Bacterial Canker of Greenhouse Tomato

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Bacterial canker, caused by *Clavibacter michiganensis* pv. *michiganensis*, is a damaging disease of greenhouse-grown tomatoes in British Columbia (B.C.). It affects both tomato seedlings at the propagation stage and tomato plants in the greenhouse. Since bacterial canker is very difficult to control once the symptoms are expressed it is important to monitor for early signs of the disease, confirm the disease by proper diagnosis, and implement management strategies immediately. Although tomato is the primary host of *C. michiganensis* the bacterium has also been reported to cause symptoms on sweet pepper, eggplant, and many weed species belonging to the family solanaceae.

Symptoms

Seedlings – If tomato seedlings are infected during the propagation stage, symptoms may develop as cream-to-white, raised blisters or pustules on leaves and stems. These symptoms may resemble oedema, a physiological condition. However, in many cases, symptoms on infected seedlings go unnoticed (non-symptomatic) during propagation if the growing conditions are unfavourable for the pathogen. Under humid, hot conditions, wilting of infected seedlings (especially grafted seedlings) can be observed.

Plants – Initial symptoms may appear as interveinal, pale-green water-soaked areas on leaves which quickly turn into yellow-brown to brown necrotic areas, resembling sun-burn. Infected plants begin to wilt, often just the lower leaves or just above the area of the stem/vascular tissue that is infected. It may look like the leaflets on only one side of a leaf are affected. Wilted leaves may also show marginal necrosis (brown, dead tissue) (Figure 1.) As the disease progresses, more wilting and leaf necrosis develop (Figure 2). If stems are infected, light yellow to brown streaks/cankers may appear on stems (Figure 3). These cankers darken with age. As the disease progresses, the affected stems are split open lengthwise; a thin, yellow to reddish-brown discolouration of the vascular tissue may be observed (Figure 3). The pith of infected stem turns brown, dry and mealy. These internal symptoms are evidence of systemic infection and spread of the pathogen.

Fruit – A reported diagnostic feature of bacterial canker is the appearance of distinct white halo spots called "bird's-eye" on green fruit (Figure 4). Although this symptom is helpful for visual identification, it is not likely to be observed in the early stages of fruit development or in a greenhouse. Therefore, do not rely on this particular "halo spot" symptom for diagnosing bacterial canker infection in your greenhouse. Infected fruit may also have yellowing or browning in its vascular tissue, may have a marbled appearance, or may be symptomless.

Figure 1. Necrosis on leaf margins of tomato plant infected with Clavibacter michiganensis pv. michiganensis.

Figure 2. Brown lesion on stem and vascular discolouration of tomato plant infected with Clavibacter michiganensis pv. michiganensis.

Figure 3. Field tomato plant infected with bacterial canker showing necrosis and death of lower leaves and wilting. Photo credit: D. Cuppels, Agriculture & Agri-Food Canada

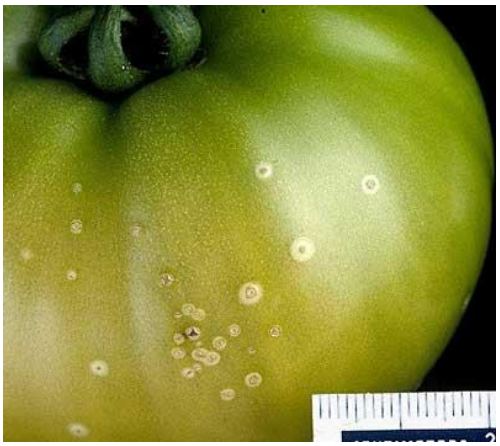

Figure 4. Tomato infected with bacterial canker showing "Bird's-eye" like spots on fruit. Photo credit: D. Cuppels, Agriculture & Agri-Food Canada

Spread

The pathogen enters the host plant through wounds and, perhaps, natural openings such as stomata, lenticels, hydathodes etc. It can spread mechanically via pruning knives during de-leafing, tools, machinery and workers' hand and clothing during crop handling. The pathogen can also be carried on seeds (i.e. seed-borne). However, in many cases, the symptoms may not be visible at the propagation stage but the disease develops rapidly in the greenhouse. The pathogen spreads systemically through the vascular (xylem) system of the host plant and the symptoms may appear as local infections on leaf (leaf necrosis), stem (stem canker) and fruit (lesions or spots). Symptoms and the disease severity may vary depending on the type of bacterial strain, plant variety, age and vigour, and environmental/growing conditions. Warm (temperatures between 24-27°C) and a

moist environment is highly conducive for rapid disease development. The pathogen can also be carried in irrigation water, particularly in a greenhouse with a history of bacterial canker. The bacterium may not survive for long, perhaps 2-4 weeks, in the absence of the host plant. It can, however, survive for a longer period (several months) in contaminated, dry plant debris.

Disease Control

Prevention

- Bacterial canker is very difficult to eradicate once established in a greenhouse. Therefore, preventing the introduction and spread of the disease in a greenhouse is very important. Practice strict overall greenhouse sanitation and biosecurity procedures. For details, refer to the factsheets on "Disinfection and Sanitation Practices" and "Biosecurity Guidelines".
- Buy disease-free seed/transplants from a reputable source. Treated seed and seed derived from an "acid extraction" procedure are highly recommended. Although the possibility of contaminated seed source is very low, grafting of transplants in a propagation house can increase the chances of spread of the pathogen if infected seedlings are present.
- Use tomato cultivars, if any, that are resistant to bacterial canker.
- Examine transplants for symptoms, by keeping them in a header-house for a few weeks, before planting them in a greenhouse. Plant only healthy seedlings.
- Reduce possible sources of contamination from soil and plant debris.
- Control weeds, particularly solanaceous species, in and around the facility.
- Maintain periodic scouting for early detection of bacterial canker symptoms, particularly on young tomato plants. Submit any suspected plant samples to the Ministry of Agriculture Plant Health Laboratory or to a recognized plant pest diagnostic laboratory for proper diagnosis and confirmation.
- Thoroughly clean and sanitize the greenhouse after harvest. Remove plant material, clean all greenhouse surfaces, and disinfect irrigation lines, etc.

Eradication & management

- Immediately remove the entire infected plant(s) and adjacent plants carefully. Do not break or shred infected plants inside the facility.
- Place the infected plants in plastic bags to reduce spread and remove them from greenhouse. Deep burial of infected plant material at a far-site or land-fill is recommended.
- Do not reuse the growing medium (sawdust, coconut fibre etc.) from any infected plants.
- Disinfect pruning tools and machinery used in the cleanup promptly.
- Wash hands well with hand-soap and change clothing after handing the infected plants (wash clothing before wearing them again).
- Disinfect the infected and surrounding area. If the infected area has a soil-floor covered with a tarp, do not remove the tarp, carefully remove all plant material and debris, treat with a disinfectant and place a new tarp on top. Restrict traffic in the areas where infected plants were found. Work with plants in the infected area last or assign certain workers to this area. Wear protective clothing and enforce strict sanitation measures when working in and around the infected areas.
- Avoid using overhead irrigation in the infected and surrounding areas. Monitor the crop carefully for disease. Pay close attention to plants in the proximity of the initial outbreak.
- Greenhouses with a history of bacterial canker must take extra precautions. A preventative copper spray program may help to reduce the risk of bacterial canker outbreak in the following years.

Chemical Control

Table 1. A summary of registered bactericides and label information. Please refer to Health Canada's Pest Management Regulatory Agency website for product labels and information.

Product	Active ingredient	Chemical or Biological group	Mode of action	REI[1] hrs	PHI[2] days	Application guidelines
Cueva	copper octanoate	M	protectant & curative (non-systemic)	12 or until dry	1	Apply preventatively at 5- to 10-day interval. Do not exceed 14 applications per crop cycle.
Guardsman	copper oxychloride	M	protectant & curative (non-systemic)	48	2	Apply preventatively at 7- to 10-day interval. Do not exceed 10 applications per crop cycle.
Cyclone	citric acid + lactic acid	derived from *Lactobacillus casei* LPT-111	protectant & curative (non-systemic)	4 or until dry	0	Apply preventatively at 5- to 10-day interval.
Lacto-San	citric acid + lactic acid	derived from *Lactobacillus casei* LPT-111	protectant & curative (non-systemic)	4 or until dry	0	Apply preventatively at 5- to 10-day interval.
Kasumin	kasugamycin	24 (antibiotic)	curative	12	1	Apply at first sign of symptoms at 7-day interval. Do not exceed 3 applications per crop cycle.

[1]REI - re-entry interval
[2]PHI - pre-harvest interval

For Further Information

- Bacterial Diseases of Tomato: Bacterial Spot, Bacterial Speck, Bacterial Canker. Ontario Ministry of Agriculture, Food and Rural Affairs.
- Hausbeck, M.K., Bell, J., Medina-Mora, C., Podolsky, R. and Fulbright, D.W. (2000). Effect of bactericides on population sizes and spread of *Clavibacter michiganensis* subsp. *michiganensis* on tomatoes in the greenhouse and on disease development and crop yield in the field. Phytopathology 90:38-44.
- Werner, N.A., Fulbright, D.W., Podolsky, R., Bell, J. and Hausbeck, M.K. (2002). Limiting Populations and Spread of *Clavibacter michiganensis* subsp. *michiganensis* on Seedling Tomatoes in the Greenhouse. Plant Disease 86(5):535-542.

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