NP 303 – PLANT DISEASES
Retrospective Review
GWCC
Beltsville, MD
February 28-29, 2012

EXECUTIVE SUMMARY

The Retrospective Review of NP 303 was held electronically February 28 & 29, 2012. The review team consisted of five Plant Pathologists: Mike Davis, Ray Hammerschmidt, Phyllis Himmell, James Moyer and Mary Palm. The panel was greeted by USDA NPL's and administrators and was ably managed by Tracy Havermann. The review was based on the 2007 – 2011 Accomplishment Report prepared by the NPLs. This document was supported by the NP 303 Action Plan and an Appendix of Publications from each of the 63 NP 303 CRIS projects.

The team was impressed by the diverse portfolio of projects investigating plant diseases of economically important crops. The output from the projects was a continuum ranging from upstream, cutting edge science published in the highest impact journals to mission oriented direct impact science published in journals frequented by the target customers.

The Plant Diseases National Program (NP 303) is comprised of four components:

1. Disease Diagnosis: Detection, identification and characterization of plant pathogens;
2. Biology, ecology, epidemiology, and spread of plant pathogens and their relationships with hosts and vectors;
3. Plant disease resistance; and
4. Biological and cultural strategies for sustainable disease management.

COMPONENT 1. DISEASE DIAGNOSIS: DETECTION, IDENTIFICATION AND CHARACTERIZATION OF PLANT PATHOGENS

PROBLEM STATEMENT 1A: NEW DIAGNOSTIC METHODS AND TOOLS

The target pathogens were of major economic and regulatory importance including (but not limited to) golden nematodes, Huanglongbing, chrysanthemum white rust, soybean rust, citrus tristeza virus and powdery mildew. Several of the studies provided diagnostic tools for identification of quarantine-significant organisms by state and federal regulatory officials. Diagnostic tools developed in projects covered in 1B could also be included as significant accomplishments in this output (e.g. bunt species, Ug99 strains). The Trichoderma identification system is a model in that it is based on sound systematics knowledge, voucher specimens and cultures are designated, and the identification tool combines morphological and molecular characters that allow non-experts to identify these difficult to identify, important biocontrol organisms. The

outputs from a number of these projects have had high impact and several others could have a more significant impact if there was a greater effort to ensure they reach end-users in land-grant universities and industry. A closer tie-in with the NPDN would be a good first step for this. Multiple projects were listed working on the same pathogen and the team was concerned that there was insufficient coordination between projects.

PROBLEM STATEMENT 1B: DETECTION, IDENTIFICATION, CHARACTERIZATION, AND CLASSIFICATION OF PATHOGENS

Phylogenetic studies which properly characterize and classify plant pathogens are foundational by their very nature. They are necessary for proper identification and provide the foundation for development of pathogen detection protocols. These projects identified more than 70 new pathogenic species of plant associated fungi, nematodes, virus' and phytoplasmas and eluciated phylogenetic relationships in many of these groups. Significant advances were made in understanding the evolution of phytoplasmas. Many publications were in high impact journals. Accurate and comprehensive phylogenetic systems resulting from ARS research has an immediate impact on our ability to identify species as well as a significant long term impact by providing a framework for rapidly determining novel taxa and predicting biological characteristics, such as was possible with the new bunt species. The determination that there are at least seven strains of Ug99, in advance of its introduction, allows the development of resistant wheat and barley varieties. Research on nematode taxonomy meets a national need for training. ARS collections meet a major national and international need for preservation of reference collections and the databases serve as unique reference resources that are used by researchers, regulators, diagnosticians, and industry worldwide.

COMPONENT 2. BIOLOGY, ECOLOGY, EPIDEMIOLOGY, AND SPREAD OF PLANT PATHOGENS AND THEIR RELATIONSHIPS WITH HOSTS AND VECTORS

PROBLEM STATEMENT 2A: PATHOGEN BIOLOGY, VIRULENCE DETERMINANTS, AND GENETICS OF THE PATHOGEN

The bacterial (*Ca. Liberabacter spp.*), oomycete (*P. infestans*) and fungal genomes (rusts, *M. graminocola*) sequenced were pathogens of economically important crops and the information will significantly impact the scientific community. In addition, scientists made significant contributions to our understanding of the molecular basis of pathogenicity of a novel sweetpotato virus, a toxigenic fusarium and the golden nematode. This group also contained a number of projects whose outcomes are more downstream, closer to having immediate impact such as revealing the synergisms in wheat viruses, timing of insecticides to prevent boll rot of cotton. Scientists were also adapting new technologies to deliver therapeutic agents by novel means. The team agreed that most of these projects were of very high impact and had the potential to greatly influence the end user. Many publications were in high impact journals. It should be noted that some were either early stage or should be evaluated for slow development.

PROBLEM STATEMENT 2B: PLANT-MICROBE-VECTOR INTERACTIONS

The national coordination of the parallel HLB projects was included here and the team thought a more definitive statement of success or assessment would have been of value to evaluate this effort. There were several projects that were of medium to high impact that did make incremental additions to our understanding or ability to manage pathogens such as antibiotic treatments for HLB, absence of seed transmission and identification of resistance in wild citrus relatives which had regulatory impact. Additional examples were the development of VIGS vectors for wheat and identifying resistance genes for FHB whose impact is yet to be determined. Publications were solid and in moderate impact, but appropriate journals.

PROBLEM STATEMENT 2C: POPULATION DYNAMICS, SPREAD, AND EPIDEMIOLOGY OF PATHOGENS

The discussion of accomplishments was not as robust as expected for 24 projects. Some projects had immediate impact with outcomes limited to local situations such as the citrus pest sampling method and the predictive models for stem rust of ryegrass. Others had broader impact such as the citrus canker pathway study and the soil phase *of P. ramorum* work. Publications were all of good quality. Citrus canker and *P. ramorum* investigations had immediate impact on quarantine regulations.

COMPONENT 3: PLANT DISEASE RESISTANCE

PROBLEM STATEMENT 3A. MECHANISMS OF PLANT DISEASE RESISTANCE

These projects produced outcomes that tend to be upstream with breeders/seed companies as customers as opposed to growers. Research results on resistance and mechanisms of resistance to rice blast, maize diseases, and stagnospora blotch on wheat were published in high impact journals. Non-race specific resistance and a possible resistance mechanism to powdery mildew in grape was identified and published in a good journal. Resistance to new strains of BNYV in sugarbeet were identified and reported as a germplasm release. The resistance in grape and sugarbeet were more end user ready. The amount of resistance to aflatoxin accumulation in maize was questioned with regard to being economically significant.

PROBLEM STATEMENT 3B. DISEASE RESISTANCE IN NEW GERMPLASM AND VARIETIES

These projects reported genetic changes in pathogens, characterized new germplasm, new markers for disease resistance, and more efficient breeding strategies. The researchers were productive; the project outputs were user-ready and have potential for high impact. However, the team did note that some markers explained 40% of the phenotypic variation when markers of commercial value explained 80 to 90% of the variation. There were many examples of promising linkages with companies that will facilitate utilization.

COMPONENT 4: BIOLOGICAL AND CULTURAL STRATEGIES FOR SUSTAINABLE DISEASE MANAGEMENT

PROBLEM STATEMENT 4A: BIOLOGICAL AND CULTURAL CONTROL TECHNOLOGIES

These projects included many very applied projects and one comparative genomics study of bacteria used as biocontrol agents. Utilization of resistant rootstocks by grafting is an emerging technology with wide application and high impact. *P. penetrans* as a biocontrol for nematodes was licensed to Syngenta. The solarization studies appear to be being adopted, at least on a limited basis, with the utility of other strategies in question. It was noted that solarization, in general, is more effective against pathogens found in cooler climates than in high temperature climates like Florida. The genomics was published in good journals and the other studies were in journals of high accessibility to intended users.

PROBLEM STATEMENT 4B: PATHOGEN, PLANT, AND ANTAGONIST INTERACTIONS

The research on the mechanisms of biocontrol activity in *P. fluourescens* continues to be of high quality and published in strong journals. The discovery of the sexual stage of *Aspergillus flavus* and *A. parasiticus* is an extremely high impact foundational contribution that will allow researchers to conduct traditional genetics on these fungi for the first time. Very high impact science. The use of brassicaceous seed meal and the fireblight forecasting system are also useful.

PROBLEM STATEMENT 4C: APPLICATION OF SUSTAINABLE DISEASE MANAGEMENT TOOLS

These projects reported promising results in the application of biocontrol agents: in one, a cocktail of yeast produced synergistic results while a cocktail of *Pseudomonas* isolates were antagonistic. The utilization of multiple fungicide-resistant yeast isolates was particularly innovative. The application on nontoxigenic aspergillus has been commercialized and is being used by growers as well as in efforts to protect people in Africa from toxin contaminated food. The results were published in good quality journals. The observation that one of the *Trichoderma* isolates used in cacao would also induce resistance in pepper to *Phytophthora capsici* was reported in a journal for fundamental science.

While the Review Team recognized incremental progress in biocontrol, we recommend a benefit analysis be conducted on those systems that have been studied for many years to ascertain the expected benefits from additional research.

Overall, we observed that USDA-ARS 303 scientists have worked to develop linkages with industry and other stakeholders and urge them to continue to develop those linkages. There also appears to be good cooperation with breeding efforts in other ARS program areas and they have been responsive to the needs of APHIS with regard to the need for science on which to base policy and regulations and in the development of diagnostic tools.