it is found and is especially destructive in home gardens.

Southern bacterial wilt is an appropriate name for this disease caused by *P. solanacearum*, because the disease of geranium caused by *Xanthomonas pelargonii* also causes wilt (7).

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