SCRI Project #2010-51181-21140

Integrated Management of Zoosporic Pathogens and Irrigation Water Quality for a Sustainable Green Industry

Progress Report

(9/2011-8/2012)

Outputs

This project had an exciting and productive second year. 1) Continued water sampling in AL, MS and PA has resulted in discovery of several new *Phytophthora* and *Pythium* species. 2) Two new species *Phytophthora aquimorbida* and *Phytophthora* taxon "aquatilis" were formally named and they were also evaluated for pathogenicity to rhododendron. 3) The hypotheses that we put forward in 2009 on water quality dynamics in agricultural irrigation reservoirs were tested with the new data from five nurseries across the mid-Atlantic region. Water quality relations to nutrient influx into the reservoirs and surrounding weather conditions were also investigated. 4) Among three high-impact pathogens assessed for zoosporic responses to water pH and electrical conductivity, *P. ramorum* is most adapted to agricultural water environment compared with *P. alni* and *P. kernoviae*. This research has been expanded to include other pathogens and water quality parameters. 5) Through an internship, the "wet-plate" method for mass zoospore production was improved and defined of its applications. 6) Diverse bacterial species were identified from both greenhouse and nursery irrigation water; selected species and strains are being evaluated for their biocontrol potential. 7) Some of the new *Pythium* species found repeatedly in recycling greenhouse irrigation water are non-plant pathogenic but may inhibit the survival and activity of highly pathogenic species of *Pythium*. 8) Current heat treatment protocol was re-examined consequently a new treatment temperature and time combination has been proposed for greenhouse applications to improve the economics and reduce the environmental footprint. 9) After consultation with collaborating growers and advisory panel members as well as other industry professionals, a survey was developed on consumer preference for ornamental plants with disease-free and water conservation labels. This survey was administered by qSample to 14,175 individuals with gardening interest in MD, PA, VA and GA. The resultant 1,596 usable surveys were analyzed and written in a thesis. 10) A producer survey is being developed on water recycling and disease control practices, and the associated economics. 11) To complement the proposed project activities, current knowledge on biology and management of plant pathogens in irrigation water was synthesized in a 30-chapter book in collaboration with 49 world leading scientists. As a result, our research consortium also has expanded to cover vegetables, tree fruit and nut crops, and to have a global focus. 12) The knowledge center has been established as part of eXtension and three learning modules have been developed. 13) Our research updates were disseminated through organization of a session at the 7th International IPM Symposium in Memphis, TN on March 27, 2012, and sixteen presentations at national and international extension and outreach venues. 14) Five graduate students, two summer interns from a medium-sized college in Newport News, VA, and one high school senior from an International Baccalaureate Program in Virginia Beach, VA, were mentored. 15) Industry support increased in research grant and in-kind contribution.

Outcomes/Impacts

As illustrated in two theses, eight refereed journal articles, two conference papers and six abstracts, this project has advanced the science and technology in a broad range of disciplines from biology to agricultural engineering and economics. Each of these advancements provides a basis for technology innovation and development of an integrated approach to zoosporic pathogens and irrigation water quality for more profitable and sustainable green industry. Some of these findings have already been incorporated into the practices at collaborating nurseries and greenhouses as well as a few early adapters, resulting positive impacts. This is exemplified by a change in heat pasteurization practice in a greenhouse that recycles 500 liter of water for irrigation per day under an ambient temperature at 20^{o}C. The energy required to raise and maintain water temperature at 95^{o}C for 30 seconds per the current heat treatment protocol is 148,500 British thermal units (Btu), neglecting the heat loss during treatment. Comparatively, per new protocol resulted from this project, only 55,000 Btu is needed to raise the water temperature to 48^{o}C, and an additional 10,748 Btu to maintain at this temperature for 24 hours according to the minimum energy performance standard (MEPS and Labeling Requirements, 2005). Switching from the current heat treatment practice to the new protocol would cut the energy consumption by half (55%) in this greenhouse operation. The immediate benefits of such a switch are reduced production cost and environmental footprint, improving the profitability and promoting the "green" status of this green industry. This new protocol also has several other benefits which could further improve its economics and reduce the environmental impact. It enhances bacterial activities against plant pathogens, thus improves its compatibility with other disease control strategies in particular of biological control. It also opens the possibility to use solar, geothermal and possibly other alternative energy sources. The overall potential benefits of implementing the resultant findings and novel technologies from this project are enormous on a national scale. Particularly, the benefits of using better design for new recycling irrigation systems and modifying the existing systems to prolong irrigation runoff water turnover time will be everlasting and multifaceted. With these new technologies and practices, growers will be able to reduce crop losses consequently produce more and better quality horticultural products at reduced energy consumption, fungicide and water usage, improving their profit margin and public image. Disease-free ornamental plants produced with water conservation practices may be marketed and sold at greater prices while adding to the consumer satisfaction. These additional benefits, in turn, will put the horticulture industry on an even faster track to great profitability and sustainability.

Publications

1. Burgos-Garay, M., Edson, J., and Moorman, G. W. 2012. Influence of *Pythium aphanidermatum*, *P. irregulare*, and *P. cryptoirregulare* on the bacterial community in recycled irrigated water. Phytopathology 102:S1.2
2. Garzón, C. D., Molineros, J. E., Yánez, J. M., Flores, F. J., Jiménez-Gasco, M. M., and Moorman, G. W. 2011. Sublethal doses of mefenoxam enhance *Pythium* damping-off of geraniums. Plant Disease 95:1233-1238
3. Hao, W. 2012. A potential energy efficient heat treatment and its biological mechanisms. PhD Dissertation. Department of Plant Pathology, Physiology and Weed Science, Virginia Tech

4. Hao, W., Ahonsi, M. O., Vinatzer, B. A., and Hong, C. X. 2012. Inactivation of *Phytophthora* and bacterial species in water by a potential energy-saving heat treatment. European Journal of Plant Pathology DOI 10.1007/s10658-012-9994-4
5. Hartter, D. 2012. Understanding consumers' ornamental plant preferences for disease-free and water conservation labels. M.S. Thesis. Department of Agricultural and Applied Economics, Virginia Tech
6. Hong, C. X., and Richardson, P. A. 2012. Validation of water quality fluctuation patterns in runoff water containment basins of eastern and central Virginia. Phytopathology 102:S4.55
7. Hong, C. X., Richardson, P. A., Hao, W., Ghimire, S. R., Kong, P., Moorman, G. W., Lea-Cox, J. D., and Ross, D. S. 2012. *Phytophthora aquimorbida* sp. nov. and *Phytophthora* taxon 'aquatilis' recovered from irrigation reservoirs and a stream in Virginia, USA. Mycologia doi:10.3852/11-055
8. Lea-Cox, J. D, Belayneh, B., Kim, J., and Majsztrik, J. C. 2012. The value of weather data for daily nursery management decisions. Proceedings of Southern Nursery Association Research Conference 57:87-93
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10. Kong, P. 2012. Carbon dioxide as a potential water disinfectant for Phytophthora disease risk mitigation. Plant Disease http://dx.doi.org/10.1094/PDIS-09-12-0844-RE
11. Kong, P., Lea-Cox, J. D., and Hong, C. X. 2012. Effect of electrical conductivity on survival of *Phytophthora alni*, *P. kernoviae* and *P. ramorum* in a simulated aquatic environment. Plant Pathology DOI: 10.1111/j.1365-3059.2012.02614.x
12. Kong, P., Lea-Cox, J. D., Moorman, G. W., and Hong, C. X. 2012. Survival of *Phytophthora alni*, *P. kernoviae and P. ramorum* in a simulated aquatic environment at different levels of pH. FEMS Microbiology Letters DOI: 10.1111/j.1574-6968.2012.02574.x
13. Majsztrik, J., Lea-Cox, J. D., Ross, D. S., and Ristvey, A. G. 2011. Modeling nitrogen, phosphorus, and water dynamics in the nursery and greenhouse industry. 108th Annual American Society for Horticulture Science Conference. Waikoloa, HI. HortScience 46(9): S160-161
14. Majsztrik, J., Lea-Cox, J. D., Ross, D. S., and Ristvey, A. G. 2011. An in-depth analysis of water and nutrient management in the nursery and greenhouse industry in Maryland. 108th Annual American Society for Horticulture Science Conference. Waikoloa, HI. HortScience 46(9): S220-221
15. Majsztrik, J. C., Ristvey, A. G., and Lea-Cox, J. D. 2012. An in-depth look at fertilizer and irrigation practices in Maryland's ornamental nursery industry. Proceedings of Southern Nursery Association Research Conference 57:35-42.
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Participants

Gary Moorman (co-PI, Pennsylvania State University),
John Lea-Cox (co-PI, University of Maryland),
Kevin Boyle (co-PI, Virginia Tech),
Ping Kong (co-PI, Virginia Tech),
Darrell Bosch (co-PI, Virginia Tech),
James Pease (co-PI, Virginia Tech),
Warren Copes (co-PI, USDA-ARS),
Belinda Carroll (co-PI, Virginia Tech),
Edward Weiss (co-PI, Christopher Newport University),
Andrew Ristvey (co-PI, University of Maryland),
Boris Vinatzer (co-PI, Virginia Tech),
Joshua Chambers (Web Design Specialist, Virginia Tech),
Carl Estes (Instructional Technologist, Virginia Tech),
Giovanni Cafa (Postdoctoral Research Associate, Virginia Tech),
Patricia Richardson (Research Specialist, Virginia Tech),
Marcia Stefani (Research Specialist, Virginia Tech),
Thomas Wilchynski (Field Research Support Staff, Virginia Tech),
Adam Sleeper (Field Research Support Staff, Virginia Tech),
Peter Schultz (Professor, Virginia Tech),
Bruk Belayneh (Research Associate, University of Maryland),
Maria Burgos-Garay (Graduate Research Assistant, Pennsylvania State University),
Alyssa Cultice (Graduate Research Assistant, Virginia Tech),
Wei Hao (Graduate Research Assistant, Virginia Tech),
David Hartter (Graduate Research Assistant, Virginia Tech),
Xiao Yang (Graduate Research Assistant, Virginia Tech),
Michael Pistininzi (Summer Intern, Christopher Newport University),
Andrew Rotzin (Summer Intern, Christopher Newport University),
Kevin Hu (High School Senior, Princess Anne High School in Virginia Beach)
David Ross (co-PI, University of Maryland),
Mike Stanghellini (co-PI, UC Riverside),
Gladis Zinati (co-PI, Rutgers),
Gary Chastagner (Washington State University),
All Advisory Panel members,
All collaborating growers, and
Chuan Hong (PD, Virginia Tech)

Target Audience

Growers,
diagnosticians and field responders,
extension specialists and agents,

crop health care professionals,
microbiologists, mycologists, bacteriologists,
horticulturists and irrigation specialists,
conservation biologists, and
policy-makers