Bacterial Wilt, Leaf Spot, and Blight of Geraniums

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Geraniums are subject to many infectious diseases. Of all the diseases, bacterial wilt, leaf spot, and blight caused by *Xanthomonas campestris* pv. *pelargonii* is the most important.

When conditions are optimum for spread and development of the bacteria, an entire crop can be infected in a few days. To appreciate the particular danger of this bacterial disease on geraniums, some information on the epidemiology (cause and control of epidemic disease) is presented at the outset of this article.

X. *campestris* pv. *pelargonii* is a "single-celled" organism. It can reproduce by simple cell division every 20 minutes. The two daughter cells are identical. Bacterial populations on, in, or near plants can reach very high numbers within a short time. It is this development of populations into high numbers that causes damage to host plants. When the bacteria reproduce in the vascular system of a geranium, it is not long until there are millions of cells plugging the vascular tissue and causing leaves to wilt.

Environmental factors influence reproduction and death of bacterial populations. As temperatures, food supply, moisture availability, pH, gas supplies, and presence of toxic materials and antagonistic organisms change, X. *campestris* pv. *pelargonii* populations rise and fall. Bacterial blight develops slowly when temper-atures are below 60°F. If plants are held above 70°F but below 81°F, symptoms ap-pear in 7 to 10 days.

During unfavorable environmental periods, **many** bacterial cells die. However, **all** bacterial cells of a population usually do not die, even under extremely adverse conditions. The surviving cells often enter a state of reduced metabolism or dormancy until conditions again become favorable for growth and reproduction. In such states, they are undetectable on or in plants, pots, growing media, or water. X. *campestris* pv. *pelargonii* cells are undetectable within plants, and this creates problems in the spread and/or management of the disease.

Perfectly healthy appearing cuttings may be harvested from symptomless, infected stock plants. These cuttings may then be shipped anywhere in the world.

Symptoms

Small water-soaked spots sometimes appear on leaves. These spots, usually ⅛ inch in diameter or smaller, become sunken, well defined, and the leaves eventually die. On some varieties, spots may be up to ¼ inch in diameter. These leaf spots are rarely seen on zonal cutting geraniums in the greenhouse. They will develop on infected plants after they are transplanted outdoors. Leaf spots are more common on seedling geraniums, even in the greenhouse.

V-shaped yellow areas, in which the wide part of the "V" is on the leaf margin and the point on a vein, are frequently observed as an early wilting symptom on greenhouse crops. This may represent signs of a recent infection. Bacteria are often spread to adjoining plants in splashing water. Once on a leaf, they will infect at a hydathode on the leaf edge where water and carbohydrates are available.

As the infestation progresses within the plant, leaves on one or two branches wilt. The wilt starts along the margin and progresses slowly back toward the petiole, with the leaf blade eventually hanging on the intact petiole. All the leaves on the affected branch will yellow and die.

Cutting across the affected branch with a sharp instrument may reveal darkened vascular tissue. If this cut stub is examined hours later, a slimy ooze may sometimes exude from the darkened vascular tissue. This ooze contains millions of bacterial cells.

As the disease progresses, stems will develop sunken, cankered areas. In the final stages, dead leaves fall off, stems become darkened, and the entire plant dies.

Verticillium wilt, caused by a fungus, exhibits very similar symptoms. Samples must be cultured in a special medium to be certain whether plants are infected with *Xanthomonas* or *Verticillium*. Actually, *Verticillium* wilt has rarely been seen in greenhouses in recent years.

Growers suspecting bacterial wilt based on the non-specific symptoms outlined above must proceed with a special diagnosis at once. The potential losses from bacterial wilt or cost of needed controls demand more than a diagnostic guess.

Examination of cut vascular tissues in symptomatic leaf blades or petioles under the microscope will often reveal cells of the pathogen oozing from the cut tissue. This "ooze test" is considered specific for bacterial diseases in general. It is a good, quick test to use on suspect geraniums.

Culturing of symptomatic plant tissue on special bacterial growth medium followed by a bioassay on a healthy geranium cutting has long been used as a specific diagnostic procedure. It is specific, but requires 7 to 10 days to complete.

Now a serological test (ELISA) is commonly used as a laboratory procedure to specifically detect X. *campestris* pv. *pelargonii*. The ELISA test is fast, sensitive, and extremely specific. In the near future, a field test kit based on the ELISA procedure will be available for growers to use. These ELISA tests are not inexpensive, but their quickness and sensitivity make them worth the money for concerned growers.

Spread

X. *campestris* pv. *pelargonii* spreads most readily in plant material. Cuttings taken from infected stock plants are the most important means of transmission. Stock plants may not exhibit symptoms, but if infected, cuttings from such plants are probably infected.

The bacteria can be spread from infected plants to healthy ones on knives, splashed from plant to plant during irrigation, or transmitted to cuttings through root contact in infested growing medium. The bacterium survives in plant debris embedded in soil for up to a year. Thus, if geraniums are planted in outdoor beds where blight developed last year, it may develop again this year.

Humans are important agents in the dispersal of X. *campestris* pv. *pelargonii*. Simply touching an infested plant, then touching a noninfested plant, may result in the transmission of the pathogen. Bacteria are often transmitted from plant to plant on knives during propagation and pruning procedures. Bacteria surviving in plant debris and in soil are often carried from one area to another on shoes and machinery.

Water is an excellent dispersal agent of *Xanthomonas campestris* pv. *pelargonii* when it is active during periods of warm weather. Many producers irrigate plants

overhead. In addition, application of pesticides may serve as an excellent source of dispersal.

Dipping cuttings in fungicide or rooting hormone is a good way to spread X. *campestris* pv. *pelargonii*. When bacteria are present on a cutting, they can be released into the dip where they can later be introduced to other plants.

Insects may also play an important role in dispersal and survival of X. *campestris* pv. *pelargonii*. Greenhouse whitefly has been found capable of bringing the pathogen into a crop after having contacted contaminated plants outdoors. However, this is probably of minor importance in properly maintained production areas.

Hosts

X. *campestris* pv. *pelargonii* can cause disease in all cultivated geranium varieties. Zonal cutting geraniums are particularly susceptible.

Ivy geraniums are commonly infected but often do not show symptoms. Certain types of geraniums (*Pelargonium* X. *domesticum*) have appeared resistant in some experiments but have been shown to carry the pathogen without exhibiting symptoms.

Control

That geraniums are not a continuous crop in the greenhouse makes possible the basic control or prevention strategy for X. *campestris* pv. *pelargonii*. Even if only seemingly healthy plants were present in the just finished crop, discard all geraniums at the end of the season and wash bench surfaces, irrigation devices, etc., with a Q-salt disinfestant.

Discard all plants returned by customers and do not allow such plants to be brought into your growing area. Do not save any plants for use as stock plants. Do not collect outdoor plants at the end of the summer for use as stock in your greenhouse.

Purchase pathogen-free plants or cuttings each year. You have the greatest chance of obtaining plants free of X. *campestris* pv. *pelargonii* if you buy cuttings from cultured index stock. Such cuttings are the end point in an elaborate program to develop and produce pathogen-free vegetative propagative material.

Two or three years before final sale of a particular variety, a plant is selected which is believed to be pathogen free. It may have been heat treated or meristem derived. Cuttings taken from this plant are brought directly to a laboratory. In the laboratory, the basal end of the cutting is removed and subjected to various culturing tests for bacteria and fungi and various indexing tests for viruses. This is where the term "culture-indexing" comes from.

The top portion of these cuttings is carefully rooted and planted in an isolation greenhouse. If the results of all tests are negative, the cutting is grown on to form a "nucleus" block to yield more cuttings. These, too, are subjected to the culture-indexing procedure to check for mixes during the first indexing. Sometimes, a third procedure of culture-indexing is done.

Cuttings that "survive" the culture indexing become the "mother" block of the "mother block system" of plant increase. Cuttings taken from these mother block plants are placed in "increase" blocks. From increase blocks are formed "production" blocks.

Growers who purchase "cultured" material receive plants from these production blocks. Production block cuttings are not directly cultured. They are at least four generations from culturing. Furthermore, production blocks may be in different greenhouses — even in different countries — from the original nucleus material. The material may have been pathogen-free at the beginning but could possibly be infested again when you receive it.

There is nothing really wrong with this system. It is a proven, successful system. As long as growers buy material from a company who administers the original steps in the program (or from a licensed propagator), there is a great likelihood they will be buying pathogen-free material. These companies have their reputation to uphold. They take great care to protect material properly as it is being increased via the mother block system.

If X. *campestris* pv. *pelargonii* is detected in a geranium crop, another set of control strategies must be employed. The strategies will depend on particular circumstances and the degree of risk to be assumed by the grower.

The precise nature of the infestation is the first important situation that must be evaluated. Good growers should always keep geranium varieties separated. If an infestation of X. *campestris* pv. *pelargonii* is noted in one variety, quick action may limit it to that variety. Of course, this is a risk many would not want to assume. The classic recommendation would be to destroy all geraniums in the greenhouse if the pathogen is detected in any degree whatsoever.

But what if trying to limit infestation is a risk that must be taken to financially survive? If the infestation is in a block of stock plants, all plants of the suspect variety must be destroyed immediately. The rest of the crop should be placed under a protective spray program using an approved copper fungicide such as Phyton 27.

Watch all plants carefully and have diagnostic ELISA tests conducted regularly on any questionable symptomatic plants. Control the access to and handling of the stock plants. Train employees on the diagnosis of and infectious nature of X. *campestris* pv. *pelargonii*. Instruct them to break off cuttings from stock plants for propagation rather than using knives.

Good cultural practices to limit development of X. *campestris* pv. *pelargonii* include proper fertilization, spacing plants to

provide good air movement and prevent water splash, and irrigating to avoid wetting foliage. Plants stressed from improper fertilization, poor irrigation practices, or inadequate light intensity are usually more susceptible to disease.

If the infestation is in a block of plants to be finished for sale, you may wish to assume a bit more risk. If you are very good at observing plants, you may be able to recognize infected plants and discard them before they are sold. Many growers try this late in the season. I must warn you, however, that such strategy rarely works. Diseased plants will not be detected completely. They may be the source of a breakout late in the season and ruin your entire crop.

Diseased plants will be sold to customers. These plants will perform poorly or die in a few weeks in the garden. The outcome is this approach is not a risk worth taking!

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