

**TRAINING THE TRAINERS: EXPANDING THE USE OF SEED HEAT TREATMENT FOR  
MANAGEMENT OF BACTERIAL DISEASES OF TOMATO AND OTHER VEGETABLE CROPS IN  
THE MID-ATLANTIC AND SURROUNDING REGION.**

**Co-PI's**

Andy Wyenandt and Kris Holmstrom – Rutgers University

**Co-Investigators**

Margaret McGrath – Cornell University

Beth Gugino – Penn State University

Kate Everts – University of Maryland

Robert Mulrooney – University of Delaware

Steven Rideout – Virginia Tech

**Project type: Extension**

**Summary**

This is a multi-region, Extension project seeking total funds of \$69,917. This project will help promote effective bacterial disease management strategies for tomato and other vegetable crops which will lead to better industry practices in the mid-Atlantic region. The goals of this project are to educate and train vegetable growers, extension personnel, and seedsmen about the procedures and benefits of using hot water seed treatment for managing bacterial diseases of tomato and other vegetables. The Priority Pests identified by the Northeast Vegetable IPM Working Group in 2007 included bacterial pathogens of tomato and pepper, which remained on the list when up-dated in 2009. This project includes the expanded adoption of IPM (Part 4A) by serving the needs of small or isolated farm operations and/or highly diversified farms where monitoring services are not available. With the goal of growers being able to accomplish IPM independently, by placing an emphasis on preventative practices and encouraging application of IPM methods enhancing the success of organic farming systems, this project will address priority needs for the region (Part 4C). Another priority set by the region is to support professional training and communication across the region for agricultural professionals in vegetable IPM (Part 8). Extension personnel will gain the knowledge needed to establish their own heat-seed treatment programs and to train vegetable growers on how to properly heat treat seeds and educate these growers about all IPM practices that can be used in their farms, reducing bacterial diseases of tomato and other important vegetable crops.

**TRAINING THE TRAINERS: EXPANDING THE USE OF SEED HEAT TREATMENT FOR  
MANAGEMENT OF BACTERIAL DISEASES OF TOMATO AND OTHER VEGETABLE CROPS IN THE  
MID-ATLANTIC AND SURROUNDING REGION.**

**Co-PI's**

Andy Wyenandt and Kris Holmstrom – Rutgers University

**Co-Investigators**

Margaret McGrath – Cornell University

Beth Gugino – Penn State University

Kate Everts – University of Maryland

Robert Mulrooney – University of Delaware

Steven Rideout – Virginia Tech

**Problem, Background, Justification**

**Problem:**

Bacterial canker, caused by *Clavibacter michiganensis* subsp. *michiganensis* (*Cmm*), bacterial speck caused by *Pseudomonas syringae* pv. *tomato* and bacterial spot caused by *Xanthomonas campestris* pv. *tomato* are serious diseases of fresh-market tomatoes in the Northeast (Hock, 1999, Hazzard, 2006, McGrath, personal communication). The three largest tomato producing states in the Northeast (NJ, NY and PA) harvest over 8500 acres of fresh market tomatoes annually with a value of over 75 million dollars (NASS). Additionally, the eastern shore of Virginia harvested approximately 5,000 A of fresh-market tomatoes in 2008. Much of the fresh market tomato crop in the mid-Atlantic and NE region is sold locally and is an important crop sold in farmers markets, as well as, local grocery stores. Within the past decade, the incidence of bacterial diseases of tomato including bacterial canker, spot and speck have increased throughout the region. Importantly, the current management practices for the control of bacterial diseases in tomato, especially canker, have not been effective, or are completely absent, in some regions of the Northeast. For many tomato growers in the region, bacterial canker, spot and/or speck are the most serious economic diseases in fresh-market tomato production. Losses to bacterial canker can vary from minimal foliar injury to total systemic infections and are dependent on source of the infection, weather conditions, and cultural and disease management practices. Late season infections of developing fruit by bacterial spot can also lead to serious losses due to unmarketable fruit. For example, prior to 2006, many roadside market tomato growers in central and northern New Jersey experienced some losses due to fruit infection by bacterial canker and spot, while a number of growers experienced losses of entire plantings to systemic bacterial canker infections. All of these diseases also cause premature death of leaves, which reduces fruit flavor, leaves fruit vulnerable to sunscald, and negatively impacts other aspects of fruit quality.

Seed-borne pathogens like bacterial speck, spot and canker generally can be an even greater concern for organic growers. Organic growers must use non-chemically treated seed. Importantly, organic seed is often saved or purchased from small companies that do not have the

resources to test their seed for important seed-borne pathogens. In addition to the bacterial diseases that are the focus of this proposed project, other important diseases can occur on organic farms such as bacterial spot of pepper, black rot of crucifers, Septoria leaf spot of tomato, and Alternaria leaf spot of carrot. For these reasons, an effective and economically feasible method for reducing potential seed-borne pathogens in organic vegetable production is greatly needed by the organic industry in the mid-Atlantic and Northeast regions.

### **Background:**

This project will address specific needs identified by the Northeast IPM Vegetable Working Group. One of the pest priorities identified is bacterial pathogens of tomato and pepper. The priority needs addressed include i) expanded adoption of IPM through addressing the unique needs of all types of vegetable growers including ii) small or isolated operations and/or highly diversified farms and organic farms and iii) support of training and communication across the region for agricultural professionals in vegetable IPM. Conducting research and outreach on alternative cultural and biological pest control strategies was funding priority 3 from the Northeastern IPM Center PMAP Program in 2007. Additionally, non-chemical pest management was identified as a high priority vegetable research need by the New York IPM Program in 2007. In 2008, bacterial canker and spot prevention and management were listed as a high priority research need by the Pennsylvania Vegetable Marketing and Research Program and the Pennsylvania Vegetable Growers Association. The Tomato Crop Profile for New Jersey lists bacterial canker as a major disease pest (Walker and Kline, 2007). In Pennsylvania, although bacterial spot is listed as one of the most important diseases in the most recent Tomato Crop Profile in 1999, when growers were asked which tomato disease is of most concern annually; bacterial canker was cited (B. Gugino, *personal communication*).

### **Ongoing and Completed Work:**

Increased research on bacterial canker followed a serious bacterial canker epidemic in the mid-western states in the 1980's. Much of this work was reviewed by Gleason (1993), and included advances in pathogen detection, isolation and epidemiology. An understanding of the origin of infection is critically important for managing bacterial disease, and a focus of research has been on seed as the source of primary inoculum, with various seed treatments evaluated for control of *Cmm*. (Fatmi et al., 1991; Xu, et.al., 2009). Consistently, research has shown that hot water treatment of tomato seed has been one of the most effective treatments for minimizing bacterial canker infections while maintaining acceptable seed germination rates. Recognizing the value of this practice, Dr. Sally Miller of the Ohio State University produced an extension publication (OSUE Fact Sheet HYG-3120-96) detailing procedures for heat treating vegetable seed to eradicate pathogens on and within seeds.

In 2005, Rutgers Cooperative Extension (RCE) IPM Program staff established a seed heat treatment facility (using a similar apparatus and following the protocol developed by S. Miller) at the Snyder Research and Extension Farm in Pittstown, Hunterdon County, NJ. With funding from the Northeast IPM Program in 2006 and 2007, heat seed treatment was expanded to include more New Jersey vegetable growers, as well as, further studies into grower practices that were contributing to difficulties controlling bacterial canker. Since 2007, use of seed heat treatment in New Jersey has increased from 19 growers either treating their own seed, contracting for seed heat treatment or purchasing transplants from producers using the practice to

approximately 90 farms that heat treated all or some portion of their seed either on their own, at the RCE facility, at RCE sponsored workshops, or had seeds heat treated by Eastern Seed Services (Pilesgrove, NJ). Thirty-three growers participated in the 2009 heat seed treatment workshops and RCE seed treatment sessions. The incidence of severe bacterial canker infections in New Jersey has been reduced following heat treatment of tomato seed; with central New Jersey growers who suffered severe losses in 2007 having no symptoms of the disease in 2008. For most growers, subsequent infections were less severe and did not cause economic losses after implementing heat seed treatment. Infections that did develop in NJ in 2008 were determined to be related to less than adequate crop rotations and possibly the presence of alternate weed hosts for the pathogen, such as horsenettle (*Solanum carolinense*), present in some tomato fields. Overall, activities in New Jersey funded by the Northeastern IPM Center in 2006-7 demonstrated that grower ability to comply with a number of hygienic practices designed to limit spread of bacterial pathogens on tomato plants was highly variable. Despite this, the occurrence and severity of bacterial canker symptoms on participating tomato farms has been consistently reduced following heat treatment of seeds. Intensive sampling and field surveys of tomato farms link existing, largely sub-economic bacterial canker infections with field sources of inoculum resulting from inadequate rotation and possibly poor control of the solanaceous weed horsenettle (*Solanum carolinense*) which has been implicated as an overwintering host. Results of this work indicated that heat treatment of seed was the single most important practice for limiting the occurrence and severity of bacterial canker (Holmstrom and Wyenandt, unpublished).

#### **Justification:**

Vegetable growers in the mid-Atlantic and surrounding region are the primary beneficiaries of this extension project. This project will also allow mid-Atlantic and surrounding extension personnel to better serve their constituents through the introduction and demonstration of a technique to add to their IPM toolbox to help control economically-important bacterial diseases of tomato. Presently, heat-treatment is not a common practice among seed producers due to its potential to reduce shelf-life of seed, and the heating and cooling regimen necessitating smaller batches of seed. Importantly, the same seed heat-treatment techniques used in this project on tomato seed can easily be expanded to help reduce potential seed-borne diseases on many different vegetable crops such as bacterial spot of pepper, downy mildew on various vegetable crops, and on black-rot of crucifer crops. The appropriate treatment time and temperature for killing pathogens without adversely affecting seed germination has already been determined for several vegetable crops in addition to tomato, including pepper, carrot and cruciferous crops.

Prior to the initiation of heat treatment, one grower in northern New Jersey calculated yield losses to be over 50%; and because he also produced tomato transplants for other growers, significant losses were experienced on other farms (Frank Piazza, Piazza Farms and Greenhouses, Phillipsburg, N.J., *personal communication*). Crop failures in brussels sprouts and 10-15% loss in tomatoes have been eliminated following seed heat-treatment in Milford, NJ (Marc Phillips, Hunterdon Co., NJ, *personal communication*). Losses in 2007 of over 30% were sustained by John Samaha (Holmdel, Monmouth Co., NJ, *personal communication*) on a field with no history of infestation. The tomato crop at this farm was free of bacterial pathogens in 2008 following heat treatment of the seeds and rotation to a field with no history of the pathogen.

In New York, bacterial canker has become one of the most important diseases of tomatoes (McGrath, 2000). Infections in New York are reported to be more localized, with some growers consistently affected. On these farms, 20-30% loss is common (J. Mishanec, *personal communication*). Often, infested seed is cited as the inoculum source (Chang et al., 1992; Fatmi, 1991; Jones et al., 1997; MacNab, 2004), although field sources have also been noted (MacNab, 2004), and recent work in New Jersey indicates that both seed and field sources are important (Holmstrom, et. al. 2008).

Demonstrations of seed heat treatment from 2007 to 2010 for managing bacterial canker have been well attended and enthusiastically received by tomato growers in New Jersey. Growers who have utilized the RCE facility continue to do so. Other growers have begun purchasing transplants from producers who heat treat seeds. Many growers who have learned about the practice have requested heat seed treatment by an independent seed services provider in New Jersey (Eastern Seed Services, Pilesgrove, NJ (Joseph Musumeci – proprietor, *personal communication*). Results of this practice have been positive and obvious within the current season. Having been widely accepted in NJ, this practice should be demonstrated regionally to the benefit of tomato growers (organic and conventional), extension personnel and seedsmen in the Northeast.

### **Objectives and Anticipated Impacts:**

1. Demonstrate and promote via ‘train-the-trainer’ workshops the technique of seed heat treatment for managing important bacterial diseases of tomato and other vegetable crops to extension personnel, crop advisors, seedsmen and organic and conventional vegetable growers in the mid-Atlantic and surrounding region.
2. Promote IPM techniques for managing bacterial diseases in vegetable crops.

### **Anticipated Impacts**

For extension personnel who have agreed to participate in this project, the following impacts are anticipated:

1. Extension personnel will be trained ‘hands-on’ on how to heat treat seeds through day-long workshops at their own facilities.
2. Extension personnel will have the ability to set up their own heat-seed treatment facilities and train tomato growers on how properly to heat treat seeds and train growers on IPM practices that can be used in their own farm operations to help reduce bacterial diseases of tomato and other vegetable crops.
3. Extension personnel will hold future workshops to i) train tomato growers in their region on the importance of controlling bacterial diseases of tomato, ii) train growers on how to heat treat seed and iii) have facilities and times available where growers in their region can have the option to heat treat their own vegetable seeds.

For growers who have agreed to participate in this project, the following impacts are anticipated:

1. Growers will gain increased knowledge and understanding of IPM techniques for managing seed-borne bacterial diseases of tomato and other vegetable crops; thus expanding their IPM toolbox.
2. Reduced occurrence and/or severity of symptoms will occur and translate into increased implementation of improved IPM practices by a wider group of vegetable growers in years following this extension project. Extension personnel (and vegetable growers) will gain the knowledge needed to set up their own heat treatment programs and will be able to train others in IPM tactics needed for reducing bacterial diseases in tomato and other vegetable crops.

**Upon completion of the project, the following impacts are anticipated:**

Extension personnel participating in this model project will be able to train other extension agents, seedsmen and vegetable growers in their state and region on how to use seed heat treatment to help control economically-important bacterial diseases in tomato and other vegetable crops. This will increase their ability to serve their grower constituency by demonstrating the practice growers to by providing facilities with which to continue heat treating seed. The participating extension personnel will help in the development and dissemination of IPM related information to the vegetable production community and other extension support personnel, resulting in the greater understanding and implementation of IPM tactics for management of bacterial diseases of tomato.

Tomato growers participating in this project will be introduced to the valuable IPM practice of seed heat treatment, and will be able to use the techniques and knowledge acquired in this project to help reduce potential bacterial problems in their farm operations. Further, they will have access to seed heat treatment equipment after the end of the project. Continued grower use of these facilities, as well as the adoption of heat-treatment by commercial-scale transplant producers, as has happened in NJ, is anticipated as a result of this project. The overall reduction of bacterial pathogens both in incidence and severity is anticipated.

**Approach and Procedures:**

Objective 1. *Demonstrate the importance of incorporating seed heat-treatment into an integrated management plan for bacterial diseases of tomato to extension personnel and tomato growers.*

In the winter of 2011/ 2012, project participants will hold 3 workshops in NJ, 2 workshops in southeastern, and 1 in western PA, 1 workshop in western NY, 1 workshop in eastern NY, and 1 workshop in Long Island, NY, 3 workshops in MD, 1 workshop in DE, and 3 workshops in VA to demonstrate to the cooperators the equipment needed to heat treat seeds, as well as, hold a day-long workshop for a group of selected tomato growers in the region. Topics to be covered during the workshop include: seed heat treatment and its' rationale; practices that limit development and spread of bacterial pathogens in transplant production; practices that limit spread of bacterial pathogens in the field; an overview of the epidemiology of bacterial

pathogens of tomato. A formal questionnaire (Appendix A) will be given to all participating growers so that they may detail difficulties with bacterial pathogens on their farms, as well as the economic impact of resulting infections and what steps they have taken to limit damage in the past. Growers will have an opportunity to treat their seed during the workshop. At the first heat treatment workshops in 2011/2012, growers will be provided with information detailing integrated management strategies for controlling bacterial pathogens. Grant money will be used to purchase 2 sets of seed heat treatment equipment for PA, 5 sets of equipment for NY, 2 sets for DE, 3 sets for MD, 2 sets for VA and 1 additional set for NJ in the fall of 2011 for use by each state in the late winter 2011 and early spring of 2012.

Objective 2. *Promote an integrated plan for managing bacterial diseases of tomato.*

In the fall of 2012 and winters of 2012 and 2013, extension personnel from all six states will use the equipment purchased and hold workshops open for all growers in their respective regions on how to heat treat seeds. A regional brochure entitled “Bacterial Canker of Tomato: Background and Management Strategies” will be distributed to all grower cooperators. Extension collaborators will document numbers of workshop participants and conduct follow-up surveys so grower participants can document the results of implementation as well as their acceptance of the IPM practices. In particular, participants will be asked whether or not they implemented individual aspects of the plan, as well as the ease of implementation of each practice. Specifics regarding the timing, severity and nature of bacterial disease symptoms (if any) will be obtained from participants in these surveys as well. In late 2013, results will be collected from all PI’s. Records of compliance, with expected reductions in incidence and severity of bacterial disease will be used to encourage continued and expanded use of the techniques throughout the region. Results will be compiled and reported at grower meetings and online at the NJAES Vegetable Crops Online Resource Center.

**Timeline:**

<b>Year 1 - 2011-2012 Objective 1</b>	<b>Tasks</b>
Demonstrate and promote technique of seed heat treatment for managing important bacterial diseases of tomato and other vegetable crops.	Purchase heat-treating equipment for participants in Fall 2011. Hold heat seed treatment 'train-the-trainer' workshops in PA, DE, MD, VA, NJ and NY for project collaborators
<b>Winter 2011-2012 Objective 2</b>	
Promote IPM techniques for managing bacterial diseases in vegetable crops.	Distribute updated IPM guidelines for management of bacterial diseases in tomato. Administer surveys to participating growers.
<b>Year 2 – Fall 2012/Winter 2012/2013 Objective 1</b>	
Demonstrate and promote technique of seed heat treatment for managing important bacterial diseases of tomato and other vegetable crops.	Project collaborators hold heat seed treatment workshops in PA, NJ and NY, DE, MD, and VA for tomato growers.
<b>Fall 2012/Winter 2012/2013 Objective 2</b>	
Promote IPM techniques for managing bacterial diseases in vegetable crops.	Distribute updated IPM guidelines for management of bacterial diseases in tomato. Administer surveys to new participants.
<b>Summer/Fall 2013 Objective 2</b>	
Promote IPM techniques for managing bacterial diseases in vegetable crops.	Conduct final surveys for participating growers to assess disease control, and opinions as to usefulness of the program and grower intent regarding continuation of practices.
<b>Fall/Winter 2013 Objective 2</b>	
Promote IPM techniques for managing bacterial diseases in vegetable crops.	Post results of project and related surveys online and report at regional and local grower meetings.

**Evaluation Plan:**

Success in achieving Objective 1 (year 1) will be based on completion of training sessions with extension collaborators, seedsmen and tomato growers, as well as distribution of reference material to participants and receipt of completed questionnaires regarding grower practices and history of bacterial infections. Objective 1 (year 2) will be successfully met by project participants conducting training/demonstration workshops for expanded client groups within their areas of operation. Successfully meeting Objective 2 (year 1) of the project will be based on the distribution of IPM guidelines for bacterial disease management in tomatoes and other crops, as well as the completion of grower surveys regarding on farm disease history.

Wider grower acceptance of integrated tactics for managing important bacterial diseases in year 2 of the project (Objective 2) will be contingent on the program resulting in increased use

of the technique. Grower acceptance and increased use will follow positive impacts on bacterial disease control. While this outcome is expected, growers must comply with as many features in the program as possible, with compliance documented and disease occurrence (if any) documented and categorized as to its' nature (primary, systemic infection versus secondary). Success of the program will be determined by the number of participating growers experiencing improvement in disease management and committing to continued adherence to the IPM plan (see attached logic model – condition change). In addition to extension personnel evaluating the efficacy of bacterial canker management, initial participating growers will be asked to evaluate the management regime both for efficacy and ease of implementation. At the termination of the project, all participating growers will be asked to identify which practices they will maintain as part of their regular management program.

Education of growers and related industry personnel and promotion of an integrated management plan for bacterial disease control of tomatoes will occur via mass distribution of any developed informational materials to tomato growers upon successful completion of the project. Results of the project will also be disseminated through reports at local and regional grower meetings. Numbers of individuals receiving printed and presented information will be documented and included in Extension Vegetable IPM Program annual reports. The NJAES Vegetable Crops Online Resource Center (<http://njveg.rutgers.edu/>) will be an internet based clearinghouse for all information developed through the project. Site usage data will be documented and made available via Rutgers Cooperative Research and Extension Vegetable IPM Program annual reports. County agricultural agents, crop consultants and members of the vegetable community will receive educational material developed as a result of this project and training at meetings as well as at seasonal twilight meetings when appropriate. This information will ultimately result in effective bacterial management strategies becoming standard industry practices in the participating states, with the anticipation that they will also be adopted regionally.

## **KEY PERSONNEL:**

### **CO-PROJECT INVESTIGATORS**

#### **Andy Wyenandt, Extension Specialist in Vegetable Pathology, New Jersey Agricultural Experiment Station, Rutgers University**

Dr. Wyenandt will act as co-project coordinator and state coordinator for NJ. Dr. Wyenandt will work closely with Mr. Holmstrom and Mr. Ingerson-Mahar to set-up and hold heat seed treatment workshops in cooperating states and participate in all objectives of the project.

#### **Kristian Holmstrom, Vegetable IPM, Research Coordinator II, New Jersey Agricultural Experiment Station, Rutgers University**

Mr. Holmstrom will act as co-project coordinator for NJ. Mr. Holmstrom will work closely with Dr. Wyenandt and Mr. Ingerson-Mahar to set-up and hold heat seed treatment workshops in cooperating states and participate in all objectives of the project.

### **PROJECT CO-INVESTIGATORS :**

#### **Margaret T. McGrath, Department of Plant Pathology, Long Island Horticultural Research & Extension Center, Cornell University**

Dr. McGrath will act as a state coordinator for the project for NY. Dr. McGrath will work closely with Mr. Robert Hadad, and Mr. Charles Bornt to set-up and hold heat seed treatment workshops and participate in all objectives of the project.

#### **Beth Gugino, Department of Plant Pathology, Penn State University**

Dr. Gugino will act as a state coordinator for the project for PA. Dr. Gugino will work closely with Mr. Bogash to set-up and hold heat seed treatment workshops and participate in all objectives of project.

#### **Bob Mulrooney, University of Delaware**

Dr. Mulrooney will act as a state coordinator for the project for DE. Dr. Mulrooney will work closely with Mr. Gordon Johnston and fellow colleagues in DE to set-up and hold heat seed treatment workshops and participate in all objectives of project.

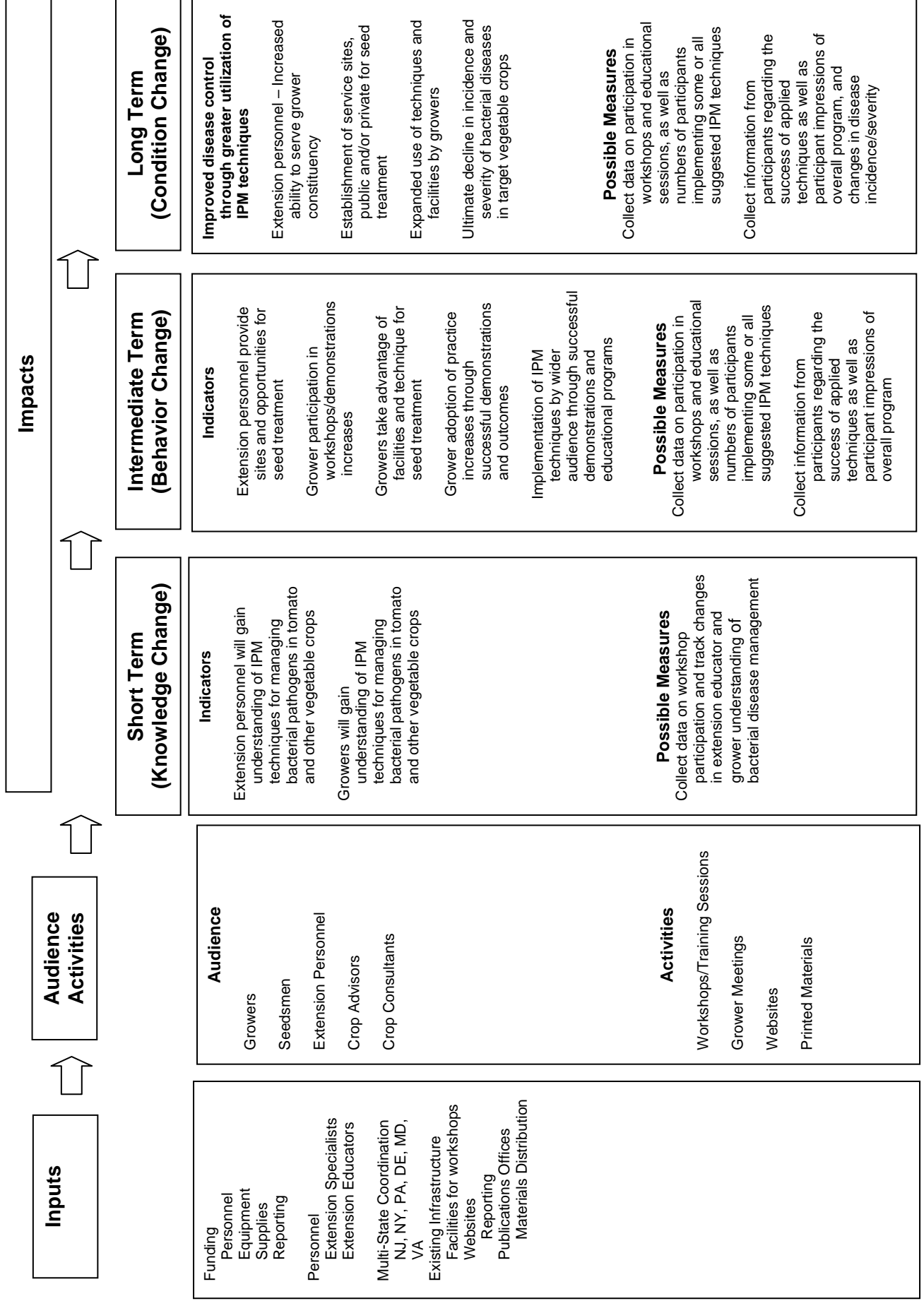
#### **Kate Everts – University of Maryland**

Dr. Everts will act as a state coordinator for the project for MD. Dr. Everts will work closely with fellow colleagues to set-up and hold heat seed treatment workshops and participate in all objectives of project.

#### **Steven Rideout – Virginia Tech**

Dr. Rideout will act as a state coordinator for the project in VA. Dr. Rideout will work closely with fellow colleagues in VA to set-up and hold heat seed treatment workshops and participate in all objectives of project.

**Focus Area: Production Agriculture**  
**Impact Area: Implementation and Adoption of IPM Techniques**  
**Roadmap Goal: Improve Pest Management through Demonstration of IPM Techniques**



## Literature Cited

1. Chang, R.J., Ries, S.M., and Pataky, J.K. Local Sources of *Clavibacter michiganensis* ssp. *michiganensis* in the Development of Bacterial Canker on Tomatoes. *Phytopathology*. 82:553-560. 1992.
2. Fatmi, M., Schaad, N.W., and Bolkan, H.A. Seed Treatments for Eradicating *Clavibacter michiganensis* subsp. *michiganensis* from Naturally Infected Tomato Seeds. *Plant Disease*. 75:383-385. 1991.
3. Gleason, M.G., Gitaitis, R.D., and Ricker, M.D. Recent Progress in Understanding and Controlling Bacterial Canker of Tomato in Eastern North America. *Plant Dis.* 77(11):1069-1076. 1993.
4. Hazzard, R.V., Wick, R.L., and Dicklow, M.B. Managing Bacterial Canker: Key Strategies. UMass Ext. [http://www.umassvegetable.org/soil\\_crop\\_pest\\_mgt/disease\\_mgt/tomato\\_clavibacter\\_canker.html](http://www.umassvegetable.org/soil_crop_pest_mgt/disease_mgt/tomato_clavibacter_canker.html) 2006.
5. Hock, W., and Hoffman, W. Crop Profile for Tomatoes in Pennsylvania. <http://northeastipm.org/cpdisplay.cfm?filename=patomatoes> 2001.
6. Holmstrom, K.E, Wyenandt, C.A., and Ingerson-Mahar, J. 2008. Development and Dissemination of an Integrated Management Plan for Bacterial Canker of Tomato <http://www.njveg.rutgers.edu/assets/pdfs/cp/Summary-BacterialCankerResearch-NewJersey.pdf>
7. Jones, J.B., Jones, J.P., Stall, R.E., and Zitter, T.A. eds. *Compendium of Tomato Diseases*. APS Press, St. Paul, Minn. 1997.
8. MacNab, A. Tomato Bacterial Canker (Some Reference Material). <http://vegdis.cas.psu.edu/03Diseases/D105.htm> 2004.
9. McGrath, M.D., Moyer, D.D., Erb, W.A., and Blomgren, T. Occurrence and Management of Tomato Canker. <http://www.nysipm.cornell.edu/grantspgm/projects/proj00/veg/mcgrath1.html> 2000.
10. Miller, S.A., Lewis Ivey, M.L. Hot water and chlorine treatment of vegetable seeds to eradicate bacterial plant pathogens. HYG-3085-05. <http://ohioline.osu.edu/hyg-fact/3000/pdf/3085.pdf>
11. National Agricultural Statistics Service (NASS). State Commercial Vegetable Production Statistics. <http://www.nass.usda.gov/> 2002-3.
12. Walker, S.D., Kline, W.L. Crop Profile for Tomatoes in New Jersey <http://www.ipmcenters.org/cropprofiles/docs/NJtomatoes.pdf> 2007.

13. Welsch, A. Crop Profile for Tomatoes in Maryland.  
<http://northeastipm.org/cpdisplay.cfm?filename=Mdtomatoes> 1999.
14. Xu, X., Bennett, M., and Miller, S.A. Evaluation of Seed Treatments to Prevent Bacterial Canker in Greenhouse Tomatoes. Poster presented at 2009 APS Nat'l Mtg. Portland, OR, 8/1-9/09.

## **RELEVANCE STATEMENT**

### **Co-PIs:**

Andy Wyenandt, Rutgers University  
Kris Holmstrom, Rutgers University

### **CO-INVESTIGATORS:**

Margaret McGrath - Cornell University  
Beth Gugino - Penn State University  
Kate Everts – University of Maryland  
Robert Mulrooney – University of Delaware  
Steven Rideout – Virginia Tech

## **TRAINING THE TRAINERS: EXPANDING THE USE OF SEED HEAT TREATMENT FOR MANAGEMENT OF BACTERIAL DISEASES OF TOMATO AND OTHER VEGETABLE CROPS IN THE MID-ATLANTIC AND SURROUNDING REGION**

### **PROJECT TYPE:** Extension

This extension project will address specific needs identified by the Northeast IPM Vegetable Working Group. In 2007, one of the priorities included bacterial pathogens of tomato and pepper. The priority needs addressed included the following: Expanded adoption of IPM, part 4A - serving needs of small or isolated operations and highly diversified farms where monitoring services are not available, with the goal of growers being able to accomplish IPM independently, and placing emphasis on preventative practices; and part 4C - encourage application of IPM methods to enhance the success of organic farming systems. Part 5 - conduct research on how to promote plant health and suppress insect, disease and weed problems through cultural and biological production practices. Part 8 - support professional training and communication across the region for agricultural professionals in vegetable IPM.

This project will allow Northeast and Mid-Atlantic extension personnel to introduce and demonstrate the technique of heat treatment of vegetable seed to growers to help control important bacterial diseases, especially those affecting tomato. Heat treatment of seed will have broad scale appeal to all vegetable growers in the region and allow them to add a value technique to their IPM toolbox to help control economically-important bacterial diseases vegetable crops.

Extension personnel participating in this project will be able to train other extension agents and tomato growers in their state and region on how to use heat seed treatment to help control bacterial diseases of tomatoes and other vegetable crops. The participating extension personnel will help in the development and dissemination of IPM related information to the vegetable community and other extension support personnel resulting in the greater understanding and implementation of IPM tactics for management of bacterial diseases of vegetable crops.

Vegetable growers participating in this model project will be introduced to the valuable IPM practice of seed heat treatment, and will be able to use the techniques and

knowledge acquired in this project to help reduce potential bacterial problems in their farm operations.

The training and educating of growers and related industry personnel on the importance of an integrated management plan for bacterial disease control in the NE will occur. Additionally, vegetable growers, county agricultural agents, seedsmen and crop consultants will have access to training and educational material developed as a result of this project. This project will help develop and promote effective bacterial management strategies in tomato and other vegetable crops and become standard industry practices in the Northeast.

#### **PROBLEM, BACKGROUND, JUSTIFICATION:**

Bacterial canker, caused by *Clavibacter michiganensis* subsp. *michiganensis* (*Cmm*), bacterial speck caused by *Pseudomonas syringae* pv. *tomato*, and bacterial spot caused by *Xanthomonas campestris* pv. *tomato* are serious diseases of fresh-market tomatoes in the Northeast (Hock, Hazzard, McGrath, personal communication). The three largest tomato producing states in the Northeast (NJ, NY, and PA) harvest over 8500 acres of fresh market tomatoes with a value of over 75 million dollars (NASS). Within the past decade, the incidence of bacterial diseases including bacterial canker, spot and speck have increased throughout the northeast region. Importantly, the current management practices for the control of bacterial diseases in tomato have not been effective, or are completely absent, in some regions of the Northeast. For many tomato growers in the region, bacterial canker, speck and/or spot are the most serious economic diseases in fresh-market tomato production. Growers in the region have experienced economic crop losses ranging from 15-50% in recent years, with transplant producers, in some circumstances, passing on infections to purchasing growers.

Over the past 5 years, Rutgers Extension faculty and staff have worked to develop protocols for managing bacterial canker on New Jersey tomato farms. Two years (2006-7) of this work were funded by the Northeastern IPM Center. These activities in New Jersey demonstrated that grower ability to comply with a number of hygienic practices designed to limit spread of bacterial pathogens on tomato plants was highly variable. Despite this, the occurrence and severity of bacterial canker symptoms on participating tomato farms has been consistently reduced following heat treatment of seeds. Intensive sampling and field surveys of tomato farms link existing, largely sub-economic bacterial canker infections with field sources of inoculum resulting from inadequate rotation and possibly poor control of the solanaceous weed horsenettle (*Solanum carolinense*) which has been implicated as an overwintering host. Results of this work indicated that heat treatment of seed was the single most important practice for limiting the occurrence and severity of bacterial canker in New Jersey (Holmstrom and Wyenandt, unpublished).

Because seeds are a recognized source for bacterial infections, seed companies frequently sell seed treated with anti-bacterial agents as well as fungicidal compounds. Presently, heat-treatment is not a common practice among seed producers due to its potential to reduce shelf-life of seed, and the heating and cooling regimen necessitating smaller batches of seed. Chemical seed treatments (ie. calcium hypochlorite, etc.) do not eradicate bacterial pathogens such as *Cmm* from seed because seed produced from systemically infected plants can contain the pathogen within the seed coat. Further,

chemical seed treatments are not acceptable in organic production systems. Thus, heat seed treatment fills a gap where chemical control is ineffective or unavailable as in the case of organic growers. Tomato growers faced with the likelihood of bacterial infection, rely heavily on the use of anti-bacterial agents in the field. Many growers, without proven alternative management solutions, resort to repeated field applications of copper hydroxide, hydrogen dioxide (OxiDate), or systemic acquired resistance inducing products (ie. Actigard, Messenger) to limit field infections. Although chemical control in the field is generally considered to be of limited value, growers have struggled to find effective means of control. Chemical control in the field is often considered to be of limited value, especially when started after disease onset, under very favorable (rainy) conditions, or when copper-resistant pathogen strains are present; thus growers have struggled to obtain effective means of control in recent years.

### **PROJECT OBJECTIVES AND ANTICIPATED OUTCOMES:**

Northeast and Mid-Atlantic region vegetable growers are the beneficiary of this extension project. This project will also allow NE extension personnel to better serve their constituents in one to two years through the introduction and demonstration of a new technique which can be added to their IPM toolbox to help control economically-important bacterial diseases of tomato. Not only is heat seed treatment effective for controlling bacterial diseases of tomatoes, but also effective for a multitude of other important seed-borne pathogens on many different vegetable crops, such as bacterial spot of pepper, downy mildew on various vegetable crops, black-rot and other bacterial infections of crucifers for which numerous applications of copper are made. This technique can easily be expanded for use in these other vegetable production systems, thereby reducing production costs and limiting economic losses associated with bacterial infections. Demonstrations of seed heat treatment from 2007 to 2010 for managing bacterial canker and other diseases have been well attended and enthusiastically received by tomato growers in New Jersey. Growers who have utilized the RCE facility continue to do so. Other growers have begun purchasing transplants from producers who heat treat seeds. Many growers who have learned about the practice have requested heat seed treatment by an independent seed services provider in New Jersey (Eastern Seed Services, Pilesgrove, NJ (Joseph Musumeci – proprietor, personal communication). Results of this practice have been positive and obvious within the current season. Having been widely accepted in NJ, this practice should be demonstrated regionally to the benefit of vegetable growers (organic and otherwise), extension personnel and seedsmen in the Northeast and Mid-Atlantic regions.

**Focus Area: Production Agriculture**  
**Impact Area: Implementation and Adoption of IPM Techniques**  
**Roadmap Goal: Improve Pest Management through Demonstration of IPM Techniques**

