Facts, Perceptions and Management Strategies

Bacterial Diseases in Tomatoes & Peppers

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Bacterial diseases have evolved into major plant disease concerns of tomato and pepper growers across Ontario. The bacterial diseases are Bacterial Canker, Bacterial Spot and Bacterial Speck affecting tomatoes and Bacterial Spot affecting peppers.

Understanding bacterial diseases, their source, spread and control have been a problem in many crop situations - Black Rot in cabbage, Bacterial Blight in field beans, Fireblight in orchards for example. The tomato and pepper industries have likewise agonized over similar questions. What are the facts?

To add to everyone's frustration, there appears to be contradictory comments within the industry regarding how best to attack the problem. This apparent difference in opinion is based on an honest attempt to make sense out of scientific data and field observations and coming up with several different conclusions. It must be stated that on most points there is agreement, however, where differences arise it is a matter of degree, emphasis or probability.

A discussion on what is known and observed in the fields and the way these "facts" are interpreted may give you a better understanding of the problem. An attempt will, however, be made to draw the divergent information together to allow for specific control measures that we all can address.

Facts and Comments

1. **Bacterial Canker, Bacterial Spot, Bacterial Speck are seed borne diseases.**
   
   **COMMENT:**
   It is felt that Bacterial canker has the ability to become systemic, meaning the disease organisms can get into the seed - underneath and/or throughout the seed coat whereas the Spot and Speck organism can only be found on the surface of the seed. This would suggest that seed treatments should be more effective in controlling Spot and Speck, those organisms on the surface than Bacterial Canker. In other words a seed treatment that controls canker should also control Spot and Speck.

2. **Bacterial Canker, Spot and Speck do not survive in soil but survive in plant tissue - eg., leaves, stems that, at year's end, are buried in the soil.**
   
   **COMMENT:**
   If these disease organisms could survive in the soil without the crop residue, it would suggest that once a field had been infected or contaminated, it is "diseased" forever. The fact that the organisms will die out once the crop residues decomposes gives us some hope of recovering that field for future
planting of tomatoes and peppers. The question is how long does crop tissue survive in the soil and are there ways to speed up the process? Some suggest that burying crop litter within the top 6’ of soil, under high nutrient levels and moisture conditions speeds up the process of decomposition thus lessening the effects of crop debris as a significant source of primary inoculum.

3. **Bacterial Canker, Spot, and Speck survive on non-host plants and machinery.**

COMMENT:  
This is a point that is agreed upon by most industry representatives but the practical significance of this fact is uncertain. If the bacterial populations are extremely low, considerable time is required to allow populations to build up to levels capable of causing damage. Often late season foliar blighting caused by these bacterial organisms is not considered a commercial problem.

If, however, the disease is introduced into the seedling beds early through contaminated trays, greenhouse equipment, etc., this early introduction would no doubt be a significant primary source.

4. **Research trials set up to determine if a field heavily infected with Bacterial Canker or Bacterial Spot the previous season could act as a source for this year's problem have most often been negative. Plants have remained free of bacterial disease.**

COMMENT:  
This would suggest that the odds of picking up sufficient disease organisms from last year's disaster is sufficiently low to not be a significant source of primary inoculum. The fact that in research trials, no carryover was observed does not mean it could not happen. Some researchers have demonstrated to their satisfaction that it can happen. We know the organisms can survive on crop residue as stated previously but the odds of this being a significant source is minimal. This introduces the concept of minimum effective dosage. During the residual phase of the disease, populations increase to a level that overcomes some threshold number required to initiate disease. This is not to imply a model of cooperative action among the pathogen population but rather that the very small PROBABILITY of one individual initiating an infection has been further reduced. Crop rotation is expected to significantly reduce the disease pressure. It is expected that over a 2 year period pepper and tomato crop residues break down to a level that will not support these pathogenic bacterial disease organisms.

5. **Research varietal trials have often been identified as primary sources of seed borne bacterial diseases. Trials are often conducted in replicates of 3 or 4. If observed early enough it has often been noticed that one or two tomato and pepper cultivars throughout all 4 reps show bacterial symptoms whereas other cultivars side by side within the plot are symptomless. This has been used to suggest that particular seedlot was contaminated. There could, however, be other explanations for this observation. This cultivar could have been contaminated in the greenhouse prior to transplanting or it could be very susceptible and showed symptoms from field infection prior to other cultivars.**
6. Peppers are a potential source of Bacterial Spot infections in tomatoes grown in close proximity, as greenhouse transplants.

COMMENT:
If we assume that there are more effective commercial methods of cleaning tomato seeds than there are for pepper seeds and that the tomato seeds come into a greenhouse complex disease free, one source of infection could come from pepper transplants. This would suggest growers should become exclusive pepper or exclusive tomato growers and not mix the two. Or develop methods of separating the two crops with the appropriate sanitation practices to eliminate cross contamination.

7. Blocks of bacterial diseased tomatoes and peppers are observed planted along side what appears to be healthy disease free plants early in the spring. Symptoms are noticed along one side of what was normally a clean crop planted up against a visually bacterial diseased field.

COMMENT:
This suggests that one planting is bringing the bacterial disease into the region or field. It is evidence that the seed source was contaminated or the plants were contaminated in the greenhouse prior to transplanting. If this same pattern was observed later in the growing season a further explanation could be due to the difference in susceptibility of the side by side crops.

8. Plants from the same seed lot, distributed to several greenhouse growers and further scattered to many field growers are found to produce symptoms in one area but NOT ALL.

COMMENT:
If the seed lot was heavily contaminated one would expect multiple dispersion of the disease and multiple symptom observations. This would, of course, depend on the local environments - wind, leaf wetness durations, rain, etc. If, however, only a few seeds were infected, the distribution could range from one location to 2-3 but not necessarily all locations.

9. Plants known to carry pathogenic bacterial cells on the foliage and stems as detected in the greenhouse and then distributed to several field growers become diseased in some fields but not all.

COMMENT:
This has been demonstrated numerous times where particular areas - presumably due to variations in leaf wetness duration and other local weather patterns - develop symptoms while other farm locations are free of the disease. For the past 4 years since detailed weather records have been taken in the operation of TOM-CAST it has been shown that Dresden area has accumulated more disease severity values - as a result of increased leaf wetness periods than Ridgetown. Bacterial cells lie in "wait" of proper environmental factors before they multiply to numbers high enough to cause plant symptoms (concept of minimum effective dosage).
10. **Hail, heavy rainfall events, high winds, excessive water with plant roots sitting in water for extended periods increase the chances of bacterial disease expression.**

**COMMENT:**
Mechanical damage, such as hail, heavy rainfall and wind help bacteria enter into plant tissue passively - eg., through wounds, leaf hair openings, edges of leaves - thus the black leaf edge symptoms, and stomates. Once inside the plant, there is sufficient moisture to promote reproductive growth and symptom expression. Plants that are standing in water "age" lowering the plants natural defence mechanisms to combat bacterial diseases.

11. **Seed treatments such as fermentation, hot water, acid or chlorine effectively control seed borne bacterial disease.**

**COMMENT:**
There is no doubt that if any of the above treatments are done correctly, seed borne bacterial populations are reduced. There will always be a few escapes but effective seed treatments are the most important factor in bacterial disease control in tomatoes and peppers.

Treating seed by any of the above methods unfortunately is not carried out exactly the same for various reasons. An example is fermentation. Some seed companies do a quick fermentation to remove the seed gel in tomatoes and use other treatments to combat bacterial disease. Again, the fact that seed is claimed to have been "fermented" does not by itself indicate that the procedure was done long enough under the proper conditions for bacterial disease control.

Treating seed uniformly is not easy. Materials used to disinfect seeds such as chlorine can be inactivated by organic matter. Miscalculations of the initial chemical concentration, length of time seeds are treated, poor mixing, dealing with "seed floaters" and many other factors must be constantly evaluated and improved upon.

Decisions on whether or not to treat or deciding the length of time the seeds are exposed to treatments have been made depending on seed weight and vigour, suggesting that all seed lots are NOT treated alike. We all recognize that often the longer seeds are exposed to these highly concentrated chemical baths the greater the risk of reduced seed germination.

12. **A certificate declaring that the seed is disease free means that particular seed lot is free of bacterial disease.**

**COMMENT:**
Those who perform seed testing procedures do an excellent job. Even under the most stringent testing procedures seeds contaminated with pathogenic bacteria are missed. This is not to denigrate present seed testing facilities but to indicate that newer technology will be providing higher levels of confidence in the future. It is well known that 1 infected seed in 10,000 produces enough bacterial inoculum to cause significant bacterial disease.
Foliar applied copper sprays control bacterial diseases in tomatoes and peppers.

**COMMENTS:**
Foliar applied copper sprays will reduce the number of bacterial cells on the foliage of tomatoes and peppers. Research at Ridgetown College and elsewhere have clearly proven this. Copper sprays are less effective, to a point of ineffectiveness when spray intervals are extended 7-10 days and/or under favourable environmental conditions for disease development. Bacteria have an enormous ability to reproduce. Foliar sprays often wipe clean surface bacteria but within a short period of time bacteria inside the leaf and those not controlled on the foliage build up to populations similar to the initial populations just prior to spraying. Low levels of control of Bacterial Spot in wholepack tomatoes may prove to be beneficial. It is hoped that even small reductions in fruit spotting will increase case recovery. Trials are being designed to evaluate this premise.

There are many locations in the USA where copper resistance to bacterial spot has been demonstrated. Under these conditions no amount of spraying with copper will provide any measure of disease control.

Foliar applications of copper under the traditional spray interval have not proven commercially acceptable for the control of Bacterial Speck and Canker.

**Bacterial Disease Control Strategies**

**GREENHOUSE**

1. Only use effectively treated seed (Acid or Chlorine). Verify that the seeds have been treated before using.

2. Plant genetic resistant cultivars where available.

3. Don't mix pepper and tomato transplants within a greenhouse complex. Operations with multiple greenhouses should organize their plantings so that the tomato and pepper plants are separated to avoid cross infection.

4. Maintain good sanitation practices, ie., weed control, reduce human traffic within greenhouses.

5. Address watering habits within a greenhouse. Attempt to reduce the number of hours leaves are wet through timing of watering, RH control, ventilation/heating.

6. Apply protective copper sprays in the seedling stage - every 3-5 days. Begin the spray program 2 ½ weeks after seeding.

7. After watering in the greenhouse just prior to shipping, first allow the foliage to dry before handling.
8. Do not wet the foliage in the shipping bins or trailers.

**FIELD**

9. Use a dip tank system to “wet up” the plug plants prior to transplanting. Try to keep the foliage as dry as possible.

10. Minimize the length of time between shipping and transplanting.

11. Practice a 2-3 year effective crop rotation.

12. Bury crop residue within the top 6" of soil for rapid decomposition of foliage.

13. Transplant into a well drained soil.


15. Record and separate seed lots into different fields.

16. Spray with a combination of Copper and mancozeb or Bravo when required.