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report on
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DISEASE

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BACTERIAL DISEASES OF GERANIUM

Geraniums (*Pelargonium* species) are the most popular flowering pot plants grown in the United States. Plant diseases are one of the key limiting factors to the high-quality production of these plants in the home and commercially.

Three bacterial diseases are known to attack geraniums: bacterial blight or wilt, southern bacterial wilt, and bacterial leaf spot. Bacterial blight or wilt is the only one of these diseases currently known to occur in the Midwest.

Figure 1. Bacterial wilt of geranium.

BACTERIAL BLIGHT OR WILT

This disease, caused by *Xanthomonas campestris* pv. *pelargonii*, is a major problem of geraniums in Illinois during warm, humid weather. It has caused losses of 10 to 100 percent, depending on the cultivar.

The symptoms are often masked indoors by low winter temperatures. Bacterial blight attacks the leaves and stems of the common garden or florist's geranium (*Pelargonium hortorum*) as well as the ivy geranium (*P. peltatum*). There is resistance to bacterial blight in the Lady Washington and Martha Washington geraniums (*P. domesticum*), as well as *P. acerifolium, pelargonium* "Torento", *P. tomentosum,* and *P. scarboroviae.*

Symptoms

Disease symptoms usually appear in warm, sunny weather when the plants are under moisture stress. Leaves infected with bacterial blight show two types of symptoms:

1. Small, round, water-soaked spots form on the underside of the leaf. Several days later, the spots develop into angular, slightly sunken, well-defined lesions about 1/16 to 1/8 inch (up to 3 mm) in diameter that may be surrounded by a diffuse yellow halo. The spots eventually turn dark brown to black and become hard and dry. Leaves quickly wilt, die, and may fall off, or hang on the plant for a week or more (Figure 1). The bacteria in these leaf lesions may migrate into the water-conducting tissues, move down through the petiole and into the stem, eventually causing the plant to die from the stem rot phase of the disease.

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2. A wilting of the leaf margin occurs in some cultivars, resulting in large angular (V-shaped), yellow or dead areas bounded by the veins. These leaves soon wither and hang on the petiole or drop off. Other factors, such as potash deficiency and Botrytis blight, may cause angular, dead patches, in geranium leaves; but the wilted condition is always associated with bacterial blight infections (Figure 2).

Figure 2. Geranium plant affected with bacterial blight. Note the wilting of the leaf margins and angular dead areas in certain leaves. (University of Wisconsin photo).

The stem rot phase of the disease is commonly called "black rot" by growers. Water-conducting tissues within the branches and stems of infected plants turn brown to black, 2 to 4 weeks after infection. At this stage, one or more leaves on the branch will usually wilt and develop angular dead areas. The bacteria soon spread from the water-conducting tissue to other stem tissues. The stem rapidly turns a dull gray to blackish brown. The roots are blackened but not decayed (Figure 3).

Figure 3. Geranium plant affected by bacterial stem rot. Tissues of stem and upper roots are blackened (Illinois Natural History Survey photo)

Plants gradually become defoliated, except for a few dwarfed leaves at the tips of the upright blackened branches (Figure 4). The stem and branches rapidly blacken and shrivel into a dry rot with all the tissues destroyed, except for the fibers and epidermis. Some plants may partially recover from initial infection and produce new, healthy-looking branches. Since these branches harbor the bacterium, such plants usually die within 3 to 6 months.

Cuttings infected with bacterial blight fail to root, the stems slowly rot, turn a dull blackish brown from the base upwards (Figure 5), and eventually die. The leaves wilt, often showing the typical symptoms described earlier. Cuttings serve as a source of infection in the propagation bed.

Disease Cycle

Infection occurs through plant openings or through wounds that are created when cuttings are taken from stock plants. A cutting knife that is not disinfected is one of the surest means of transmitting the bacteria. The bacterium survives in water-conducting and other tissues of infected cuttings that are taken from symptomless stock plants. Infected plants are symptomless during cool weather when the temperatures are below 70°F (21°C) or at very high temperatures (90-100°F or 32-38°C). The bacteria are very infectious and are spread easily from plant to plant through plant contact and contaminated propagation media, by splashing during hose watering or misting, cultural operations, contaminated cutting knives, and insects. The bacteria are spread or handling them. The organism has been isolated from

whiteflies (*Trialeurodes vaporariorum*), which may transmit the bacteria to healthy geraniums. The organism can survive in moist soil from 3 to 6 months, or until infected plant residues are completely decayed. Symptoms and disease spread occur most rapidly at temperatures of 70° to 85°F (21-29°C) and in plants overfed with nitrogen fertilizer.

SOUTHERN BACTERIAL WILT

Southern bacterial wilt caused by *Pseudomonas solanacearum* was first reported in geranium in 1979. The symptoms are similar to bacterial blight or wilt. Although it is not a major disease of geraniums, it could pose a threat to geranium growers in the South and the Midwest, due to the exchange of cuttings and plants from these geographic regions. The common geranium (*Pelargonium hortorum*), is susceptible to this disease. No geranium cultivars are resistant.

Symptoms

The initial symptoms include a wilting of the lower leaves followed by chlorosis and finally necrosis of the leaves. The stem eventually turns brown and then black at the soil line, and the plant collapses when 1/2 to 1 inch of the basal stem is infected. The roots can also become necrotic. Flowers fail to open normally. Stem sections reveal vascular discoloration (Figure 4). The symptoms of southern bacterial wilt always progress upward from the soil line, whereas those of bacterial blight or wilt move in either direction — up or down the stem. It is unknown if infected plants can remain symptomless.

Disease Cycle

Pseudomonas solanacearum is a soilborne bacterium that may persist in soil for 6 years or more in the absence of a suitable host plant. The pathogen survives and spreads within susceptible plants and cuttings. Infection normally occurs through the roots. The organism is transmitted on infected cutting knives, in soils and other planting media, in crop debris, by splashing or flowing water and by insects. *P. solanacearum* has a very wide host range.

Symptoms develop rapidly at 75° to 104°F (23-39°C), and plants die within 2 to 3 weeks under these conditions, whereas it may take 5 weeks for similar development of bacterial blight or wilt.

Figure 4. Vascular necrosis of geranium infected with Pseudomonas solanacearum.(D.L. Strider, North Carolina State University)

BACTERIAL LEAF SPOT

A bacterial leaf spot caused by *Pseudomonas cichorii* has been known to only attack geranium in the past few years. It has been reported only in Florida, but due to the exchange of plant material, the disease is a potential threat to the florist industry in the Midwest. This bacterium also has a wide host range.

Symptoms

The appearance of leaf spot symptoms varies, depending on the weather conditions. Plants growing outside exposed to rains exhibit dark brown to black, irregularly shaped areas 5 to 10 mm or larger. The margins of the spots appear water-soaked a few hours after a rain. The lesions may extend or enlarge along the veins and may coalesce until the entire leaf may eventually die and curl up.

Under less favorable conditions for disease development, such as when plants are exposed to dews or only occasional overhead watering, the lesions that develop are sunken on both the upper and lower leaf surfaces. These spots may have tan centers and may be slightly raised. A lesion may have a dark margin and a yellow halo that may be as wide as the diameter of the lesion. The lesions commonly enlarge in wet weather but are checked by dry weather. Eventually most spots turn dark brown to black and large lesions, formed by the merging of smaller lesions, may appear to have "eyes" 1 to 2 mm in diameter.

Flower clusters are susceptible and individual flowers fail to open when infection occurs in the bud stage. Young seedlings can also become infected, causing a soft, dark, wet decay of the developing leaves.

Disease Cycle

The bacterium is thought to be carried on clothes, hands, sprayers, and other equipment. Environmental parameters specific for this disease on geranium are presently unknown. Free moisture on the leaves and rainy periods are known to promote disease development.

Control

The control measures outlined will control all three diseases: bacterial blight or wilt, southern bacterial wilt, and bacterial leaf spot.

1. Purchase disease-free cuttings or plants from a reputable nursery or garden supply store. Florists should obtain CVI (culture-virus-indexed) cuttings from a commercial propagator who has established disease-free planting stock and who practices strict sanitary measures or uses culture-indexed cuttings to set up a mother block system. Start with new stock plants each year; do not keep them from year to year.

2. Follow strict sanitary procedures to prevent the contamination of healthy plants.

    a. Immediately remove and destroy all infected plants, preferably by burning. Remove all old leaf and plant debris.

    b. Florists should use an automatic watering system. If this is impossible, hang the host so that the nozzle does not touch the greenhouse floor. Avoid overwatering and sprinkling or misting water on the foliage.

    c. When propagating, select a raised bench away from other areas of geranium production. The bench surface should be periodically wiped or sprayed with a fresh household bleach (Clorox, Purex, Sunny Sol) solution prepared by adding 1 part of bleach to 9 parts of clean tap water. Also disinfect any equipment used to transport, hold, or work with geraniums.

d. Steam the propagating medium, soil mix, clay pots, and tools for 30 minutes at 180°F (82°C) or 160°F (72°C) for one hour.

e. Wash hands thoroughly with soap and hot running water before handling plants. Take cuttings by (1) breaking off succulent tips of disease-free stock plants; or (2) sterilizing the cutting knife or razor blade by dipping in a 70-percent solution of rubbing alcohol and flaming or soaking for 5 minutes in a liquid bleach solution (add 1 part of bleach to 9 parts of water).

   Knives or razor blades should be changed between stock plants. Do not dip cuttings in liquid solutions. Place cuttings in clean, sterile flats lined with new newspapers.

f. After establishment, take cuttings from flats and plant them directly into steam-treated soil mix in clean pots.

g. Maintain good cultural conditions and ventilation. Space the plants to avoid plant contact. The greenhouse bench surface should be covered with woven wire mesh.

h. Control whiteflies and other insects to lessen spread of bacteria. Follow the suggestions of Extension Entomologists at the University of Illinois.

i. Avoid forcing the plants too rapidly, especially during warm (70-85°F, 21-29°C) and humid weather. Maintain a balanced fertility based on a soil test.

j. In a field, flower bed, or nursery, wait at least a year before replanting with geraniums.

3. Infrequent sprays containing basic copper sulfate or other fixed copper fungicide may aid in control of bacterial leaf spot caused by *P. cichorii*. Frequent use (every 7 to 10 days), however, causes a surface glazing of the leaves and a stunting of growth.

Table 1. Some common plants susceptible to southern bacterial wilt

African-violet	cosmos	lantana	ragweeds
ageratum	cotton	lead-tree	rhubarb
alfalfa	cowpea	lupines	sainfoin
arrowroot	crotalaria	marigold	salvia
aster	crotons	meadow-weed	schizanthus
bananas	cyclamen	milkweed	sesame
beans, garden	dahlia	mulberry, white	soybean
bean, broad	dasheen	nasturtium, garden	spurge, garden
bean, horse or jack	dayflower	nightshade, black	Spanish needle
bean, hyacinth	eggplant	nightshade, deadly	sunflowers
bean, mung	fennel	olive	sweetpotato
bean, sword	flamingo-lily	oxalis	teak
beet, garden	fuchsia	painted-tongue	thornapples
beggarticks	gaillardia	pea, garden	tithonia
belladonna	garden balsam	peanut	tobaccos
bird-of-paradise	gerbera	pepper	tomato
bur-marigold	ginger	periwinkle	tomato, cherry
cabbage	groundcherries	petunia	tomato, pear
cabbage, Chinese	gourd, club	phlox	tomato-tree
canna	gynura	plantains	turkeyberry
cassava	heliotrope	pokeweed	vanilla
castor bean	henbane	potato	velvet bean
chrysanthemum, florist's	hibiscus	pot-marigold	verbena
	hollyhock	prickly sida	xanthosoma
cocklebur	horsenettle	proboscis-flower	watermelon
comfrey	hydrangea	pumpkin	zinnia

Table 2. Some common plants susceptible to *Pseudomonas cichorii*

Aglaonema commutatum	coffee	*Monstera deliciosa*	*Pyracantha* sp
	cyclamen	oxslip	*Ruellia humilis*
apple, paradise	daisy, Shasta	pear	rutabaga
Barleria cristata	daisy, Transvaal	*pernettya*	*Schefflera arboricola*
broccoli	eggplant	*mucronata*	
cabbage	endive	*Philodendron panduraeforme*	*Scindapsus* sp.
camellia	escarole		*Spathiphyllum* sp.
carrot	gladiolus	poppy, arctic	tobaccos
cauliflower	hydrangea	poppy, cow	tomato
celery	iris	poppy, oriental	*Viburnum* sp.
chicory	larkspur	potato	watermelon
chrysanthemum, florist's	lettuce	*Potentilla* sp.	wheat
	magnolia, southern	pot marigold	