

## Bacterial Wilt and Canker in Field-Grown Tomatoes in California *Clavibacter michiganensis* subspecies *michiganensis* (Cmm)

Bacterial canker has periodic outbreaks that can cause significant damage in a single season from primary and secondary spread. It is a vascular disease of tomato that spreads easily during the season by superficial movement of the bacterium via workers and equipment. This disease causes loss of photosynthetic surface, wilting, premature death and unmarketable fruit. Control and management relies primarily on clean seed, healthy transplant practices, sanitation, and crop rotation.

### SYMPTOMS

**All plant stages are susceptible**, though initial infection typically starts at the seedling stage. As seedlings, small, white raised spots may occur on the leaves, wilting and possibly death. However, disease may not develop in infected seedlings until conditions are more optimal, resulting in asymptomatic infected seedlings that get planted.

**Early symptoms** in-field include wilting, curling of leaflets and browning of leaves. Due to the vascular location of the organism, symptoms are often limited to one side of the plant. Early infection can be difficult to diagnose based on symptoms alone, but vigilance is important to minimize spread. Therefore, diagnosis of suspect plant material by a lab or a highly sensitive and effective in-field diagnosis kit is suggested.

**Leaf symptoms** are often called ‘firing’ due to the scorched appearance and rapid development. Initial appearance is yellow to tan patches between veins, ¼ inch diameter on the upper leaf surface of mature leaves. The leaf margin turns brown with a yellow border. As the leaves die, the petioles remain green and firmly attached to the stem.

**Fruit symptoms** are small (⅛ inch), creamy white spots with tan/brown centers found on the upper, exposed parts of the fruit. These characteristic ‘Bird’s-eye spots’ may eventually become brown, necrotic and merge with other spots. Fruit symptoms can be observed at any stage, but are usually seen on green fruit ½ to 2” diameter.

### Typical Symptoms

- **Curling, wilting of leaves, often one-sided**
- **Stem cankers**
- **Vascular discoloration**
- **Bird’s-eye spots on green fruit**
- **Necrotic leaf spots ¼ inch diameter**
- **Necrotic leaf margin with yellow edges**



Bird’s eye spots caused by Cmm



Sunken lesion due to bacterial canker



Stem damage caused by trellis line (not disease)

**Vascular discoloration**, initially yellow, then light brown to reddish, can also be seen in the stem and petiole. Pith appears dry and mealy, as well as discolored. Yellow sticky fluid may emerge from cut stem when squeezed. Stems can split open, forming cankers that facilitate secondary spread.

**Whole plant wilting** begins with the lower leaves but travels up the stem. Infection tends to be more severe in plants infected early, as seedlings, versus late in their growth cycle due to secondary spread.



Plant wilting and leaf cupping caused by Cmm



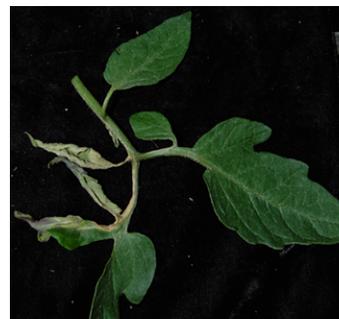
Whole plant wilting and in-row spread

**BIOLOGY and EPIDEMIOLOGY**

Disease development is favored by warm (75-90°F), moist conditions. Greenhouse operations are highly susceptible to disease development.

Initial inoculum can come from several sources, including infected plant debris in soil, infected weed hosts, infected volunteer tomato plants,

diseased transplants, contaminated wood stakes, and infested seed. Clean seed is very important, for disease can develop and spread rapidly under greenhouse conditions, and a 1% seed transmission rate is sufficient to give 100% disease. In-field spread occurs easily by workers' hands, equipment, during vine pruning, particularly when plants are moist with dew or irrigation water. Bacteria present in and on the plant can be transmitted to adjacent plants by pruning or abrasion wounds, or simply contact with infected leaves, entering through pores on the leaf margin (hydathodes) which links directly to the plant xylem vasculature.



One-sided symptoms



Cmm stem canker

**Sources of inoculum and spread**

- Seed (primary source)
- Plant debris
- Weed hosts
- Contaminated stakes
- Contaminated equipment
- Workers hands, pruners, clothing, etc.
- Irrigation water and dew

Cmm can survive as free-living bacteria in soil for short periods, in non-decomposed tomato plant debris, on weed hosts (nightshade) and volunteer tomato/pepper plants, on contaminated stakes or equipment and in association with seed. Volunteer plants from a previous infection or susceptible weeds can maintain low levels of the pathogen. It survives better in cool, dry conditions than in hot, moist conditions.

**Cmm survival duration in association with different materials**

|  |                       |
|--|-----------------------|
| Free-living in soil                      | 3-4 weeks             |
| Non-decomposed tomato debris             | Up to 3 years         |
| Weed or volunteer tomato/pepper hosts    | Indefinite            |
| Contaminated stakes, tools and equipment | One to several months |
| Seed                                     | 5 years               |

## CONTROL

Bacterial canker can be challenging to control because of challenges with early detection, the highly infectious nature of the disease, and the number of inoculum sources. Sanitation and preventative measures must be enforced.

- **Use certified, disease-free seed from canker-free plants.** The standard hydrochloric acid method or fermentation process should produce clean seed. However, these methods will not treat embryonic infection. Centrifuge extraction can lead to high levels of seed contamination.
- **Certified disease-free transplants.** It is not usually possible to identify infected seedlings at the time of transplanting.
- **Remove disease plants as soon as possible.** If infection occurs early in the season, infected areas should be plowed down to prevent spread to nearby healthy fields. Several healthy plants adjacent to symptomatic plants should also be removed.
- **Hands, tools, shoes and crop support materials should all be disinfected.** Hypochlorite (bleach) is not satisfactory as a disinfectant. Quaternary ammonium compounds are recommended.
- Copper-fungicide compounds in **foliar sprays are not highly effective** for bacterial canker control because they only act at the tissue surface while many of the bacteria are internal to the plant. Sprays should not be applied at high pressure as this may damage the plant (causing many micro-wounds) and lead to more disease. Fixed copper field sprays may help in protecting healthy plants, especially if only superficial symptoms are present.
- **When leaves are moist with irrigation water or dew, do not allow movement** through the field by workers or equipment
- **Remove or plow in infected plants** as soon as possible after harvest in order to ensure good decomposition. The bacterium cannot survive in soil for long, but can survive in the field in complex with plant material.
- **Discard wooden stakes** and strings from infected areas. The porous condition of wood makes sanitation imperfect.
- **Rotate out of tomato, peppers, eggplant** and related crops for 2-3 years
- **Control Solanaceous weeds** and volunteer tomatoes and peppers.
- There are currently **no resistant tomato varieties** for bacterial canker

## REFERENCES

Koike, S., P. Gladders, and A. Paulus. (2007) Vegetable Diseases: A Colour Handbook. Boca Raton, FL: CRC Press.

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Special thanks to input from Dr. Gitta Coaker and Dr. Cassandra Swett.