BRITISH COLUMBIA | Ministry of Agriculture, Food and Fisheries

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 symptoms of the disease, confirm the disease by proper diagnosis, and implement management strategies immediately. Although tomato is the primary host of *C. michiganensis* it has also been reported to cause symptoms on sweet pepper, eggplant, and many weed species of 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 warm and humid 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 yellowish brown to brown necrotic areas, resembling sunburn. Infected plants begin to wilt, often just the lower mature leaves or leave just above the area of the stem that is infected. Wilted leaves may also show marginal necrosis (brown, dead tissue) (Figure 1A.) As the disease progresses, more wilting and leaf necrosis develop (Figure 2A). If stems are infected, light yellow to brown streaks/cankers may appear on stems (Figure 1B). 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 and the pith of infected stem turns brown and may appear dry and mealy (Figure 1B). These internal symptoms are evidence of systemic infection and spread of the pathogen.

Fruit – A characteristic diagnostic feature of bacterial canker is the appearance of distinct white "halo spots", also called "bird's-eye", on green fruit (Figure 2B). 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, "halo spot" symptom may not be a reliable diagnostic feature for bacterial canker infection in a greenhouse. Infected fruit may have marbled appearance on the surface, yellowing or browning of the vascular tissue, or remain symptomless.

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 can develop rapidly in the greenhouse. The pathogen spreads systemically through the vascular (xylem) system of the host plant and the symptoms may appear as localized infections on leaf (leaf necrosis), stem (stem canker) and fruit (lesions or

spots). The symptoms or 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 period, 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.

Figure 1. Necrosis on the margins of tomato leaf (A) and brown canker lesion and vascular discolouration on a tomato stem (B) infected with *Clavibacter michiganensis* pv. *michiganensis*.

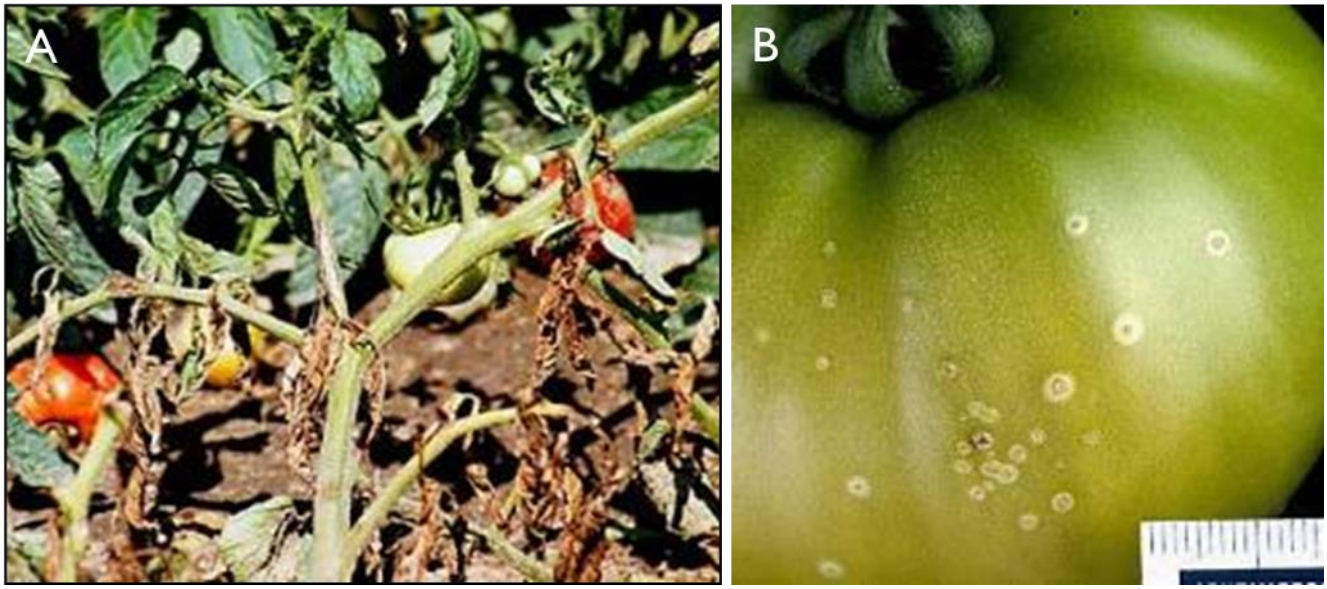

Figure 2. Bacterial canker on a field tomato plant showing necrosis and death of lower leaves and wilting (A) and "Bird's-eye" like spots on tomato fruit (B) infected with bacterial canker. Photo credit: D. Cuppels, Agriculture & Agri-Food Canada.

Disease Management

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 protocols during production and year-end greenhouse cleanup and disinfection measures. For details, refer to the Ministry's factsheets on "Disinfection and Sanitation Practices".
- 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, growing media 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, Food and Fisheries - Plant Health Laboratory or to a recognized plant diagnostic laboratory for disease 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 any infected plant(s) and the adjacent plants carefully from the production area. 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 landfill is recommended.
- Do not reuse the growing media (sawdust, coconut fibre etc.) from 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. Chemical and biological based bactericides that are registered for managing bacterial canker is depicted on Table 1. A preventative copper spray program may help to reduce the risk of bacterial canker outbreak in the following years. However, once the infection has occurred in a greenhouse it is difficult to control the speed of the disease.

Table 1. A summary of registered chemical and biological bactericides and application information. Please refer to Health Canada's Pest Management Regulatory Agency website for the manufacture's label and strictly follow the instructions as outlined on the label.

Product	Active ingredient	Chemical or Biological group	Mode of action	PEI[1] hrs	PHI[2] days	Application guidelines
Cueva	copper octanoate	M	protectant & curative (non-systemic)	12 or until dry	1	Apply preventatively at 5-10 days interval. Do not exceed 14 applications per crop cycle.
Guardsman	copper oxychloride	M	protectant & curative (non-systemic)	48	2	Apply preventatively at 7-10 days 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 5-10 days 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 5-10 days 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.
AgriPhage CMM	bacteriophage	bacteria feeding virus (biological)	protectant	-	0	For seedings, apply immediately after planting or grafting, and then at 3-4 days intervals. Plants in greenhouse, apply prior to or at early stages of disease, and then at 3-4 days intervals throughout the growing season.

[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.

Prepared by:
Siva Sabaratnam, Plant Pathologist
Abbotsford Agriculture Centre,
British Columbia Ministry of Agriculture, Food and Fisheries
Abbotsford, B.C.