Plant Diseases
FY 2001 National Program Annual Report

Introduction

This program addresses the characterization of plant diseases and strategies to control them. The program is divided into five components: identification and classification of pathogens; biological control; cultural control; pathogen biology, genetics, population dynamics, spread, and relationship with hosts and vectors; and host plant resistance to disease. The overall goal of the Plant Diseases National Program is to develop and improve ways to reduce crop losses caused by plant diseases. The program focuses on developing effective control strategies that are not environmentally harmful, do not threaten the safety of consumers, and are compatible with sustainable and profitable crop production. The ARS program is conducted in cooperation with related research in other public and private institutions.

Selected Accomplishments by Component

Identification and Classification of Pathogens

<u>Rapid diagnosis for Pierce's disease of grapes</u>. Pierce's disease of grape threatens the $5 billion California grape industry. Conventional identification of the pathogen takes 10 days to 2 weeks because the organism is difficult to isolate. Delayed detection and diagnosis results in severe crop losses and possible trade restrictions. ARS scientists at the Foreign Disease-Weed Science Research Unit in Frederick, Maryland, developed a same-day, on-site portable molecular assay for the Pierce's disease bacterium. Field tests demonstrate that infected grapestock can be diagnosed within 1-2 hours. Growers could use the portable assay to identify infected vines before the disease spreads within and among vineyards.

<u>Detection and discrimination of soybean rust pathogens</u>. Soybean rust occurs in Australia and many countries throughout Africa, Asia, and South America. The causal agents of soybean rust are two closely related fungi, *Phakopsora pachyrhizi* and *P. meibomiae*, which are discriminated based upon morphological characteristics of the telia. Recent findings of soybean rust in Hawaii and Zimbabwe, and the re-emergence of the disease in India, has prompted concern that the pathogen(s) are spreading to new geographic regions. If *Phakopsora pachrhizi* were to gain entry into the United States and become established, yield losses could exceed 10 percent in most of the United States and up to 50 percent in the Mississippi delta and southeastern states. ARS scientists at the Foreign Diseases – Weed Science Research Unit, Fort Detrick/Frederick,

Maryland, have developed classical and real-time PCR assays for the rapid detection and discrimination of the two soybean rust pathogens. Identification of *Phakopsora pachyrhizi* from infected soybean leaves using real-time PCR assay allows for more rapid diagnosis.

Improved sampling and detection of Plum Pox Virus on stone fruits. The overall ARS and cooperator research program on Plum Pox Virus (PPV) is focused on improved detection and characterization, virus-vector transmission, and enhancement of germplasm for resistance, through both biotechnology and conventional breeding techniques. ARS allocated funds to our Appalachian Fruit Research Laboratory, Kearneysville, West Virginia, where ARS scientists developed, in cooperation with European scientists, a transgenic plum plant that provides genetic resistance to PPV. ARS and APHIS officials are in consultation regarding ARS research support to meet the regulatory needs of APHIS.

Biological Control

Biologically based management of fire blight on pome fruits. Fire blight is a serious disease of apple and pear trees caused by the bacterium, *Erwinia amylovora*. The pathogen can cause tremendous tree damage or death and poses a barrier to the export of pome fruits from the United States to countries where this disease does not occur. Research was conducted at the Physiology and Pathology of Tree Fruits Research Unit, Wenatchee, Washington, to develop a biologically based approach for controlling fire blight of apple and pear trees. New techniques of evaluating beneficial microorganisms on blossoms, the site of primary infections, led to the discovery of *Pantoea agglomerans* strain E325, which was patented as a biological control agent of fire blight. In FY2001, ARS signed a license with a private company in Washington, and progress was made under a CRADA to develop the fermentation and formulation technology needed for commercial application. The new technology will allow producers to more effectively control fire blight.

Biologically based management strategy to control soil-borne plant pathogens. As regulated by an international treaty and the U.S. Clean Air Act, the use of the soil fumigant methyl bromide is being phased out due to its role in ozone depletion. Alternatives to methyl bromide are needed for control of soil-borne plant pests. ARS scientists at the Floral and Nursery Plants Research Laboratory at Beltsville, Maryland, have developed biologically based management strategies for the control of soil-borne pathogens as an alternative to the current use of methyl bromide pre-plant soil fumigation. This integrated management approach utilizing multiple treatments will significantly reduce the level of disease to a potentially acceptable level for commercial usage as a replacement for methyl bromide fumigation.

Development of integrated pest management strategies for floriculture crops. There is a need to reduce the use of chemical pesticides for the production of floriculture crops, including greenhouse grown roses in California. Research conducted by ARS scientists at Davis, California, provide the floriculture industry, especially rose growers in California, with alternatives to reliance on applications of chemical pesticides to control insect pests and diseases. Using sampling techniques and economic thresholds, data on incidence of spider mites, western flower thrips, and powdery mildew were collected from an IPM greenhouse and grower “control” greenhouse. The IPM greenhouses incorporated predatory mites to control pests.

Cultural Control

<u>Mixing resistant susceptible sugar beets reduces disease losses</u>. The soil-borne pathogen *Rhizoctonia solani* causes crown and root rot in sugar beets which results in severe losses. Growers, however, are reluctant to plant resistant varieties because of lower yields and sugar content. ARS researchers at the Sugarbeet and Bean Research Unit, East Lansing, Michigan, found that combination plantings with one-sixth to one-third resistant varieties showed no yield or sugar reductions, even under disease-free conditions, and significantly reduced disease damage when disease was present.

<u>Reduction in fungicide use by determining alternate strategies to control postharvest decay</u>. A significant amount of fresh-cut melon tissue becomes unmarketable after about 3 days due to tissue translucency and water release (watering). The impact on melon quality and shelf life from dipping freshly processed melon cubes in aqueous calcium amino acid solutions was studied by ARS scientists at the Plant Science Institute, Beltsville, Maryland, in collaboration with the University of the District of Columbia. A dip in chlorine water supplemented with calcium chelate maintained the quality and more then doubled the shelf life of fresh cut melon. The new post-processing technology can be easily incorporated into commercial fresh-cut melon operations.

Pathogen Biology, Genetics, Population Dynamics, Spread, and Relationship with Hosts and Vectors

<u>Sampling strategy for detection of citrus tristeza virus</u>. Citrus tristeza virus (CTV) is the most important virus disease of citrus. In central California it has been controlled by survey and eradication of infected trees. A sampling strategy that allows coverage of large areas has been developed by ARS scientists at the Horticultural Crops Research Laboratory at Davis, California, and the Subtropical Plant Pathology Research Laboratory at Fort Pierce, Florida, in cooperation with the Central California Tristeza Eradication Agency, to optimize detection of CTV “hotspots.” This cost-effective sampling procedure successfully identified the level of CTV infection in specific fields and is used by growers to determine CTV incidence in new areas or where current data is lacking to make decisions on control measures.

<u>Molecular genetics of toxin production in phytopathogenic pseudomonads</u>. Economic loss to agricultural crops due to disease causing bacteria is a major problem in the United States. Currently, adequate chemical or biological control of bacterial disease is not economically feasible or simply not available. ARS scientists at the Plants Disease Resistance Research Unit, Madison, Wisconsin, have identified genetic traits within phytopathogenic bacteria that lead to disease. Numerous genes have been identified for production of plant toxins and the elicitation of disease symptoms on plants. Through collaborations with university cooperators, mutant bacterial strains can be constructed and tested in the field for possible disease control applications.

Host Plant Resistance to Disease

Genetic diversity of major wheat pathogen determined. *Fusarium* head blight or scab is an extremely destructive disease on all varieties of wheat and barley. The disease has accounted for up to $1billion in crop losses during certain years by reduction in overall yield, seed quality, and contamination of infected grain with mycotoxins that make the harvest less desirable for use in food or beverage products. ARS research at the Cereal Disease Laboratory at St. Paul, Minnesota, has lead to a better understanding of the ability of the *Fusarium* head blight pathogen to spread within wheat varieties by obtaining DNA sequences from wheat infected with high virulence and low virulence strains of the fungus. This information will be used to identify genes that allow the fungus to spread within wheat heads. Once identified, these genes and their products may serve as targets for the design of compounds and treatments that block this essential disease pathway.

Molecular-genetic characterization of tobacco mosaic virus (TMV) resistance genes. Little is known on how resistance genes function. Understanding the mechanism of natural disease resistance in plants is critical for minimizing pesticide usage in crop production. Using TMV to test for disease resistance, ARS researchers at the Western Regional Research Center, Albany, California, conducted gene modification studies to determine the importance of two specific compounds produced by the plant disease resistance gene “N.” These two compounds are both needed for complete resistance to TMV. Studying disease resistance conferred by compounds with differing structures provides important information on how resistance genes, and compounds produced by these genes, protect plants against diseases.