

## **A. Grant Data**

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**Title: Development and Dissemination of an Integrated Management Plan for Bacterial Canker of Tomato**

Project Type: Critical and Emerging Issues

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## **B. Non-technical Summary**

This project was undertaken to address the growing occurrence and severity of bacterial canker of tomatoes in New Jersey. Nine commercial growers in Hunterdon, Morris and Warren in northern New Jersey counties were asked to participate in this

study based on their involvement in the Rutgers Cooperative Extension Integrated Pest Management (IPM) Program and their history of bacterial canker on tomato. Participants were provided information regarding practices that would help prevent the development and spread of bacterial canker. Additionally, participants were strongly advised to heat treat all tomato seeds prior to sowing to eliminate bacterial pathogens that might be present. Heat treatment of seed was a new practice for NJ growers. Heat treatment facilities were provided by the RCE IPM Program and one of the project participants.

Growers were asked to follow as many of the practices as were possible. They were surveyed at the end of each season to determine what varieties they grew, which practices they were able to complete and what their overall impressions were of the progress (or lack of) as a result of the project. The occurrence, severity and characteristics of bacterial canker infections (if present) were documented on each farm. The primary goal of these activities was to examine the tomato production activities on all farms and attempt to use the information to determine where weaknesses that contributed to bacterial canker infections occurred. All developments were reported at local, state and regional grower meetings; commodity working group meetings, and industry advisory meetings. A document entitled: *Bacterial Canker of Tomato: Background and Management Strategies* was produced and will be distributed at grower meetings.

### **C. Introduction**

Bacterial canker, caused by *Clavibacter michiganensis* subsp. *michiganensis* (*Cmm*) is a serious disease of fresh-market tomatoes in the Northeast. New Jersey growers annually harvest over 3,000 acres of fresh market tomatoes valued at nearly 28 million dollars. Fresh market tomato production in neighboring states is similar, with New York harvesting 2300 acres at 25.9 million dollars, Pennsylvania with 4000 harvested acres at 13.9 million dollars, and Maryland with 2000 acres valued at 12.6 million dollars. Much of the fresh market tomato crop is sold locally, and is a key item in supermarket produce departments as well as farmers markets.

Within the past five years, the incidence of bacterial canker has increased throughout New Jersey and the northeast region, and current management practices for other bacterial diseases of tomato have not been effective against bacterial canker. For many New Jersey growers, bacterial canker is the most serious disease in fresh-market tomato production. In New Jersey, many growers experience some loss due to fruit infection, while a number of growers lose entire plantings to systemic infections. In the 2005 growing season, heavily infected early tomato plantings on two farms in the northern New Jersey Vegetable IPM Program resulted in significant loss of that crop and spread to subsequent plantings. Overall losses have been assessed as high as fifty percent by growers in northern New Jersey. In New York, bacterial canker has become one of the most important diseases of tomatoes. Infections in New York are reported to be more localized, with some growers consistently affected. On these farms, 20-30% loss is common. Often, infested seed is cited as the inoculum source, although field sources have also been noted, and recent work in New Jersey indicates that both seed and field sources are important. Losses to bacterial canker can vary from none (minimal foliar

injury) to total (systemic infection), and are dependent on source of the infection, weather conditions, and cultural and disease management practices.

The primary needs expressed by growers in New Jersey are for identification of the initial source of infection in their production systems and, for those with aggressive bacterial management programs, what currently utilized management practices are inadequate for control. With this study, we attempted to address these needs by introducing heat treatment of seeds as a technique to eliminate seed as a primary inoculum source, and by encouraging growers to follow numerous procedures to limit development and spread of the pathogen.

#### **D. Objectives**

1. *Identify grower practices that contribute to poor control of bacterial canker.*

Observations of bacterial canker infections before and after growers began heat treating seeds indicate that this practice is likely eliminating seed as a primary inoculum source. Evidence from grower surveys and observations of transplant production facilities (point of origin) and fate of those transplants indicates that the most significant contribution to the appearance of bacterial canker is inadequate crop rotation.

2. *Demonstrate the importance of incorporating seed heat-treatment into an integrated management plan for bacterial canker.*

Heat treatment of seeds was enthusiastically undertaken by all study participants, and appears to have resulted in significantly fewer serious bacterial canker infections. This practice has been so well received that many New Jersey growers now incorporate it into their production scheme, either by using the Rutgers Cooperative Extension facility or by purchasing their own apparatus and following procedures developed by Dr. S. Miller of the Ohio State University.

3. *Demonstrate the importance of integrated tactics, including seed heat-treatment, vigorous sampling, and hygienic production practices in a management plan for control of bacterial canker.*

While grower acceptance and enthusiasm for seed heat treatment was significant, grower compliance with many of the suggested hygienic practices in transplant production and in the field were highly variable. This was not entirely negative, however, in that this variability assisted in the determination that field sources were the likely origin of canker infections once seed had been heat treated. Sampling of field debris and solanaceous weeds contributed to this determination.

4. *Promote an integrated plan for managing bacterial diseases of tomato.*

In addition to exposing growers in this study to integrated tactics for control of bacterial canker, numerous presentations were made to grower groups and industry

working groups at the local, state and regional level. Acceptance and incorporation of a number of suggested practices by growers in New Jersey has been positive.

### **E. Approach**

Nine tomato growers in northern New Jersey were asked to participate in the study. Participation required that each grower heat treat all tomato seeds, receive information regarding integrated tactics for bacterial disease control, and submit to observations and surveys of their production practices.

Beginning in February and March of 2006 and 2007, participating growers either brought their seeds in to the seed heat treatment facility established at the Rutgers Sustainable Agriculture Research and Extension Farm in Pittstown, NJ. Those who had their own apparatus undertook their own heat treatment. Several growers purchased transplants from a producer who heat treated seeds. All heat treatment was conducted following the procedure established by Dr. Sally Miller of the Ohio State University. All participants were provided a set of suggested practices ranging from appropriate spacing of seedlings in the greenhouse to field sanitation activities. These practices were discussed regularly with the growers as part of the overall vegetable IPM Program activities. Samples of tomato stakes, overwintered debris from current and past tomato fields, symptomatic live tomato foliage, and solanaceous weeds such as horsenettle were taken frequently each season. Samples were subject to ELISA, culture on selective media (if warranted) and bio-assay with the indicator plant *Mirabilis jalapa* (if warranted). After each season, growers were surveyed as to compliance with suggested practices, varieties used, development and occurrence of bacterial canker, and overall impressions regarding efforts at managing bacterial canker.

### **F. Progress**

The four primary objectives of this project included a) educating cooperating grower's on how to incorporate seed heat treatment into their production methods, b) heat treatment of tomato seeds eliminated the occurrence of early-onset, yield limiting incidents of bacterial canker on participating farms, leading growers to enthusiastically embrace this practice; c) growers are now (as per comments throughout this project) acutely aware of the need for eliminating primary inoculum sources, and the how sanitary practices (including field selection and management) contribute to the persistence of the bacterial canker organism; d) and finally, through participation in this project, seed treatment demonstrations, grower meetings, newsletters and grower-to-grower contact, growers have received information regarding bacterial canker management.

### **G. Results**

Growers were asked to incorporate seed heat treatment into their management scheme and were provided a set of suggested strategies for minimizing spread of bacterial pathogens. Moreover, where transplants were grown by contract, these were monitored for disease occurrence after leaving transplant the transplant production facility. Finally, growers were surveyed as to compliance with the suggested set of strategies. The

information gathered through these activities indicated that plants were disease free at the point of transplant production. Further, no correlation occurred between variety and appearance of bacterial canker in the field. Finally, the wide disparity among growers regarding use of “anti-spread” practices did not appear to impact the appearance of bacterial canker. The late onset of symptoms and minimal impact of bacterial canker among growers whose plants became infected, combined with the pattern of infection in plants from the same production facility going to separate field sites indicates strongly that the main inoculum source (once seeds have been cleaned through heat treatment) is the field. It is likely that crop and field rotations is not adequate either spatially, temporally, or possibly through the presence of a weed host, to completely avoid bacterial canker.

Grower enthusiasm for and acceptance of heat treatment of seeds is now widespread in New Jersey. As a result of this project and similar earlier work done by the Rutgers Cooperative Extension Vegetable IPM Program, many growers in northern New Jersey bring in seeds for heat treatment at the RCE Snyder Research and Extension Farm facility. Furthermore, one contract grower of transplants, and one seed services contractor in New Jersey have established heat treatment facilities because of demonstrated positive impacts of that practice.

The use of *Mirabilis jalapa* as a quicker assay for *Cmm* detection was successful. Although this assay still required the time consuming (7-10 day) culture of the organism, it returned results within 48 hrs. of inoculation where inoculations with tomato plants might take 4-6 weeks. An additional benefit of the *M. jalapa* assay is that pure cultures are not required. *M. jalapa* assays were used to identify *Cmm* from the roots of the common perennial weed *Solanum carolinense* (horsenettle). This unexpected result shows that *S. carolinense* may be a perennial carrier of the pathogen. Initial attempts at detecting *Cmm* from cultures derived from tomato debris using bio-PCR methods were inconsistent because the cultures could not be adequately cleaned of contaminants.

## H. Impacts

A. Participating growers all have been supportive and enthusiastic about the progress resulting from the project. As more growers became aware of this project, the result was increased adoption of heat treatment of tomato seeds for the elimination of bacterial canker (and other bacterial pathogens). The method utilized is that described by Dr. Sally Miller of the Ohio State University. Not only are growers (9 farms in 2008) seeking to use the RCE seed treatment facility, but many others are now choosing to purchase transplants from a contractor that now practices heat treatment. This contractor (Piazza Farms and Greenhouses, a participant in this project) purchased hot-water baths and followed the procedure used in this project. In 2008, Piazza Farms and Greenhouses heat treated seed for 10 northern New Jersey tomato growers. Many more growers are now turning to Eastern Seed Services LLC. of Pilesgrove, New Jersey for heat treatment of tomato seed. In 2008, Eastern Seed Services heat treated seed for **69 growers** from around New Jersey. This practice eliminates seed as the primary inoculum source, and as such helps to prevent early-onset, systemic infections. This in turn, prevents significant economic loss to the grower and helps reduce the need for constant anti-bacterial agent

applications to the crop. This project has resulted in a strong working relationship between the RCE Vegetable IPM Program and Eastern Seed Services, whereby RCE staff demonstrate seed treatment techniques and encourage growers to utilize Eastern Seed for those services. Additional practices that are now standard for most growers include chlorine soaking of stakes, chemical cleansing (with chlorine, or hydrogen dioxide) of greenhouse surfaces.

Educational meetings during the course of this project included three northern New Jersey vegetable growers meetings, three tomato industry advisory meetings, one regional growers meeting held in Pennsylvania, and one seed treatment workshop. In total, these meetings were attended by approximately 340 growers, industry representatives and research personnel. An informational brochure entitled “Bacterial Canker of Tomato – Background and Management Strategies”, was produced and will be distributed to New Jersey county offices to make available to growers.

This project has shown a need for even quicker diagnosis of bacterial canker from weed and tomato tissue. Further, knowledge of *Cmm* strain differences from year to year and among farms would be extremely useful in determining ultimately the origin of the infections. Both needs may be met with PCR techniques. In 2008, the Rutgers Agricultural Research and Extension Center in Bridgeton, NJ acquired a real-time PCR unit, and under the supervision of Dr. C. Andrew Wyenandt, RCE staff will begin examining fresh samples from tomato plants and horsenettle.