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# TOMATO INFO



## Bacterial canker: beware of spread

Bacterial canker likely occurs at a low level in our Central Valley processing tomato fields. The causal pathogen, *Clavibacter michiganensis* subsp. *michiganensis*, was first reported in a Michigan greenhouse in 1909 and is now found in most tomato-growing regions of the world.

Bacterial canker can be seedborne and transplants can be an important source of primary inoculum.

What's the concern? Primary infection of young plants can severely stunt or kill plants. And primary infections can be the source of further in-field spread as secondary infections. These late crop stage infections can cause moderate to severe leaf scorching, resulting in sunburn damage and perhaps reduced yield. In the upper Midwest, the pathogen can survive over 2 years in infected crop debris. Thus sanitation is an important practice for managing the potential spread to other fields.

Diagnosis of bacterial canker can be challenging and easily overlooked unless the infestation is severe. While not common in our region, if stem cracking and especially fruit infections are present, these symptoms are diagnostic. If limited to leaf burn, the cause might be dismissed as high salts, including boron toxicity, Verticillium wilt or common vine senescence. Field test kits are available for bacterial canker detection. The simplest to use is AgDia's ImmunoStrip®.

What are some possible routes of dissemination? The pathogen can spread in transplant seedling greenhouses in overhead irrigation. In fields, it can move in splashing water from rain and overhead irrigation. Routine handling operations including transplanting, hand weeding and mechanical cultivation can spread the pathogen by direct contact. Our vine training and trimming practices, when conditions are wet, heighten risk of spread. In the spring, 'protective' tunnel shields on cultivators and soil incorporators may increase risk of spreading the pathogen due to the abrasive contact with plants.

Guidance for harvest sanitation: Harvesters especially should be cleaned of debris and then sprayed with a disinfectant (like Physan® or other similar materials) when leaving an infested field. Follow the label using personal protective clothing with attention to eye protection. In the case of the bacterial canker pathogen, scrapping and pressure washing is insufficient alone. Presumptively, the harvester's shaker, vine shredder and suction fans are areas likely to have the highest bacterial accumulation. All these areas are recognizably very challenging to thoroughly clean. Infection and disease severity is tied to pathogen concentration, so any level of cleaning effort is rewarded. Most critical would be to remove diseased stem tissue.

After harvest, the tillage goal is to bury plant debris into the soil to begin the breakdown of host plant tissue. Avoid leaving plant residue on the soil surface. Rotation out of tomato for at least a year may be prudent.

Mary Hausbeck (Michigan State University) concluded her summary of research studies; "successful strategies for disease management are best begun in the greenhouse." 'Alternate sprays of copper hydroxide and streptomycin beginning when transplants develop their 1st true leaves and repeat at 5 to 7-day intervals until planted in the field. Under Michigan field conditions, disease management strategies might continue in the field with alternating applications of AMB (Actigard®), copper hydroxide and Tanos®.'

Under our California summer weather conditions, a chemical spray program may have marginal value (based upon our experience with chemical control of bacterial speck, as a related comparison to a lesser pathogen).

Bottom Line: Attention to sanitation may reduce the introduction and limit the spread of unwanted pests.

*The following is excerpted from the UC Pest Management Guidelines at*
http://ipm.ucanr.edu/PMG/r783101811.html

**SYMPTOMS**

There are usually no symptoms of bacterial canker on seedlings; however, on young plants symptoms consist of poor growth and temporary wilting of branches. Lower leaves yellow and shrivel, but symptoms may not show until flowering. On mature plants there are two kinds of symptoms. One kind is from systemic infections (i.e., the bacteria enter and invade much of the plant) and the other resulting from secondary infections (limited to local infections of leaves, stem, and fruit).

In systemic infections of mature plants, leaflets of the oldest leaves curl, yellow, wilt, and finally turn brown and collapse (known as firing). Sometimes, one side of a leaf is affected. Plants grow poorly and wilt. Pith of stems becomes yellow and later reddish brown, especially at the nodes, and has a mealy appearance. The pith may later become somewhat hollow. In advanced infections, cankers may or may not form at the nodes. Light and later dark streaks may develop on stems. Branches break off easily. Plants may die.

In secondary infections, infection of the margins of leaves is common. Lesions are dark brown to almost black. Round to irregular spotting of leaves also occurs. Fruit may be spotted, especially near calyx.

On fruit, bacterial canker symptoms appear as yellow to brown spots, slightly raised, surrounded by a persistent white halo ('bird's eye spot'). Spots are usually about 0.125 inch (3 mm) in diameter. Vascular tissue under the calyx can scar, leading to seeds that may be brown.

**COMMENTS ON THE DISEASE**

In California, the source of the pathogen is probably seed and transplants, although local contamination within greenhouses is a potential source. In California, the pathogen only overwinters in the soil when the previous crop residue is not thoroughly incorporated and does not decompose. In colder climates, the bacterium may overwinter on undecomposed plant residue.

Tomato is the most important host of the pathogen. Several nightshades are naturally infected. It is not known how long the bacterium can persist on nightshade. Pepper and eggplant can be artificially inoculated, but they are probably not important in the epidemiology of the disease on tomato.

In California, economic losses in direct-seeded fields are very uncommon. During unusually wet weather, however, secondary spread from frequent vine-training, cultivation, or other operations may cause extensive leaf loss. Canker probably occurs at a low incidence in many direct-seeded fields but almost always goes unnoticed.

Seed contamination with only a few bacterial cells, apparently below the level of detection, can result in relatively high numbers of

infected transplants. For that reason, certified seed reduces the chances of infections, but is no guarantee of contaminated-free seed. A seed lot contaminated with very few infested seeds can cause serious problems in a greenhouse.

When the seed germinates, the bacteria enter the seedling through small wounds in the cotyledon, probably through broken trichomes. The bacteria move systemically through the xylem from which it invades the phloem, pith, and cortex. In a highly conducive environment, like a greenhouse, bacteria on the surface of infected plants are then splashed to surrounding plants during overhead irrigation. This kind of spread accounts for the occurrence of groups of plants or trays in the greenhouse and subsequent rows of infected transplants in the field. During planting, which invariably causes wounds, transplants may also be infected after an infected plant is handled, especially if the plants are wet.

Secondary spread occurs in splashing water, on contaminated equipment, during clipping, cultivation, vine-training operations, and other activities. In the field, such spread usually results in local infections (i.e., leaf, stem, and fruit spots).

**MANAGEMENT**

In the field, the pathogen will survive indefinitely in tomato tissue. Once that tissue has decomposed in the ground, however, the bacteria will die because they are not soil inhabitants. Thus, it is very important to turn under infected plant residue at the end of the season. Once that residue decomposes, the bacteria will die and the field does not pose a problem for subsequent plantings. It is prudent, however, to rotate to another crop for at least one season to assure that the tomato residue is completely gone.

In research trials, bacteria have survived as long as 10 months on contaminated wooden stakes. Hence, in the greenhouse it may be extremely important to disinfest the surface of benches and equipment to prevent spread to subsequent trays of transplants. In fields of more mature plants, disinfesting equipment is not as critical because any spread to other plants would probably result in local, and not systemic, infections. It is prudent, however, to wash equipment that has been through a heavily infested field. Surface disinfectants include bleach solutions (0.5 to 1% calcium or sodium hypochlorite) and Physan, among other products.

Planting clean transplants is the most important control measure.

- Vigilantly monitor seed fields and implement strict quality control measures. Assay seed for detectable levels of contamination and discard lots if the bacterium is found. Soak all seed in 130°F water for 25 minutes.
- In the greenhouse, steam potting mix and flats; flats may also be washed with a 1% solution of calcium hypochlorite. Empty greenhouses between crops of transplants to allow time to disinfest benches and irrigation hoses. Overhead water pressure should be low to prevent wounding during irrigation.

In the field, special measures may have to be taken once canker has been identified.

- Do not work fields when the foliage is wet. Frequent field operations when foliage is wet can result in spread of the disease throughout the field. Unless the number of infected plants is small, it may do more harm than good to try to remove the symptomatic plants.
- Copper applications offer limited benefits because systemic infections cannot be affected and localized infections (the most probable scenario if other precautions are taken) pose a small economic threat.
- During wet weather, however, bactericides may be justified.
- At the season's end, incorporate all plant tissue. Tissue that remains on the surface and doesn't decompose is a real risk to subsequent tomato crops. Once the tomato residue decomposes, however, canker is no longer a threat.
- To be certain that the bacterium has been eliminated from the field, rotate out of tomatoes for at least one year.

1st page images: Stunted plants within plant line likely started in greenhouse from seed or contamination. Second image of infected mature plant with secondary infections displaying only marginal leaf burn and leaf 'firing'.

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Fig 3. From primary infection, severely stunted plant with linear stem cracking and leaf necrosis.

Fig 4 & 5. Fruit lesions, the bird's eye lesions. Each spot is an infection with multiple infections, in these cases. Note leaf burning.

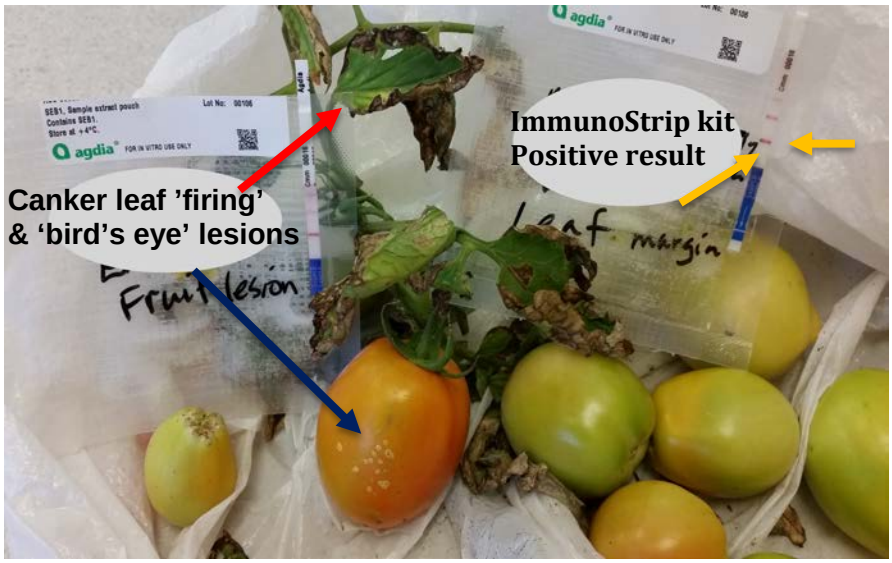


Fig 6. AgDia ImmunoStrip® detecting bacterial canker from fruit lesions and from leaf tissue.

## COUNTY OF YOLO REGULATIONS

Sanitation is an important field management practice. In recent years, the Ag Commissioner's office in Yolo County (and perhaps other counties) applied field restrictions to confirmed bacterial canker fields. The regulatory action was taken to protect agricultural crop production. Included in the field restrictions were: no irrigation water exists the infested field, all equipment is cleaned and inspected before leaving field including harvest machinery and a required rotation out of tomatoes for at least a year.

## HARVESTER SANITATION FOR FUSARIUM

Discussions about sanitation especially with tomato harvesting equipment includes management of Fusarium wilt. Fusarium is continuing to show in new fields and increase from old introductions. Effort to slow the spread makes sense especially in fields without current incidence.

The highest concentration of Fusarium wilt inoculum resides in diseased plant tissue. Discarding the branches should be the target. Fusarium resides in the soil as well, but at a much lower level compared to plant tissue. Scrapping soil off the harvester is wise, but focus most attention on removing plant tissue. Unfortunately, a preliminary study indicates that seeds of fruit from Fusarium wilt diseased plants might have over 10% of the seeds infested. The concern is seeds are an avenue for further spread within and between fields.

The seed concern is likely minor compared to infesting with plant debris. Removing all seeds from a tomato harvester, vine diverter and even tractors and trailers is impractical to achieve.

What is practical? In the case of Fusarium wilt, scrape off the piles of plant debris and soil from the undercarriage area. Cut away vines wrapped around shafts. Remove the piles of soil accumulated around the dirt sorters and conveyors.

If a field has a high infestation in a section and has a non-infested area, designating the dirty side for equipment cleanup makes sense.

If a grower has multiple harvesters with capacity and can dedicate a machine to only infested fields, that might also make sense (while still cleaning between fields).

## NEW ADVISORS

Amber Vinchesi is the new vegetable crops farm advisor for Colusa and Sutter-Yuba counties. She is housed at the UC Cooperative Extension office in Colusa. She can be reached at (530) 458-0575 and acvinchesi@ucanr.edu

Amber is originally from Massachusetts and received her Bachelors of Science in Entomology at Purdue University in 2009. She received both her Masters and PhD in Entomology at Washington State University focusing on behavioral studies and environmental mitigation to protect the alkali bee, an efficient pollinator of alfalfa grown for seed. After receiving her PhD in 2014, she completed a year-long postdoc with Oregon State University working with alternative control methods, specifically vitamin B1, for potato diseases. In 2015, Amber returned to WSU as a postdoctoral research associate working on beneficial insects in alfalfa fields and their impact on pest populations, especially after certain insecticides were applied. Amber is looking forward to serving as the new Vegetable Crops Advisor.

Margaret Lloyd is our small farms advisor with emphasis on organic production for Yolo, Solano and Sacramento counties. She is housed in the Yolo County office and can be reached at (530) 564-8642 and mglloyd@ucanr.edu

Margaret received her PhD from UC Davis in Plant Pathology in 2015. She researched non-chemical alternatives to soilborne disease management in strawberries. She focused on three main topics: the role of legume rotation crops in *Verticillium dahliae* management, the effect of 4 different composts on strawberry production, and a social study understanding the level of adoption of soilborne disease management tools among practitioners.

Submitted by,

Gene Miyao
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