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7. Title

Effect of Spring-Pruning Method, Copper Sprays and Training Systems on Bacterial Canker of Sweet Cherry

12. Investigator Name(s) (Last Name and Initials)

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20. Termination Date 09/30/2010	40. Period Covered (mo/da/year): 10/01/2007 TO 09/30/2010

Outputs:

Activities: Pruning techniques and bactericides (copper, COCS or Cuprofix Ultra at 4 lb/100 gal, phosphorous acid, Agri-Fos at 2.5 qt/100gal, applied in March and April, or no treatment) were evaluated in bacterial canker field experiments in replicate sweet cherry orchard blocks at the NYSAES, Geneva, NY and the Hudson Valley Lab, Highland, NY (2009 only; no bactericides). In 2008, trees were pruned and inoculated in April. In 2009 and 2010, another experiment was conducted with pruning and inoculation in March, April, May and post-harvest. Pruned branches averaged 3.5 cm diameter and cuts left a stub, average 20-cm-long. In 2008, flush cuts were compared to stub cuts in a separate experiment. Cut surfaces were inoculated with copper-sensitive Pseudomonas syringae pv. syringae (Pss) (10 to the 8th cfu/ml). In 2010, the impact of natural and induced freeze events on canker progression was examined. Canker progression was assessed during the growing season. In 2008, bacteria were re-isolated from inoculated cuts and Pss identified with biochemical and PCR assays. In 2008, the efficacy of phosphite or copper against leaf scar infections generated by inoculating branches at 80 percent leaf drop was tested and bud blast assessed. In the 2008-2009 dormant season, six sweet cherry orchard planting systems and five cultivars were assessed visually for incidence of cankers to rate relative susceptibility. Laboratory experiments with detached shoots and green cherry fruit were conducted to determine pre-infection and post-infection activity of labeled or specified rates of copper hydroxide (standard), phosphite, Pentra Bark, kasugamycin, biological MOI-106, biological yeast in proprietary buffer, oxytetracycline, urea, Bacillus subtilis, and hydrogen dioxide against Pss, compared to untreated. The isolate of Pss used for inoculum in the field experiments (Ps34 collected by Burr from sweet cherry, Wayne County, NY) was submitted for genome sequencing. Three naturally-occurring, streptomycin resistant isolates of Pss were recovered from apple buds in Geneva, NY. Events: A 2009 Sweet Cherry Field Meeting and a 2010 Summer Fruit Tour held at NYSAES, Geneva, NY featured our research, reaching over 240 sweet cherry growers, nurserymen, industry personnel, consultants, educators and faculty. Services: We ruled out bacterial canker outbreaks at three orchards and verified bacterial canker at three orchards. Products: Copper and phosphite are essentially ineffective against bacterial infections of pruning cuts, pruning stubs may effectively contain canker infections, and cankers progress least when pruning is done after harvest. Flamout and Kasumin show activity against Pss infection in sweet cherry. We have a collection of contigs for the Ps34 genome and a physical collection of 420 Pss isolates. Dissemination: Carroll provided research results to Cornell Cooperative Extension for summer and winter fruit schools for farmers and presented project results to scientists at the American Phytopathological Society, the Great Lakes Fruit Workers, and the Cumberland-Shenandoah Fruit Workers meetings.

Outcomes/Impacts:

We have developed knowledge that copper and phosphate provide little to no protection against bacterial infections of pruning cuts, that pruning stubs may effectively contain bacterial canker infections, that freeze events contribute to canker progression in shoots, and that cankers progress least in branch stubs pruned after harvest. The bactericide treatments only provided 0-22 percent control of canker progression in cuts. Flush cuts were as likely to become infected, but stub infections rarely progressed down into scaffolds or trunks. Canker progressed furthest in stubs pruned in March and least in those pruned after harvest. Pss was re-isolated from all inoculated stub and flush cuts. None of these Pss isolates were resistant to copper. In 2010, the impact of natural and induced freeze events on canker development showed that cold temperature increased canker progression but did not lead to severe blight on inoculated shoots. Although twice as many blasted buds (26 out of 300) were seen on inoculated branches as on uninoculated (13 out of 300), phosphite or copper treatments provided no control against leaf scar infections. We rated, in order of higher to lower canker incidence, the training systems Modified Central Leader, Spanish Bush, Vogel Slender Spindle, Vertical Axis, Marchant, and Perpendicular V, and the cultivars, in order of higher to lower canker incidence, Tehranivee, Hedelfingen, Regina, Lapins, and Sweetheart, though no statistical separation in the ratings was found. We were unable to draw definitive conclusions from the detached shoot tests of chemicals due to variability in results among the experiments. Results from the green cherry tests suggest that Flameout may have promise as an eradicant material to replace or augment the use of copper, whereas in the protectant tests no significant differences from the inoculated control (P 0.05, Tukey's HSD) were found for any of the materials tested. We have utilized a PCR approach to identify bacterial isolates. Either Pseudomonas syringae pv syringae or pv morsprunorum can cause bacterial canker. Results from PCR analysis confirmed only pv syringae in the collection of 420 P. syringae isolates recovered from the Geneva orchard. We verified that pv morsprunorum was associated with a deadly outbreak of bacterial canker in Ulster county on Schmidt sweet cherry, whereas pv syringae was recovered from an orchard in Monroe county with serious dead bud problems on several cultivars. We have started sequencing the PCR-amplified DNA from the pv syringae isolates to determine how closely they match the isolate Ps34, used for inoculum, in order to better understand the etiology and management of this disease. The main impact of our work will come through the de-emphasis of copper sprays in spring to manage this disease and the placement of greater emphasis on pruning after harvest and to leave a stub. This will prove beneficial in controlling the canker phase of the disease, reducing copper applications in cherry orchards, slowing the emergence of copper-resistant bacterial strains, and reducing copper build-up in orchard soils.

Publications:

Carroll, J.E., Robinson, T., Burr, T. Hoying, S., and Cox, K. 2010. Evaluation of pruning techniques and bactericides to manage bacterial canker of sweet cherry. NY Fruit Quarterly 18(1):9-15 http://www.nyshs.org/fq/10spring/evaluation-of-pruning-techniques-and-bactericides-to-manage-bacterial-canker-of-sweet-cherry.pdf

Carroll, J., Robinson, T., Burr, T., and Hoying, S. 2010. Effect of spring-pruning method, copper sprays and training systems on bacterial canker of sweet cherry. NYS IPM Program Project Report. http://nysipm.cornell.edu/grantspgm/projects/proj09/fruit/carroll5.pdf

Carroll, J., Hoying, S., Robinson, T., Burr, T., Cox, K., Bucien, T., Rugh, A. and Rosenberger, D. 2009. Evaluation of pruning techniques and bactericides for managing bacterial canker on sweet cherry. Proc. 85th Annual Cumberland-Shenandoah Fruit Workers Conference, pp 134-135.

Carroll, J., Hoying, S., Robinson, T., Burr, T., Cox, K., Bucien, T., Rugh, A. and Rosenberger, D. 2009. Evaluation of pruning techniques and bactericides for managing bacterial canker of sweet cherry. 2009 Great Lakes Fruit Workers Meeting Abstracts, pp 30-31. http://www.hrt.msu.edu/glfw/GLFW_2009_Abstracts/2009_15.pdf

Carroll, J., Robinson, T. and Burr, T. 2007. Importance of early-spring-pruning copper sprays and training systems in managing bacterial canker of sweet cherry. 2006 NYS Fruit IPM Project Reports, Cornell. NYS IPM Publication #222:49-54.

Carroll, J, Robinson, T. and Burr, T. 2007. Effect of early-spring-pruning and copper sprays for managing bacterial canker of sweet cherry. Phytopathology 97:S177 http://www.apsnet.org/meetings/div/ne06abs.asp.

Carroll, J, Robinson, T. and Burr, T. 2007. Managing bacterial canker of sweet cherry - contributions of copper sprays, pruning stubs, training system and cultivar. 2007 Great Lakes Fruit Workers Meeting Abstracts, p 7. http://www.hrt.msu.edu/glfw/GLFW_2007_Abstracts/20070003.pdf

Participants:

Juliet Carroll, Senior Extension Associate, New York State IPM Program. Her role is principal investigator. She led all research efforts including field and laboratory experiments, the collection and identification of Pss isolates, and provided overall coordination of the project. Terence Robinson, Professor, Horticultural Sciences. His role is co-principal investigator. He provided and maintained experimental orchards, pruning and spraying of all field experiments, and input on direction of research. Thomas Burr, Professor, Plant Pathology and Plant-Microbe Biology. His role is co-principal investigator. He provided research laboratory facilities and equipment, guidance on bacterial laboratory work and input on direction of research. Stephen Hoying, Senior Extension Associate, Horticultural Sciences. His role is co-principal investigator. He conducted the field experiments in Highland, NY. He provided input on direction of research. Theodora Bucien, Research Aide. She worked under the direction of Carroll providing technical support for field and laboratory experiments, maintained and identified cultures of bacterial isolates from the field, and assisted with data collection. Collaborators: Kerik Cox, Assistant Professor, Plant Pathology and Plant-Microbe Biology. He collaborated on field-testing of phosphite to substitute for copper in the management of bacterial canker and on the molecular genetics and identification of Pss isolates. David Rosenberger, Professor, Plant Pathology and Plant-Microbe Biology. He collaborated on identification and awareness of outbreaks of bacterial canker in orchards in the Hudson Valley and input on direction of research. His laboratory assisted with preparation of inoculum for the Highland, NY experiments. Training: Carroll provided results of her research to the Cornell Cooperative Extension Lake Ontario Fruit Program for dissemination at their summer and winter fruit schools. Carroll presented project results to research and extension scientists at the national and regional meetings of the American Phytopathological Society, the Great Lakes Fruit Workers Meetings, and the Cumberland-Shenandoah Fruit Workers Meetings.

Target Audiences:

Sweet and tart cherry growers are the target audiences, in New York, the USA, and worldwide where this disease threatens cherry production. New York ranks fourth in the nation in tart cherry production with 2000 acres producing 7.5 million pounds of fruit valued at 3.24 million dollars. New York farmers grew 700 acres of sweet cherries producing 800 tons of fruit valued at 1.27 million dollars in 2005. New York tree fruit growers ranked the need for research on bacterial canker biology and management in the top ten. We extended our knowledge of this disease through farm visits with the following farmers, Mark Nicholson, Red Jacket Orchards, Geneva, NY; Steve Clarke, sweet cherry orchards, Milford, NY; Jeff Morris, Glenora Farms, Dundee, NY; and Bill Schwartz, sweet cherry orchards, Ontario, NY, to collect samples and verify bacterial canker outbreaks. We extended our knowledge of this disease by holding a 2009 Sweet Cherry Field Meeting on July 14 at which 40 sweet cherry growers, nurserymen, and consultants attended. During the 2010 Summer Fruit Tour at the NY State Agricultural Experiment Station in Geneva, NY, Carroll presented results of the bacterial canker field research to over 200 sweet cherry growers, industry personnel, educators and faculty on July 29.

Project Modifications:

Not relevant to this project.

Approved (Signature)	Title	Date

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