LEAF SPOT AND STEM ROT (BACTERIAL BLIGHT) OF GERANIUM (*Pelargonium* spp.)

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Bacterial leaf spot and stem rot are probably the most common and the most serious diseases affecting commercial and homegrown geraniums (*Pelargonium* spp.). Also known as "bacterial blight," this disease is a familiar problem on the common geranium (*P. hortorum*), the horseshoe geranium (*P. zonale*) and the ivy geranium (*P. peltatum*). Under warm humid conditions, losses may be as high as 100 percent, depending upon the cultivar. The disease is difficult to manage because cool temperatures mask disease symptoms. Plants which seem healthy may later show symptoms when conditions favorable for the bacteria occur.

Leaf spot and stem rot of geranium are caused by *Xanthomonas campestris* pv. *pelargonii* (hereafter called *X. pelargonii*). The bacteria attack leaves and stems of seedlings, cuttings and mature plants. Symptoms of leaf spot and stem rot are often followed by sudden wilt, collapse and disintegration of infected tissue. All commercial varieties are susceptible to stem infection but many show varying degrees of resistance to the leaf spotting phase of the disease. Resistant geraniums include the cultivars Lady Washington and Martha Washington (*P. domesticum*), Madame Layal and Marie Vogel (*P.* x *domesticum*), P. 'Torento', Peppermint (*P. tomentosum*), and Countess of Scarborough (*P. scarboroviae*).

Symptoms

LEAVES - Plants infected with *X. pelargonii* exhibit two distinctly different leaf symptoms. Spots may develop on the undersurfaces of infected leaves. Initially they are small, somewhat rounded and usually watersoaked; however, within a few days the spots develop into large sunken areas. Borders of the lesions may be round or angular depending upon the variety of geranium attacked. The spots could eventually reach a diameter of 1/8 to 3/16-inch, turn dark and become hard and dry. Coalescence of spots seldom occurs. Infected leaves may drop from the plant shortly after they die or remain soft and wilted but attached to the stem for several days. Bacteria can enter the stem through the petioles of infected leaves and spread to other portions of the plant, ultimately resulting in more leaf infections. If bacteria reach the upper part of the plant, stem rots may develop. These infections frequently result in death of the plant. Stem rot is often seen at the point where diseased leaves are attached to the stem.

The second prevalent symptom, wilting of the leaf margins, occurs in nearly every variety of geranium. In many cases, these wilted areas quickly die, become dry, and form large, angular necrotic

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regions enclosed by leaf veins. As with leaves showing spot symptoms, these leaves also quickly drop from the plant. Similar symptoms could be caused by other plant pathogens or certain nutrient deficiencies, but spotting in conjunction with leaf margin wilt is diagnostic of *X. pelargonii* infections.

STEMS - Stem rot is commonly called "black rot" by growers. The vascular system of infected stems darkens and eventually becomes black. This commonly occurs two to four weeks after infection. As bacteria rot through the stem, infected tissue becomes dry, black and shriveled. If the stem is cut at the advancing edge of the rot, yellow bacterial ooze often appears on the cut surfaces. Plants may possess several blackened branches in addition to the main stem. Infected branches usually become completely defoliated except for small clusters of leaves at the tips. Blackening may also progress down the stem and affect the roots; however, rotting of root tissue rarely occurs. Some infected plants may seem to recover and produce branches that appear to be healthy but this new growth nearly always becomes infected and dies.

CUTTINGS - Infected cuttings typically fail to root. Instead they develop rot that gradually moves up the stem. Leaf wilt and leaf spotting may be evident. The rotted stem eventually becomes shriveled and a dull dark brown to black in color. These symptoms are similar to those produced by damping off fungi such as Pythium. The rot produced by *Pythium splendens* (blackleg) is black, moist, and shiny while *X. pelargonii* produces a dull black rot that appears quite dry. In addition, bacterial stem rot develops much more slowly and may take as long as a month to kill a plant. Pythium may kill a geranium cutting within a week. A distinguishing characteristic of *X. pelargonii* stem rot, slimy bacterial ooze exuded from a cut stem, is never associated with Pythium blackleg.

Disease Development

X. pelargonii is commonly introduced into the planting medium on cuttings taken from infected plants. There is also some evidence which suggests that the pathogen might be seed transmitted. The bacteria can spread through the rooting medium to healthy cuttings if plants are being rooted close together and the moisture level is high. The pathogen is frequently spread by contaminated tools and by physical contact between blighted and healthy leaves. The greenhouse whitefly (*Trialeurodes vaporariorum*) and perhaps other insects can serve as vectors (carriers of the bacteria). Bacteria can enter a plant wherever wounds occur. Once *X. pelargonii* is inside the host, it spreads through the vascular system producing the stem rot and leaf symptoms. If infected plants are held at low temperatures and under dry conditions, it is possible that they might appear healthy (latent infections). When the temperature becomes elevated, symptoms normally associated with *X. pelargonii* develop. Generally latent infections will occur when geraniums are grown at or below 68 degrees Fahrenheit. Latent infections might be expected in geraniums grown as house plants, especially when they originate from cuttings taken in late summer or fall. The cooler fall and winter temperatures may prevent symptom development until the following spring. Cooler temperatures occur around plants kept close to windows, away from any direct source of heat.

Portions of diseased plants carry the bacteria to the soil. *X. pelargonii* can survive in decaying tissue for extended periods of time and contaminated soil can serve as a source of infection. Because the bacteria easily enter the plant through cutting wounds or damaged roots, nearly every plant in contaminated soil will eventually develop the disease. Leaf spot and stem rot can develop rapidly when plants are exposed to high moisture levels and temperatures between 70 F and 80 F. The disease spreads quickly through greenhouse flats and field plots when these conditions occur. Excessive nitrogen and phosphorus fertilization and low levels of calcium may also promote disease development.

Control

Few commercially produced geranium varieties show resistance to *X. pelargonii.* The fact that some resistant cultivars have been identified as symptomless carriers of latent infections of *X. pelargonii* has reduced the effectiveness of using resistance as a control measure. The pathogen is easily spread and there is no effective chemical control, so exclusion and sanitation are the most practical means of controlling the disease. A comprehensive control program for leaf spot and stem rot of geranium would include the following:

1. Start nursery and hobby stock from seed. Cuttings taken from these plants should be removed from the upper branches. Plants must be grown in sterilized flats or pots using fumigated or pasteurized potting mixture.

2. Take geranium cuttings by breaking rather than cutting with tools. This is the most important means of controlling the disease in commercial production, and the technique should also be helpful for home growers. If a blade is used, it should be dipped in 70 percent alcohol and flamed between source plants. Cuttings should never be treated with liquid dips!

3. Root cuttings in individual pots containing steam sterilized soil, if possible. This reduces the likeli-

hood of spreading bacteria through the rooting medium. If flats are used, cuttings should be adequately spaced to prevent foliage contact between adjacent plants.

4. Avoid damaging roots when rooted cuttings are transplanted. Again, transplanted geraniums should be placed in sterile pots containing fumigated or pasteurized soil.

5. Observe strict sanitation procedures when handling plants and cuttings. Hands should be washed with soap and water before and after contacting plant tissue. Benches holding plants from which cuttings are taken should be washed periodically with a 20 percent solution of sodium hypochlorite (one part commercial bleach + four parts water) or any other disinfectant. Allow benches to air dry after chemical disinfection. In addition, these benches should not be located in areas where other geraniums are grown.

6. Avoid overwatering and wetting of the leaves. If possible, do not use overhead sprinklers to water geraniums. Instead, each pot or flat should be watered at the soil surface. The area where plants are grown should be adequately ventilated to keep the leaves dry. Use caution when applying pesticides to minimize splashing from plant to plant. To prevent the possible buildup of bacterial populations on benches, they should be of the open mesh type. Growing geraniums on solid top benches or in soil-filled beds should be avoided.

7. Do not overfertilize geraniums. High nitrogen and phosphorus fertilizers should be limited or avoided. Geraniums should be fertilized with a balanced nutrient solution containing relatively low levels of phosphorus and nitrogen and proportionally higher levels of calcium and potassium. When commercial production requires forcing plants at high temperatures and high nutrient levels, the amount of time that geraniums are held under these conditions must be kept to a minimum. In general, it is best to avoid placing geraniums under conditions that stimulate rapid growth.

8. It is important to control whiteflies and other insects that might act as vectors. Any of the variety of insecticides currently on the market should prove effective for most insects. Whiteflies are generally difficult to control, but pyrethrum and insecticides containing pyrethrum derivatives such as pyrethrin work well. Yellow stick boards are also effective. For more comprehensive control recommendations refer to NDSU Extension circular PP-744 (Revised) "House Plants - Proper Care and Problem Solving."

9. Do not rely upon chemical control. Cupric hydroxide and copper sulfate and certain antibiotics (streptomycin, agrimycin) have inhibited the pathogen under controlled experimental conditions but do not perform well under large scale greenhouse conditions. Because of the inconsistent results obtained with chemical control measures, it has generally been concluded that they do not provide a practical method for controlling bacterial blight.

There is no effective treatment for bacterial leaf spot and stem rot of geranium once it becomes established. Once symptoms appear it is possible to remove blighted leaves and branches but this treatment is merely cosmetic. If diseased plants are found, it is best to immediately remove and destroy them. Because of the possibility of latent infections, it is advisable to destroy all cuttings from flats containing infected plants. Although this is impractical for commercially produced geraniums, the method is feasible for the home grower. Since the pathogen can survive for some time in the soil, it is important to wait one to two years before planting geraniums in a field or home flower bed where diseased plants were previously grown. In addition, plants grown outside are usually infected by the end of the summer, so if these plants are to be used for indoor propagation, cuttings should be taken early in the growing season.

Other bacteria (*Pseudomonas cichorii, Pseudomonas erodii*) can cause leaf spotting in geraniums but the symptoms are not as severe as those produced by *X. pelargonii.* These pathogens are not associated with wilting or stem rots. Leaf spot produced by *Pseudomonas* spp. is of limited importance in geranium production and is readily controlled by the same measures used to control bacterial blight caused by *X. pelargonii.*

COMMERCIAL GROWERS NOTE:

The pathogen can be excluded by purchasing clean stock. Commercial growers should ensure that initial stocks have been through a culture indexing program prior to mass propagation. Individual growers are not encouraged to establish culture index programs themselves. They can send geraniums to specialist propagators who will return stocks certified to be free of the pathogen. Specialist propagators often use the latest technologies such as immunofluorescence which can detect latent infections of *X. pelargonii.* This is important because *X. pelargonii* can be found in nearly all commercially produced stock.

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