SCRI Project Report (2010-51181-21140)

Integrated management of zoosporic pathogens and irrigation water quality
for a sustainable green industry

(9/1/2010-8/31/2011)

Outputs

During the first year, the following project outputs were achieved: 1) Instruments were installed to continuously monitor water quality in nine reservoirs and weather conditions at five nurseries in Maryland and Virginia. Water quality data from four ponds are transmitted real-time to an office computer through telemetry systems and satellites. Weather data are communicated through the Internet, allowing access by team members and collaborating growers. 2) Nineteen new and distinct subgroups of *Phytophthora* were identified from Virginia nursery irrigation water. From these subgroups, two new species were formally described and thirty representative isolates were assessed for their pathogenicity to rhododendron plants. Irrigation water was baited with rhododendron leaves for *Phytophthora* species at two nurseries in Alabama and Mississippi and with bentgrass for *Pythium* species in two greenhouses in Pennsylvania. 3) Water samples were taken for characterization of bacteria species by ARISA (automated ribosomal intergenic spacer analysis). Selected bacterial strains were evaluated in the lab and greenhouse for their potential as pathogen-suppressive microbes. 4) Laboratory systems were developed to assess the impacts of pH, electrical conductivity, and dissolved oxygen on zoospores from a variety of *Phytophthora* species including three quarantine pathogens (*P. alni, P. kernoviae, P. ramorum*). 5) A consumer survey has been drafted after visiting garden centers and meeting three consumer focus groups. This survey focuses on consumer awareness of plant disease and risk of plant loss and their willingness to pay for healthier plant products or those grown using water conservation practices. Irrigation systems, extent and causes of crop losses, control methods and water decontamination technologies used, and marketing techniques were documented by visiting production nurseries and meeting one focus group at the MANTS in Baltimore, MD. 6) The current knowledge on biology, detection, and management of plant pathogens in irrigation water was reviewed and assembled into a book to be published by APS Press. 7) A draft outline of knowledgebase contents was developed for an online learning center. The web host and general templates for individual learning modules were explored with a test module. 8) Four graduate students and three interns were mentored. To maximize the impacts of our activities, the team met with the Advisory Panel at Virginia Tech in October 2010 to chart detailed project plans and kept the panel members informed through two web conferences in February and June 2011and Project Newsletters. Panel feedback and grower collaborations from instrument installation and maintenance to pathogen baiting and data interpretation have been crucial to project progress. A collaboration web site (scholar.vt.edu) was developed to facilitate communications among the subject teams and between researchers and panel members. A second website (irrigation-pathogens.inf) was developed to promote outreach activities. Research updates were presented as invited speakers at three international and regional conferences, one refereed journal article and six abstracts.

Outcomes/Impacts

This project has advanced the science in a wide range of disciplines from taxonomy to plant biosecurity, from microbial interactions to chemical communication, from water quality dynamics to pathogen aquatic biology, and from agricultural engineering to economics, as well as the environmental and social dimensions of waterborne pathogens and crop health management. Each of these findings provides the basis for development of novel pathogen and disease control technologies and better management practices that will lead to more sustainable agricultural industries while reducing their environmental footprints. For example, the collected water quality data has had multiple immediate uses. The water pH in runoff containment ponds was mostly basic and could go up to 10.8, depending on location and time of the year. This observation has tremendous ramifications. One immediate use of this data is to improve the efficacy of pesticide applications. The ideal pH for most pesticides is 5 to 6, and pesticides degrade with increasing pH through a hydrolysis process, which can be rapid in the pH range of 8 and 9. Pest control could be greatly diminished or lost completely at the basic pH observed in water from runoff containment ponds. Checking pH and acidifying as needed before pond water is used in a spray solution could easily realize 5 to 20% of the pesticide potential that otherwise would have been lost. In the United States, approximately 500 million kilograms of more than 600 different pesticides are estimated to be applied annually at a direct cost of $10 billion plus an indirect cost of over $10 billion (Pimentel, 2005). This improved practice alone could save $1 to 4 billion per year in the United States. Water pH is equally important in the performance of chlorination, the most widely-used water treatment in the green industry. There are three species of free chlorine (Cl2, HClO-, OCl-) in water and their equilibrium is pH dependent. The proportion of hypochlorous acid, the most potent chlorine species for pathogen kill, is the highest at pH 5 and 6. The proportion of hypochlorous acid and, subsequently, chlorination efficacy drops sharply with increasing pH and can be reduced by 80% at pH 8. Thus, measuring pH and acidifying water as needed is essential to maximize the pathogen control potential of every chlorine dollar; otherwise, not only is the chlorine expense wasted but entire crops could be at risk to pathogens. The water pH data also provides a framework for interpreting pathogen survival data from controlled conditions and understanding pathogen dynamics in recycled irrigation systems. In addition, the data will help time water sampling for assessing microbial diversity and identifying naturally-occurring pathogen-suppressive microbes in irrigation ponds, adding quality and productivity to this project. Finally, these data are essential to assessing the green industry contributions to global water resource conservation and protection by capturing runoff water in containment ponds and using it for irrigation.

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Publications

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Hao, W., Vinatzer, B. A., and Hong, C. X. 2011. Effect of temperature on survival of *Phytophthora* and bacterial species in irrigation water. Phytopathology 101:S69

Hong, C. X. 2011. Irrigation pathogen mitigation without water treatment. Proceedings of the 36th Annual Meeting of the International Plant Propagator Society - Southern Region of North America, Valdosta, GA, USA, October 23-26, 2011 (in press)

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Kong, P., Tyler, B. M., Richardson, P. A., Lee, B. W. K., Zhou, Z. H., and Hong, C. X. 2010. Zoospore interspecific signaling promotes plant infection by *Phytophthora*. BMC Microbiology http:www.biomedcentral.com/1471-2180/10/313

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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