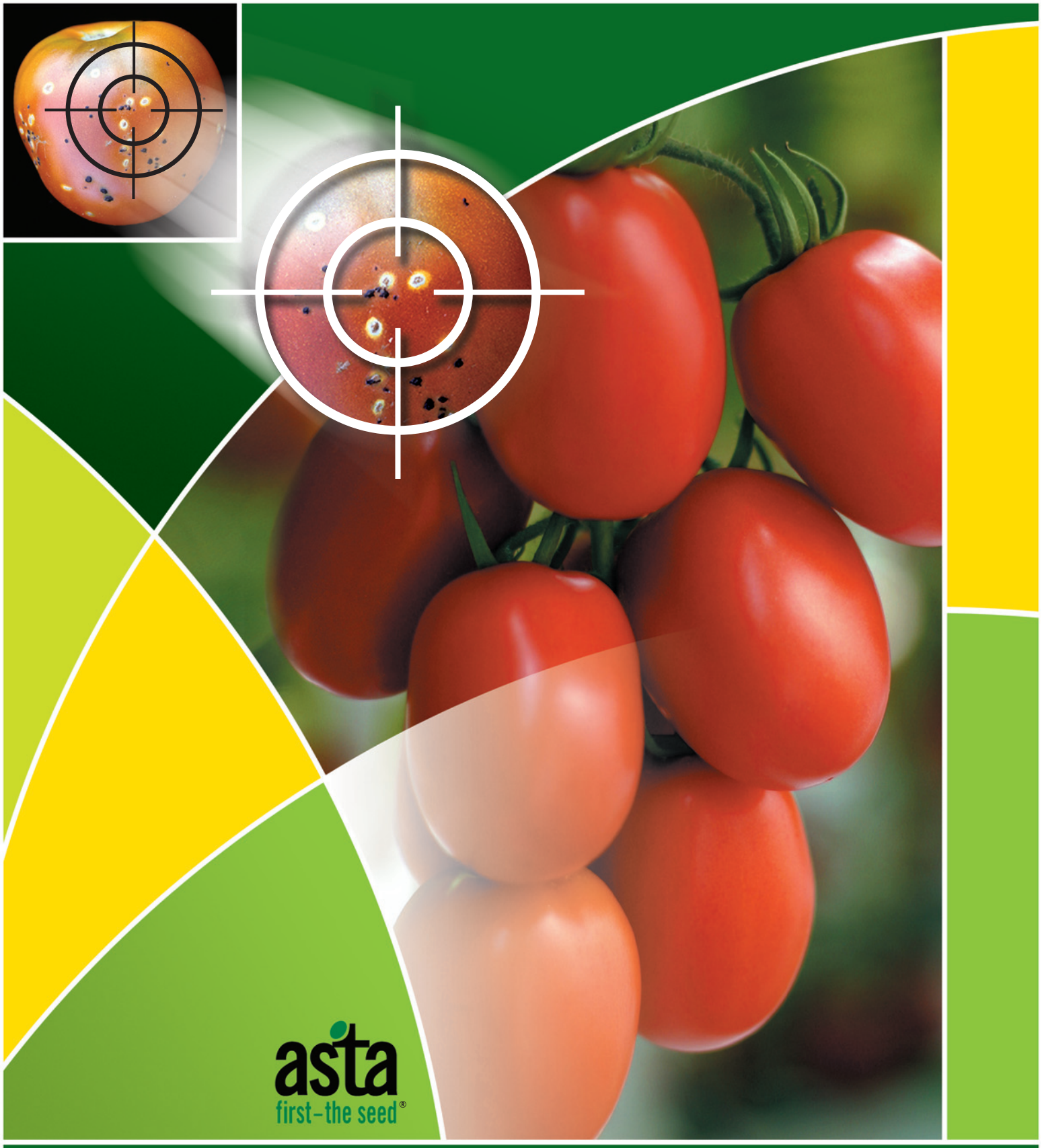
Bacterial Canker of Tomato



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A COMMERCIAL GROWERS GUIDE

Bacterial Canker of Tomato

Bacterial canker is a serious tomato disease caused by *Clavibacter michiganensis subsp. michiganensis* (Cmm). The disease was first discovered in 1909 in Grand Rapids, Michigan, USA but is currently reported in tomato production areas worldwide and outbreaks occur annually. However, preventive measures can be taken at all stages of production to avoid losses from bacterial canker.

Diagnosing bacterial canker in the greenhouse or the field:

Seedlings: Marginal necrosis, tan to dark necrotic patches on the leaves and stems, and small white raised blisters on infected leaves may be symptoms of bacterial canker infection on young plants. Stunting, wilting and stem splitting can also occur, especially in grafted seedlings. However, symptoms can take several to many weeks to develop following infection and therefore may not be visible at the seedling or transplant stage.

Leaf and plant: Leaf yellowing and necrosis around leaf margins called "firing" or "marginal necrosis" can indicate a foliar and/or systemic infection. When the stems or petioles are cut open, discoloration of the vascular tissues may be seen. In greenhouse-grown plants, symptoms appear as interveinal chlorotic to pale green patches that quickly become necrotic, giving a scorched appearance. Infected plants wilt beginning with the lower, older leaves, or leaves above the point of infection. Wilting may be asymmetric, appearing more on one side of the plant than the other. Infected leaves die, and light brown streaks or cankers, which may darken with age, develop on infected stems. Typical cankers can be common in the field but are rarely seen in the greenhouse. The vascular tissues become light brown to reddish brown and the pith appears mealy, brown and dry. Older plants tend to be less susceptible to Cmm than younger ones and the disease tends to be more severe on plants infected early vs. late in their growth cycle.

Fruit: Small dark spots on the fruit surrounded by a white halo or "bird's-eye" spots are characteristic of bacterial canker on field-grown fruit. Spots become raised and the centers turn brown with age. Infections, and the resulting spots, occur when Cmm bacteria are deposited on fruit by splashing water from rain or overhead irrigation, or mechanically during handling of the plants. When internally infected fruit are opened, yellowing or browning caused by the decay of the tissues may be seen. In the greenhouse, bird's-eye spots are typically not observed, but fruit may appear netted or marbled, or they may remain symptomless.

Figure 2. A) Bacterial canker on green tomato, showing the typical white to yellow halo or "bird's eye" symptom. **B)** The red tomato shows some brown spots surrounded by a white halo caused by Cmm. The darker brown spots (with no halo) are caused by a different bacterial pathogen, Pseudomonas syringae pv. tomato.

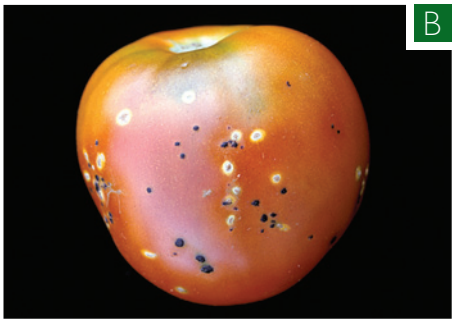

Figure 1. A) Leaf necrosis often called "firing". **B)** Peduncles and calyx illustrating necrotic lesions.

It is important to have an accurate diagnosis of any disease problem in tomatoes so that appropriate control measures can be taken. Diagnostic kits have been developed for rapid, on-site identification of Cmm. However, it is advisable to submit a tissue sample to a reputable laboratory for confirmation of the diagnosis.

Disease development and spread:

Sources of the pathogen. The pathogen can survive in many environments including free living in infested soil for short periods, in over-seasoned plant debris in the soil, on weed hosts and volunteer plants, on contaminated stakes and in association with seed. Cmm is a seed-borne pathogen, although rates of seed-borne infestation may be very low. Volunteer tomato plants from an earlier infected crop may harbor the pathogen, as can cull piles of diseased tomato plants. Cmm can infect or survive on some weeds such as nightshade, and several wild *Lycopersicon* species, and these can act as reservoirs of Cmm for new infections. Plant material (field tomatoes, weeds, cull piles) and soil infested with Cmm may be blown on wind and rain into the greenhouse. Re-circulated water systems, such as ebb and flow irrigation, may also harbor the pathogen.

Pathogen longevity. Cmm can survive for at least five years in infested tomato seed and still cause Infection. The pathogen also survives for short (up to 3-4 weeks) periods of time in soil and for up to 24 months or longer in infected plant debris. In the greenhouse, Cmm can survive at least one month on surfaces such as cement and plastic, and at least a year in plant material and rockwool. It survives better in cool and dry conditions than in hot, moist ones.

Environmental conditions favoring disease development. Development of bacterial canker is favored by warm - 75-90 F (24-32C) - moist conditions. In greenhouses, the disease tends to be more severe in the summer during long, hot days when plants are stressed. Bacterial canker is more likely to be found in wetter areas of the greenhouse (e.g. where water condenses and drips on plants) than in drier areas.

Figure 3. A) Stem illustrating classic stem canker symptom. **B)** Comparison of healthy (top) and diseased stem (bottom), which shows dark discoloration and cavities in the pith area.

Transmission. Overhead irrigation during seedling production, movement through foliage by production workers and rainfall on open fields favor the spread of Cmm, especially if plants have recently been staked or pruned. Once the disease appears in a field or greenhouse, the pathogen may spread to adjacent plants and infect them through pruning wounds and injury, or through naturally occurring pores along the leaf surface (stomates) or leaf margins (hydathodes). The pathogen can also be moved quite easily by equipment during cultivation, especially with open field processor tomatoes.

In the greenhouse, Cmm may move from infested to non-infested areas in re-circulated water and from plant to plant in bags or trays. Equipment such as clippers, cutting blades, stakes or plant ties may harbor the pathogen. Workers may transmit the bacteria on tools, hands and clothing. During pruning and grafting, improperly disinfected tools may lead to disease spread. This spread can be particularly explosive following the grafting operation, when bacteria can be directly introduced into the vascular tissue of

Figure 4.) Young seedlings after grafting. Note the conditions that promote graft healing can also promote bacterial infection.

Figure 5.) Typical netting or mottling symptoms of bacterial canker on tomato fruit produced in a greenhouse.

Figure 6. A and B) Typical stem lesions on young plants. Note the graft site.

very young plants. Plants infected in this manner may develop more extensive symptoms at a much earlier growth stage compared to the natural infection process. Cmm can also infect roots, so it is important to sterilize the soil (if used in the production system) following a diseased crop.

Controlling the disease:

Only purchase seed that has been tested and found to have No Evidence of Cmm. When grafting, be sure seed of both the rootstock and scion is tested with No Evidence of Cmm. Seed companies typically make every effort to produce seed in suitable production areas with low disease pressure or in greenhouses under strict sanitation to minimize the risk of infections. Seed tests add additional information on the health of the seed.

Follow sanitation procedures during production:

- **Seedling production:** Use only clean trays and flats for transplants. Use overhead watering sparingly – provide only enough moisture for seedling growth. Allow foliage to dry before the sun sets, as prolonged leaf wetness can lead to increased disease development, and use other strategies to minimize time of leaf wetness. Inspect plants frequently for canker and other disease symptoms.

- **Grafting:** Strict sanitation procedures must be in place during the grafting process. Seedlings should be thoroughly inspected for symptoms and suspect plants removed and tested. Ensure that seedling foliage is dry prior to grafting. Cutting tools should be disinfected regularly and workers should wear disposable gloves that are regularly changed or disinfected. Ethanol (70-75%) and other disinfectants, such as Virkon, Chemprocide, Kleengrow, etc., are effective in disinfecting cutting tools and hands. Cutting blades should soak in the disinfectant solution long enough to ensure disinfection. Disinfectants should be changed regularly to ensure the concentration is in the effective range. Disinfected tools and hands should be rinsed with clean water to avoid damage to the plant by the residual disinfectant. Workers should wear clean clothing or clean disposable coveralls.

- **Pruning, harvesting and other handling operations:** Greenhouses should be kept clean and thoroughly disinfected between crops. Hands and tools should be sanitized between plants or rows with a disinfectant solution to minimize pathogen spread. Clippers and knives that deliver a disinfectant to the cutting surface during each cut are commercially available, and when used with an effective disinfectant, such as Virkon or KleenGrow, can also help to prevent the spread of Cmm. Knives or clippers that do not deliver a disinfectant are not recommended for pruning, suckering or harvesting. These

Figure 7. A) Early **and B)** advanced leaf scorch symptoms typical of bacterial canker in greenhouse tomatoes.

operations may be carried out by hand and, with practice, the plant is not damaged and the wound is not touched. Hands should nonetheless be sanitized regularly. Any symptomatic plants should be removed immediately in sealed plastic bags or containers and buried in a pit away from greenhouses or field irrigation ditches. Be sure to avoid touching any healthy plants with hands, clothing or the plastic bags during the plant removal process. Note that symptoms may take several weeks (2-7 weeks) to develop following infection, depending on conditions. Therefore, during an infection there may be symptomless plants that serve as inoculum for spread of the disease. Thus, several neighboring plants in both directions down the row, as well as visibly infected ones, should be removed even if they do not show symptoms.

- Tomato or pepper cull piles and solanceous weeds must not be allowed in the vicinity of the greenhouse and production site. Re-circulated water should be disinfected before being reused again as irrigation water.

Minimize chance of disease in subsequent crops. Plant debris decomposes faster and the survival of Cmm decreases if the debris is plowed under and soil is moist. Properly dispose of vines and other plant residuals as far from the greenhouse and production fields as possible. Remove weeds in and around the greenhouse and fields. Thoroughly disinfect the greenhouse / screenhouse, machinery, tools and crates between crops. In open field production, rotate tomatoes with a non-host crop (peppers are hosts of Cmm) for 2-3 or more years. In greenhouses, where rotation is not possible, growing media such as rockwool and coconut dust, and ground covers should be changed to minimize the chance of Cmm carry-over to subsequent crops.

Question and Answers:

Q1: Should I treat the tomato seed with hot water before planting?

A1: Heat treatment (hot water or dry heat) is the only way to eliminate Cmm from inside the seed coat, but it can affect germination rate and shelf life of the treated seed. High temperature handling or treatment of the seed will typically void seed company warranties and seed suppliers do not recommend the use of heat treatment on tomato seed. If seeded immediately after heat treatment (within a week), germination may not be affected, but this can vary greatly by variety and seed lot. The treating temperature and duration must be precisely controlled and requires specialized equipment.

Q2: What are possible sources of the pathogen that can lead to bacterial canker in my tomato crop?

A2: Seed can be an important source of Cmm. Volunteer tomato plants and a few weedy hosts can also be infected with the pathogen, and serve as a source from which it spreads to subsequent crops. Cmm can also be carried into the greenhouse with wind-blown dust, or can be present there from a previously infected crop.

Species reported to be susceptible and therefore possible hosts to Cmm include *Lycopersicon esculentum, L. glandulosum, L. hirsutum, L. peruvianum, L. pimpinellifolium, Nicotiana glutinosa, Physalis pruinosa*, and many *Solanum* sp., such as night shade (*S. douglasii, S. nigrum var. quineense, S. rostatum*), and tree tomato (*Cyphomandra betacea*). Peppers (*Capsicum annuum* and other *Capsicum* species) are alternate hosts for the pathogen and Cmm from pepper can infect tomato.

Q3: Are any foliar sprays effective in controlling bacterial canker?

A3: Foliar sprays with copper-fungicide compounds 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. However, these compounds may help reduce Cmm populations on plant surfaces before they infect the plant through wounds or natural openings. Sprays should not be applied at high pressure as this may damage the plant (causing many micro-wounds) and lead to more disease.

Q4: What can I do to help minimize the risk of bacterial canker in my greenhouse or screenhouse?

A4: Start with tested, treated seed from a reliable seed company. Do not over water plants – provide only enough water for healthy seedling growth and allow foliage to dry quickly. Constant monitoring of your crop is critical for controlling disease. Symptomatic and adjacent plants should be removed immediately from the premises to prevent the spread of disease. Affected plants should be placed in a plastic bag or container and disposed off-site. Healthy appearing plants next to the diseased plants should also be removed as a precaution. Maintain a strict sanitation protocol at all times.

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Q4: If bacterial canker occurs in my greenhouse or screenhouse, what should I do before a new tomato crop is planted?

A4: Before planting the new tomato crop, eliminate the pathogen from the greenhouse or screenhouse. Remove all plant materials. Disinfect the structure and all equipment. Do not use bleach (sodium hypochlorite), as toxic fumes may form. Quaternary ammonium compounds such as Triathalon are better for greenhouse use. Disinfectants containing chlorine compounds such as Selectrocide, Chemprocide or Virkon S are also labeled for greenhouse application. Make sure these chemicals are registered for use in your area. Treat all surfaces, including irrigation lines, pathways and doorways. Treat all tools, including pots, flats, clippers and plant ties. Once the area is clean do not allow anything back into the greenhouse if it has not been disinfected.

Q5: After the disinfecting process, is there a safe length of time before a new crop can be planted?

A5: You can plant your crop immediately after the disinfection. However, solarizing soil between crops is highly recommended. Allow cleaned surfaces to dry before planting operations begin. In case of soil culture, plant residuals left in the soil can harbor Cmm for many months, and the bacterium can survive as a free living organism in the soil for several weeks. Keeping the soil in a warm and moist condition for period of time can accelerate the decomposing process of plant residuals and reducing the chance of Cmm survival.

Sponsors:

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Websites: The Ohio State University at http://ohioline.osu.edu/hyg-fact/3000/3120.html
Cornell University at http://vegetablemdonline.ppath.cornell.edu/factsheets/Tomato_Bacterial.htm

Additional sources of information on bacterial canker on tomato:

Compendium of Tomato Diseases
The American Phytopathological Diseases
3340 Pilot Knob Road, St. Paul, Minnesota 55121-2997

The Colour Atlas of Tomato Diseases
Observation, Identification and Control
D. Blancard
INRA Vegetable Pathology Unit, Monfavet, France
Manson Publishing, Ltd., London, UK