National Program 303 • PLANT DISEASES
FY 2012 Annual Report

National Program 303, Plant Diseases, focuses on developing effective disease management strategies that are environmentally friendly, safe for consumers, and compatible with sustainable and profitable crop production. This USDA-Agricultural Research Service (ARS) National Program is conducted in cooperation with related research in other public and private institutions. In particular, NP 303 projects are coordinated with those in National Program 301 (Plant Genetic Resource, Genomics, and Genetic Improvement) toward the overall goal of crop improvement through increased resistance to biotic and abiotic factors and increased understanding of host-pathogen interactions.

The overall goal of NP 303 is to develop and improve ways to reduce crop losses caused by plant diseases, while safeguarding the environment. To this end, projects in this national program aim to reduce the impact of diseases on yields, product quality or shelf-life, aesthetic or nutritional value, and potential contamination of food and feed with toxins.

Management of plant diseases is essential for providing an adequate and consistent supply of food, feed, fiber, and aesthetic plants, and has long been a high priority for ARS. Besides the obvious monetary benefits to producers and processors, successful plant health protection is important for maintaining and increasing food supplies with minimal increases in land under cultivation. Additionally, the knowledge and management of plant diseases of quarantine significance are vital, not only for protecting our domestic crops from foreign disease, but also for maintaining and expanding export markets for plants and plant products.

NP 303 consists of 63 projects located in 22 different states. Most of the more than 140 scientists working within this national program are specialists in plant pathology and/or nematology. Significant contributions to NP 303 also come through multidisciplinary teams that include geneticists, agronomists, botanists, horticulturists, physiologists, soil scientists, entomologists, chemists, and microbiologists.

NP 303 is comprised of the following three components:

- *Diagnostics, Etiology, and Systematics*
- *Biology and Epidemiology of Plant Disease*
- *Plant Health Management*

Together, these components include research to understand and control plant diseases and to develop strategies for disease management and control that enhance agricultural production and value. During fiscal year 2012, this program produced many important discoveries and advances. Some of these are described below, grouped by program component.

Component 1 – Diagnostics, Etiology, and Systematics

Diagnostic test for the new boxwood blight pathogen. The recent rapid emergence and spread of boxwood blight disease in the United States places the nursery and landscape industry at substantial risk. Boxwood is a high value ornamental nursery crop valued at $103 million annually. Early and rapid detection of *Calonectria pseudonaviculata* in plants and soil is needed to prevent the spread of this emergent disease which threatens the health and production of U.S. boxwood. ARS scientists in Beltsville, Maryland, developed a DNA-based boxwood blight diagnostic assay capable of detecting the presence of the causal agent of boxwood blight disease. This diagnostic test will be used by plant scientists developing methods to halt the spread of boxwood blight and to develop control measures for the disease.

New molecular diagnostic assays for emerging pathogens of potato. New nematode species and new, necrotic strains of *Potato virus Y* (PVY) have emerged in the United States. A new species related to potato cyst nematode was recently detected in Oregon, for which there was no reliable diagnostic method. ARS researchers in Ithaca, New York, developed a molecular method that provides highly reliable and rapid identification of this Oregon nematode species that will be used to monitor the potential spread of this new potato pest within Oregon and in other potato producing states. Likewise, tuber necrotic strains of PVY are emerging in the United States and have the potential to become a major quality disease issue for the U.S. potato industry, threatening farm income and export options. In collaboration with scientists at the University of Idaho, ARS researchers in Ithaca have developed improved testing protocols that eliminate false positives and allow detection of all variants within the tuber necrotic strain of PVY. Protocols were transferred to state and federal partners, which conduct product testing and regulate interstate and international commerce of potatoes.

Grape Powdery Mildew Detection. ARS scientists in Corvallis, Oregon, developed and demonstrated over a two year period that grower-performed Loop Mediated Isothermal Amplification assay can be used to detect grape powdery mildew. This new technology makes it much easier and less costly for growers to determine pathogen inoculum levels (which is useful in determining whether to apply fungicides) thus making this approach available to even small acreage growers. This technology is currently being transferred to two commercial entities as well as being made directly available to grape growers in Oregon, Washington, and California. The reduction in fungicide use will have significant economic savings and enhance environmental quality by reducing impact on water shed, carbon footprint, and air quality.

Component 2 – Biology and Epidemiology of Plant Disease

Sudden oak death fungus soil remediation. *Phytophthora ramorum* causes sudden oak death and also seriously impacts the commercial nursery industry due to losses resulting from quarantine issues. The nursery industry badly needs new methods of control of *P. ramorum* so that infested nurseries can be removed from quarantine status and resume normal production. ARS researchers in Fort Detrick, Maryland, demonstrated for the first time in a nursery setting that the beneficial biocontrol fungus *Trichoderma asperellum,* grown on wheat bran and raked into nursery test-plot soil, can reduce *P. ramorum* soil populations to non-detectable levels after six weeks. California regulatory agents confirmed these results at a commercial nursery, and the nursery was lifted from quarantine status. The new method will have wide applicability in reducing losses to the nursery industry due to *P. ramorum*, and technology transfer is underway to facilitate development of a commercial formulation of the biocontrol fungus.

New information developed to enhance biological control of aflatoxin contamination in corn. Infection of corn by some strains of *Aspergillus (A.) flavus*, and subsequent contamination with the mycotoxin aflatoxin, results in costs of $923 million (UN Food and Agriculture Organization) and can cause illness in livestock and humans. An effective approach to reduce aflatoxin contamination in corn is biological control, using non-aflatoxin-producing strains of *A. flavus*, as developed by USDA-ARS researchers. In 2012 ARS researchers in Stoneville, Mississippi, completed the genome sequencing of three benign strains of *A. flavus* enabling the future comparison of the DNA genome sequence with that of the toxigenic strain. The researchers also assessed two novel formulations for applying the non-toxigenic strains via solid application with bioplastic granules and water dispersible granule formulation, and a U.S. patent was granted on "Granular bioplastic biocontrol composition."

Optimizing disease management strategies for HLB (citrus greening) in Florida. An epidemiological model to predict the spatial and temporal dynamics of citrus Huanglongbing (HLB) from infected areas of South Florida, which can be used to test various disease control strategies, was finalized and validated. A web-based version of the model has also been developed for non-researcher use. For example, the model output suggests that controlling secondary infections by diseased tree removal and insecticide applications, plus controlling primary infection from new insect immigrations through area-wide control strategies, can reduce disease increase to a manageable 2 to 5% increase per year, which appears to be economically sustainable.

Soybean mosaic virus (SMV) genome regions required for aphid and seed transmission. *Soybean mosaic virus* (SMV) is transmitted by aphids and through seed, and can cause yield reductions as high as 35% in soybean. SMV-infected seeds serve as the primary source of inoculum for the virus in North America, and secondary spread occurs by aphids. ARS researchers in Urbana, Illinois, and scientists at the University of Illinois studied the role of virus-encoded proteins in aphid and seed transmission, severity of foliar symptoms, and induction of seed coat mottling. Two virus proteins previously associated with aphid transmission were shown to also be required for efficient seed transmission, and this discovery suggests that interactions of the two proteins are important for multiple functions in the virus life cycle. In addition, two other regions within the SMV genome were shown to affect transmission through seed and the presence of seed-coat mottling in virus-infected seeds. The information will help pathologists and virologists develop novel methods to disrupt this disease.

***Web-based mobile support for disease scouting and management*.** A web-based and mobile technology platform (known as AgScouter) was developed as a plant disease and insect scouting and management tool. It is currently being updated (v2.0) to allow growers and scouts to enter GPS-labeled disease, insect, and production information directly into their mobile device (e.g., smartphone) where it will be processed and used to develop field-specific, pest management recommendations. *Tomato yellow leaf curl virus* and whiteflies were initially used to validate this approach. Subsequently the adaptability of this approach has been demonstrated by expanding it to include the emerging *Squash vein yellowing virus* (cause of viral watermelon vine decline) and *Groundnut ringspot virus* and their vectors. Use of this system to promote real-time, regional pest management is being evaluated.

Component 3 – Plant Health Management

Extensive cereal disease evaluation protects U.S. wheat and barley from stripe rust losses. Cereal rust expertise provided by ARS researchers in Pullman, Washington, was applied in 2012 to protect the wheat and barley crop from new, emerging strains of the stripe rust fungus. During the 2012 growing season, ARS scientists in Pullman evaluated more than 18,000 wheat and 5,000 barley lines for resistance to stripe rust in the field, and hundreds were also tested in the greenhouse with cultured stripe rust strains. This enabled U.S. wheat and barley breeders to select lines for advancing new varieties with resistance to new stripe rust strains. The results of the extensive evaluation combined with molecular marker analysis in fiscal year 2012 enabled the advancement and release of more than 10 new wheat and barley varieties with increased stripe rust protection.

High yielding soybean with resistance to multiple cyst nematode populations. In the United States, nearly a billion dollars are lost in annual soybean production due to a tiny root parasite, soybean cyst nematode. Cultivars with genetically controlled resistance will reduce these losses. ARS researchers at Jackson, Tennessee, in cooperation with the Tennessee Agricultural Experiment Station, released soybean germplasm line JTN-5203 with resistance to multiple pathogens endemic to the mid-southern United States, combined with high yield potential. Traditional breeding methods were combined with modern marker assisted biotechnology techniques for rapid advancements. Soybean JTN-5203 will be highly useful as parent material in breeding for more durable resistance, especially to soybean cyst nematode, while maintaining very high yield potential in new cultivars. It can also be adapted directly as an excellent soybean cultivar in the mid-southern United States.

Evaluation of beneficial yeasts to manage fire blight. Yeasts are being evaluated for use against fire blight of apple and pear at the point of infection in the flower nectar cup. Yeasts can complement bacterial agents that primarily suppress the disease on flower stigmas, the main source of cells invading the flower tissues. ARS researchers in Wenatchee, Washington, demonstrated in orchard trials that the yeast strain *Cryptococcus infirmo-miniatus* CIMyy6 reduces fire blight in apple trees. These yeasts are already approved or developed commercially, so they can be rapidly employed for biological control of fire blight.

Soybean dwarf virus is limited by the aphid vector in the United States. *Soybean dwarf virus* (SbDV), which significantly affects soybean crops in Japan and other Asian countries, has been identified in multiple locations within the United States. Outbreaks of SbDV in the United States have always been limited, perhaps because the primary aphid colonizing soybean (*Aphis glycines)* is reported to be a poor vector of SbDV. An experimental analysis conducted by ARS researchers in Frederick, Maryland, identified soybean mutations that tend to prevent effective transmission of SbDV. This work provides new information on how to protect U.S. soybeans from SbDV.

New sources of resistance to fungal diseases in sorghum identified. Fungal molds and smuts reduce the yield and quality of sorghum worldwide. In 2012, ARS researchers in College Station, Texas, working with cooperators in Puerto Rico, Senegal, and Mexico, identified sorghum lines with resistance to anthracnose, downy mildew, grain mold, and long smut. Twenty sorghum accessions were evaluated for leaf spot and anthracnose resistance in González, Tamaulipas, Mexico, in collaboration with the Instituto Nacional de Investigaciones Forestales Agricolas y Pecuarias (INIFAP), and seven lines were found with protection for leaf spot and anthracnose. All the identified resistant lines will provide sorghum breeders new sources of genetic resistance to fungal diseases and contribute to international food security.

***Evaluation techniques for resistance to charcoal rot in soybean*.** Charcoal rot of soybean is caused by a fungal pathogen that is the leading soil-borne disease in many states and is especially destructive under dry soil conditions. Effective and reliable methods to evaluate soybean for resistance to this fungus are needed as part of a management scheme that would utilize host resistance. ARS scientists in Urbana, Illinois, and researchers from the University of Illinois investigated a cut-stem inoculation technique to evaluate soybean genotypes for resistance to this fungal pathogen. The cut-stem inoculation technique distinguished differences in aggressiveness among isolates of the charcoal rot fungus and differences among soybean genotypes for resistance to the charcoal rot fungus, which were comparable to results from field tests. This information will be useful for soybean breeders, pathologists, and those interested in crop improvement because it provides information on how to evaluate soybean germplasm accessions for resistance to a disease for which there are no resistant soybean cultivars available for growers.

Preplant IPM strategy for managing root-knot nematode in peach. Peach growers in the Southeast often find it an economic hardship to apply fumigants to orchard sites. Finding a nonchemical alternative to preplant chemical control of nematode pests is warranted. ARS researchers in Byron, Georgia, and in Beltsville, Maryland, evaluated a tall fescue grass cultivar as a preplant rotation for suppressing the Southern root-knot nematode. Trees planted after a 1-year or 2-year tall fescue grass cover crop and planted in fumigated soil are significantly larger than trees in unfumigated soil. This work provided the essential baseline data to develop the nonchemical preplant nematode control recommendation communicated to peach growers in the *2012 Southeastern Peach, Nectarine, and Plum Pest Management and Culture Guide*.