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PSEUDOMONAS SYRINGAE DAMAGE INCREASING IN SOME NURSERY-GROWN SHADE TREES

(Report compiled by James L. Green, OSU Extension Ornamentals Specialist, based on information provided by Dr. David Buchanan [1], Dr. Steve Lindow[2], and Dr. Larry Moore[3]. Photos courtesy of Dr. Larry Moore).

Certain strains of *Pseudomonas syringae* bacteria cause symptoms ranging from tip dieback of maple seedlings and cuttings to sudden death of 3 to 4 year old nursery trees. Red maples are particularly susceptible to these bacterial pathogens, but they also cause leaf spots-on Linden, Norway maple and Amur maple. Production of Bradford pear *(Pyrus calleryana*) has been discontinued at one nursery, apparently because of severe *Pseudomonas syringae* infections. Symptoms caused by pathogenic *Pseudomonas syringae* on red maple are described in Figures 1-6

Damage to nursery trees *from Pseudomonas syringae* has increased in severity over the past 2 or 3 years. This increased incidence has prompted the initiation of research on distribution of the bacterium, conditions favoring plant infection, and potential control methods.

Strains of pseudomonas syringae - the good, the bad, and the antagonistic

Variability in pathogenicity of fungi and bacteria is not uncommon. There are both pathogenic bacteria and beneficial bacteria (antagonists) -often within the same species ... brothers, so-to-speak. A familiar example is crown gall: the pathogenic bacterium causing crown gall is *Agrobacterium tumefaciens*; the beneficial, closely related (antagonistic bacterium used for biological control of crown gall *is Agro bacterium radiobacter strain 84*.

Likewise, there are numerous strains of *Pseudomonas syringae*, and no one strain infects all hosts. Considerable pathogenic variability exists among strain: For instance, a strain inciting canker of cultivated blueberry was not pathogenic to native blueberry species or to cherries (4).

Some strains of pseudomonas syringae are involved in frost damage

Freezing (frost damage) induced by ice nucleation-active (INA) bacteria occurs at a higher temperature than that at which the plant would freeze in the absence of the INA bacteria, i.e. the freezing point of the tissue is raised.

Plants can survive temperatures below freezing (32°F) by supercooling. At temperatures below 32º F, a process known as ice nucleation must occur during which a solid particle (dust, bacterium, etc) serves as a catalyst (nucleus) for ice formation. "Frost sensitive" plants appear not to be inherently temperature sensitive: they can supercool and avoid injury, but they may be limited in this capacity by the presence of a large population of ice nucleation-active bacteria that in essence raise the freezing point of the plant tissue. It is known that several strains of *Pseudomonas syringae*, *Erwinia herbicolia*, and *Pseudomonas fluoroscens* are ice nucleation-active agents at temperatures only slightly below freezing. These bacteria live on leaf surfaces of healthy plants in large numbers.

At a given temperature, reduction in the number of INA bacteria can lead to a corresponding decrease in frost damage.

The frost sensitivity of most plants is increased when they harbor large numbers of INA bacteria. The amount of frost damage at a given temperature increases directly with increasing numbers of ice nucleation-active bacteria on that plant.

Control of induced ice nucleation:

1) Bactericides that reduce bacterial populations appear to be effective in preventing INA-bacteria-induced frost damage when applied before INA bacterial populations develop on plants. Additional applications may be needed to provide continuous prevention of bacteria establishment on the plant surfaces.

2) Other chemicals to inhibit ice nucleation include various heavy metal ions in a soluble state (i.e. copper and zinc solutions), certain cationic detergents, and chemicals inducing extremes of pH. They inactivate the nucleus produced by the ice nucleation active bacteria. The use of bacterial ice nucleation inhibitors appears to offer a 'day before' type of immediate prevention of INA-bacteria-induced frost; this immediate prevention is not provided by bactericides or antagonistic bacteria (2).

3) INA antagonistic bacteria ... Of the total bacterial population on a leaf surface, typically only 0.1% to 10% of the total bacteria are active in ice nucleation. The remaining 90%+ bacteria are competitors of the ice nucleation-active bacteria for required nutrients and growth sites on the plant surfaces. Also, the competitive bacteria can produce compounds that inhibit growth of ice nucleation-active bacteria.

Isolations from diseased plants are being made to find ina-antagonistic bacteria.

By selecting the most prolific producer of antibiotics or the most rapidly growing competitive bacteria and applying them to plant surfaces prior to their being colonized by INA bacteria, the population of INA bacteria would be reduced, thereby reducing the likelihood of frost injury.

Though significant frost control on several crop species has been obtained through use of INA-antagonistic bacteria, more work is required to determine the extent of host-specificity of INA-antagonistic bacteria and the extent of their survival on the woody plant tissues, especially during the winter.

***Any strains of *pseudomonas syringae* in and of themselves are pathogenic...**
INA bacteria are only a relatively small proportion of the total bacterial population on a plant leaf surface. Only 0.1-10% of the total bacteria are INA; the remainder are pathogens or antagonists. It must be emphasized that not all *Pseudomonas syringae* damage is related to INA bacteria and frost.

The plant in Figure 2 developed pathogenic symptoms after being inoculated with *Pseudomonas syringae* and placed in a greenhouse mist propagation bed in September where temperatures were well above freezing.

In another case, young maple seedlings apparently recovered from a severe foliar infection similar to that in Figure 1. For several years the plants exhibited no external symptoms, the *Pseudomonas syringae* was apparently latent, then 3-4 years later the plants suffered severe frost damage that may have been induced by ice nucleation-active *Pseudomonas syringae*. The possibility that a *Pseudomonas syringae* infection might remain latent for an extended period and then at a later date induce ice nucleation, frost damage and/or death of the tree is being investigated by Moore (3). If latent infections are found, the importance of preventing the initial infection at all stages of plant production, including propagation stage, would be critical.

News about another strain of pseudomonas, *Pseudomonas syringae* strain M27...

Pseudomonas syringae M27 when injected into elm trees has been reported to produce antibiotics that inhibit growth of Dutch elm disease fungus. The disease antagonistic bacterium, *Pseudomonas syringae* M27, is not yet available for commercial use. Chevron Chemical Company has a full-scale research program underway involving field research microbiology and formulation, toxicology, development of a manufacturing process, patent, legal, environmental fate studies and EPA registration.

‘Transmission of pseudomonas syringae…

The bacterium is spread on infected plants, on tools, by wind-driven rain. Disease development is favored by cold spring weather, rain and high humidity Penetration of the plant is through stomata or wounds-injuries caused by insects, pruning, and (probably) frost damage. Spur and node infections have been reported in Oregon to originate at the base of the external bud scales It has been found to overwinter in soil and on weeds.

Conclusions...

Considerable variability exists among strains of *Pseudomonas syringae*: some are virulent pathogens on certain hosts under certain environmental condition: some are ice nucleation-active, others are antagonists that may be potent biological factors in disease control programs. More work remains to be done to isolate the various strains

Please send plants that have been attacked by *pseudomonas syringae* to Larry Moore's lab...

Dr. Larry Moore's research group is obtaining numerous isolates of disease-causing *Pseudomonas syringae* from different tree species and locations to determine how common ice

nucleation activity is and to isolate antagonistic bacteria. Your assistance in providing diseased specimens and information is requested. Information from you that would be helpful and could accompany the specimen includes: 1) Record of symptom development - symptom description, when first symptoms appeared, rate of symptom development;
2) Conditions that seemingly favor or disfavor symptom development.
Please send sample and information to: Marilyn Canfield, Research Assistant, USDA ARS Ornamental Plants Research Lab, 3420 SW Orchard Street, Corvallis OR 97330, telephone 503/757-4544.

Information sources:

[1]BUCHANAN, DAVID (Department of Fruit Crops, University of Florida, Gainesville, FL 32611). 1981. Ice nucleating bacteria. Written report in the American Nurseryman, September 1, 1981, page 69, based on presentation by Buchanan at the American Association of Nurserymen's Convention, July 18, 1981. 2

[2]LINDOW, S.E. (Plant Pathology Department, University of California, Berkeley, CA 94720). 1980. New method of frost control through control of epiphytic ice nucleation-active bacteria. California Plant Pathology, 48:1-5, March 1980.

[3]MOORE, LARRY. (Botany and Plant Pathology Department, Oregon State University, Corvallis, OR 97331). 1981. *Pseudomonas syringae* damage increasing in some nursery-grown trees. Presentation at the 1981 Ornamentals Northwest Seminars, August 28, 1981 by Moore.

[4]CMI descriptions of pathogenic fungi and bacteria, No. 46.

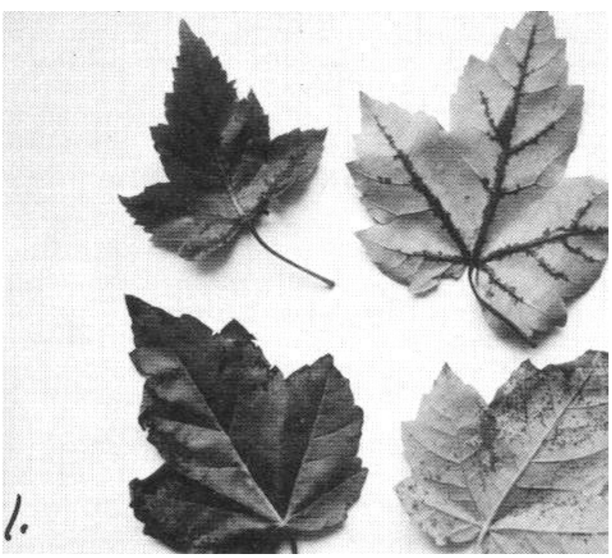
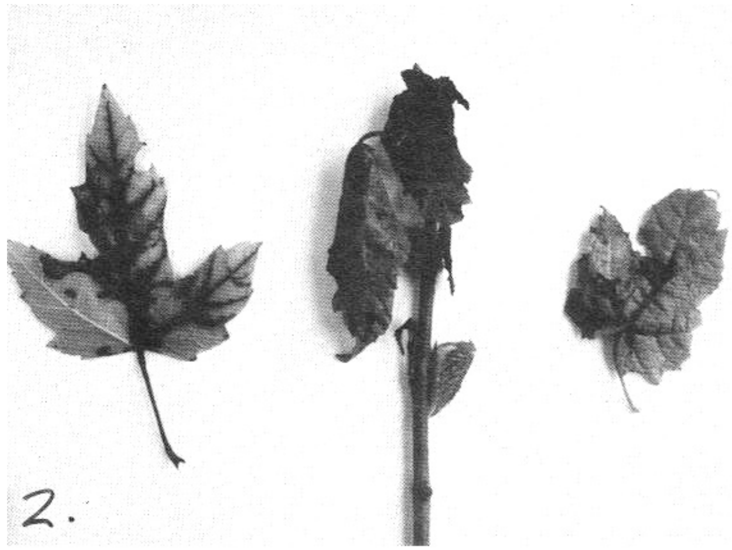


FIGURE 1. These maple leaves infected with Pseudomonas syringae were removed from seedlings growing in a seed bed. In the upper leaf, the infection appears systemic -note the discolored leaf veins and petiole. In the lower leaf the infection is limited to spots that probably resulted from secondary spread of the pathogen.

FIGURE 2. Symptoms on maple cuttings in a greenhouse mist propagation bed include vein blackening, leaf spotting (not shown), and tip dieback.



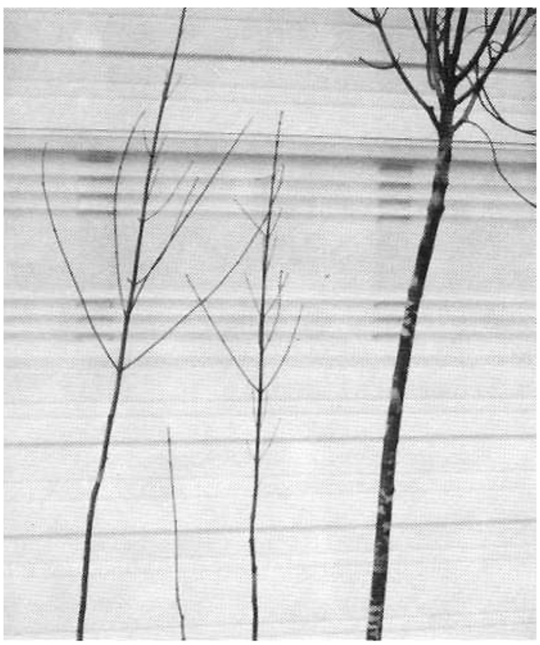


FIGURE 3. *Pseudomonas syringae* can also cause death of 3-4 year old field-grown trees such as the October Glory red maple on the far right.

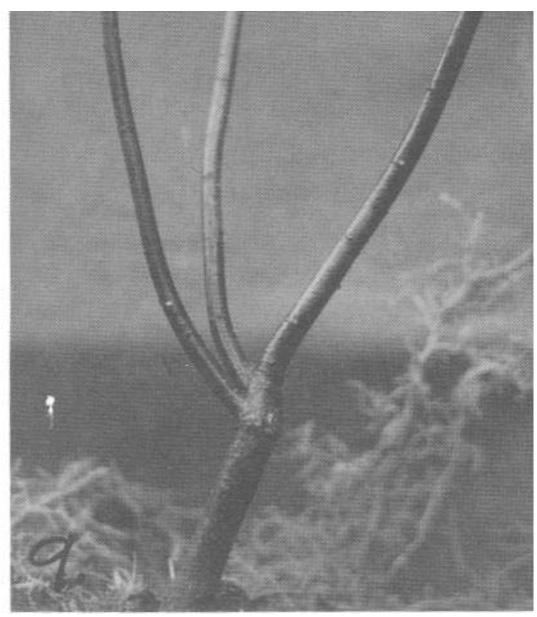


FIGURE 4. A closer examination of the dead tree in Figure 3 shows a common symptom pattern observed in 1981: the stem is blackened (can be partially or completely blackened). In some cases the lateral branches have also been blackened, but often they were free of symptoms.

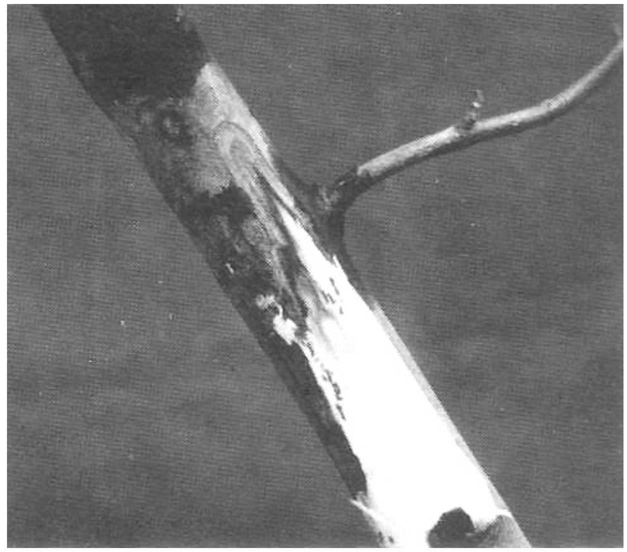


FIGURE 5. When the bark is cut away from the blackened areas, the outer vascular tissues are also discolored rather than being white like healthy vascular tissue. The vascular necrosis (discoloration) can occur in vertical streaks on the stem and/or around the tree stem.

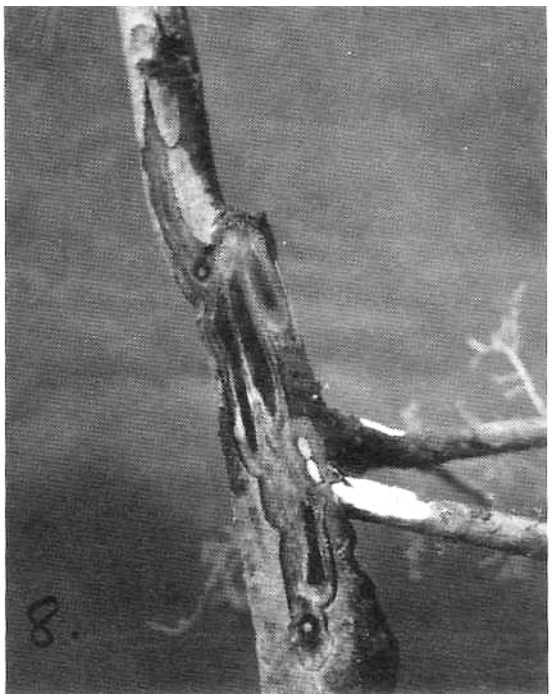


FIGURE 6. The necrosis can run down the stem to the main tap root without affecting lateral roots.
