

FY14-15 Research Categories (Areas and Coordinated Projects) Program Descriptions and Research Priorities

FHB MANAGEMENT (MGMT)

Program Description:

The FHB Management (MGMT) research area supports research to develop effective and economical disease management practices that reduce FHB severity and mycotoxins in small grain crops to meet the immediate and long-term needs of the wheat and barley industries.

This research area involves:

- tillage practices, crop sequences, and other cultural practices targeting *Fusarium*-infested residues;
- fungicides and biocontrol agents with demonstrated field efficacy, and their application technologies;
- the refinement and deployment of disease prediction and forecasting models, and disease management decision tools; and
- studies of pathogen survival, inoculum production, dispersal, infection, colonization, mycotoxin production, and factors accounting for unacceptable levels of mycotoxins in symptomatic or asymptomatic grain.

NOTE: Priority will be given to multi-PI, collaborative, integrated pre-proposals that address the research priorities listed below. Pre-proposals pertaining to uniform integrated management (IM) trials and uniform fungicide/biocontrol trials (UT) will be developed as multi-PI, collaborative, integrated proposals. Coordinators for those integrated proposals are listed on pages 6 and 23 of the FY14 RFP.

FY14-15 Research Priorities derived from Action Plan Goals:

1. Develop integrated management strategies for FHB and mycotoxins that are robust to conditions experienced in production fields of wheat and barley.
2. Help develop and validate the next generation of management and mitigation tools for FHB and mycotoxin control.
3. Develop a full understanding of specific factors influencing infection and toxin accumulation that can be used to develop the next generation of scab and DON risk assessment measures.
4. Enhance communication and end user education/outreach.

FOOD SAFETY, TOXICOLOGY AND UTILIZATION OF MYCOTOXIN-CONTAMINATED GRAIN (FSTU)

Program Description:

The Food Safety, Toxicology and Utilization of Mycotoxin-Contaminated Grain (FSTU) research area supports research on food safety and food processing issues related to the presence of *Fusarium* spp. mycotoxins in wheat and barley grain. Practical outcomes of research in this area include: 1) improved toxicological data to assure that current guidelines are providing the appropriate safety factors for the consumer; 2) analytical tools that can be used by small grain producers, elevators, millers, and processors, to rapidly and reliably identify mycotoxin-contaminated grain; 3) develop appropriate strategies to deal with contaminated grain; and 4) diagnostic data on *Fusarium* spp. mycotoxins required for development of FHB resistant/tolerant varieties of wheat and barley.

FY14-15 Research Priorities derived from Action Plan Goals:

1. Provide analytical support for DON/trichothecene quantitation for Initiative's stakeholders.
2. Provide requisite information on DON/trichothecene safety issues to producers, millers, researchers, risk assessors, and regulators.

GENE DISCOVERY AND ENGINEERING RESISTANCE (GDER)

Program Description:

The Gene Discovery and Engineering Resistance (GDER) research area (RA) will focus primarily on the identification of genes from wheat and barley that can be used to increase FHB resistance and/or reduce DON accumulation, and on development of engineered strategies for FHB resistance or reduced DON levels. Gene discovery and transformation of non-cereal systems will be supported only for the purpose of rapidly screening potential anti-*Fusarium* genes.

FY14-15 Research Priorities derived from Action Plan Goals:

1. Characterize the genetic function of existing and novel loci for FHB resistance.
2. Identify candidate genes for resistance against FHB and/or reduced DON accumulation.
3. Develop effective FHB resistance and/or reduced DON accumulation through transgenic strategies.
4. Develop improved methods for the generation of transgenic wheat and/or barley.

PATHOGEN BIOLOGY AND GENETICS (PBG)

Program Description:

Research in this area includes studies that address mycotoxin biosynthesis in vivo or in planta, host/parasite interactions, and host resistance mechanisms that target the pathogen. Research in PBG should complement and be linked to whole plant research that will lead to disease control and/or toxin reduction strategies.

FY14-15 Research Priorities derived from Action Plan Goals:

1. Characterize plant-fungal interactions in plant lines (including transgenic lines) being developed by the USWBSI.
2. Develop new strategies for reducing impact of FHB disease and mycotoxin contamination in barley and wheat. Focus on pathogen genes and responses, including specific host target genes.

VARIETY DEVELOPMENT AND HOST RESISTANCE (VDHR)

Program Description:

The VDHR research area will be Uniform Nursery based in the case of soft winter wheat and spring wheat. States will be aligned with the uniform nurseries as follows: Uniform Regional Scab Nursery for Spring Wheat Parents (MN, ND, SD, MT); Uniform Northern Winter Wheat FHB Screening Nursery (NY, MI, OH, IN, IL, MO, KY); Uniform Southern Soft Red Winter Wheat FHB Screening Nursery (NC, MD, VA, AR, GA, LA). VDHR research will be commodity-based in the case of barley, durum and hard winter wheat coordinated projects.

Each Uniform nursery will be coordinated by a regional committee. Nurseries will be conducted in collaboration with a pathologist wherever possible and a subset of promising entries may be grown at multiple locations in Integrated Management Trials. The nurseries will also be evaluated for milling and baking quality, and haplotyped at the USDA regional genotyping labs. The most promising lines may be entered in the nurseries for a second year of testing at the lines originator's request. Collaborators will submit candidate parents for crossing, and prebreeding populations derived from these crosses/populations will be made available to all collaborators. Mapping of new resistance sources will be accomplished through joint phenotyping of populations. All collaborators must screen varieties planted commercially (>5% of wheat acreage) in their state for FHB resistance and provide this information to growers.

FY14-15 Research Priorities derived from Action Plan Goals:

1. Increase acreage planted with varieties with improved FHB resistance to reduce DON in the US grain supply.
2. Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties.
3. Develop new breeding technologies and germplasm to further enhance short term and long term improvement of FHB resistance and to efficiently introgress effective resistance genes into breeding germplasm.

BARLEY COORDINATED PROJECT (BAR-CP)

Project Description:

Minimizing the impact of Fusarium head blight (FHB) on barley production in the U. S. requires a multi-dimensional, yet focused and coordinated research effort. The Barley Coordinated Project (CP) seeks to combine existing lines of productive research with new avenues of investigation to develop a set of tools and disease management strategies that will minimize disease risk to producers and end-users of barley (Figure 1). This toolbox will consist of: 1) varieties with enhanced levels of resistance to FHB, lower levels of deoxynivalenol (DON), superior agronomic performance, and good end-use quality; 2) chemical formulations, application procedures, and a disease forecasting model, that maximize fungicide efficacy; 3) residue management strategies that reduce the potential of pathogen inoculum to contribute to disease epidemics; and 4) a set of best management practices that incorporate our current understanding of the tools available to combat this disease.

FY14-15 Research Priorities derived from Action Plan Goals:

The Barley CP is organized around four of the Research Areas (RA) outlined in the USWBSI Action Plan. A set of 10 objectives are established within these four RAs.

I. Variety Development and Host Resistance (VDHR)

- Objective 1. Screen available *Hordeum* germplasm for novel sources of resistance.
- Objective 2. Map novel QTL for resistance to FHB in barley.
- Objective 3. Validate and fine map FHB resistance QTL.
- Objective 4. Develop new barley varieties with enhanced resistance to FHB and lower DON.

II. Gene Discovery and Engineering Resistance (GDER)

- Objective 5. Identify barley genes differentially regulated in the barley-*Fusarium* interaction.
- Objective 6. Evaluate promising transgenes in adapted genetic backgrounds in regional nurseries.

III. Pathogen Biology and Genetics (PBG)

- Objective 7. Investigate host genotype x pathogen interaction for infection, spread, disease development, and accumulation of DON.

IV. FHB Management (MGMT)

- Objective 8. Elucidate the epidemiology of colonization and survival of *Fusarium graminearum* on host tissue, disease development, and toxin accumulation.
- Objective 9. Develop and evaluate chemical/biological management strategies that reduce FHB and/or DON in barley.
- Objective 10. Develop and promote best management strategies through integrated disease management.

DURUM COORDINATED PROJECT (DUR-CP)

Project Description:

Fusarium head blight (FHB) caused by the fungus *Fusarium graminearum* Schwabe [telomorph: *Gibberella zeae* (Schwein.) Petch.] has been seriously attacking durum wheat (*Triticum turgidum* L. var. *durum*) in North Dakota and the surrounding states. There is continuous decline in harvested durum acreage and production in the durum producing area in the United States because of FHB. Fungicides may reduce the disease but the most environmentally safe and economical way to control the disease is with genetic resistance. A durum Coordinated Project (CP) has been created under the direction of the USWBSI to accomplish the initiative action plans. The CP's main objective is to develop FHB resistant durum wheat germplasm (lines/cultivars) with low DON levels, good agronomic traits, and good quality traits that will serve the producers, the domestic pasta industry, and the international export market. Reducing the impact of FHB requires a multidisciplinary effort and therefore the CP includes plant breeders, pathologists, geneticists, and researchers working in the area of disease management. The CP also includes stakeholders such as millers and pasta manufactures.

FY14-15 Research Priorities derived from Action Plan Goals for VDHR:

1. Search for novel sources of resistance to FHB in durum and its tetraploid relatives.
2. Identify, map, and validate FHB resistance QTL in the newly identified sources of resistance and develop user-friendly molecular markers to assist selection in durum breeding and germplasm development.
3. Incorporate FHB resistance QTL from tetraploid and hexaploid wheat accessions into adapted durum backgrounds and develop elite durum germplasm with the assistance of molecular markers in selection.
4. Develop durum varieties with enhanced level of FHB resistance and reduced DON accumulation.
5. Investigate host genotype x pathogen chemotype/genotype interaction for FHB and DON.
6. Evaluate chemical management strategies that reduce FHB and/or DON in durum.
7. Develop and promote best management strategies through integrated disease management.

HARD WINTER WHEAT COORDINATED PROJECT (HWW-CP)

Project Description:

The HWW-CP is an efficient coordinated project that will measure its success by reducing DON in the hard winter wheat grain supply to the food grade level acceptable in the European Union (EU). This level is currently lower than the US standard. Because half of our grain is exported and the majority of it shipped to the EU, the risk is that it can be sourced from high scab areas within the HWW region (e.g. the Eastern Great Plains). As the popularity of whole grain products increases, our goal is to ensure that the DON concentration in these products is also below established thresholds. Based upon the timelines expected for success in reducing DON, the HWW-CP includes the scientific activities of plant breeders, pathologists, geneticists and supporting research programs. We coordinate with disease management efforts because we realize that in addition to improved varieties, improved management will optimize project success within expected timelines. HWW-CP germplasm and information are publicly available and made available to other participating researchers in other research areas of the USWBSI. The HWW-CP remains focused on reducing DON levels as quickly as possible and by using the most efficacious methods to do so. Membership in the HWW-CP includes; all researchers currently funded within the CP, individuals designated as representatives from other research areas of the USWBSI, all interested FHB researchers who may or may not be funded by the USWBSI, stakeholders representing members from groups that fund our research (e.g. the KS, NE, SD, and ND Wheat Commissions), and members of groups that are key to our industry and who non-monetarily support HWW-CP research. These are “independent” stakeholders, such as major mills and bakeries, private wheat breeders, and chemical company representatives.

FY14-15 Research Priorities derived from Action Plan Goals:

The HWW-CP is organized around two of the research areas – Variety Development and Host Resistance (VDHR) and FHB Management (MGMT) as outlined in the USWBSI Action Plan. Two major objectives and associated research activities have been established within this CP. In addition, the HWW-CP works closely with other USWBSI Research Areas (RAs) to support the stated goal of reducing DON levels specified by the EU. Specifically, the HWW-CP works most closely with the MGMT RA.

Variety Development and Host Resistance (VDHR) and FHB Management (MGMT)

Objective 1. Increase acreage planted to varieties exhibiting improved FHB resistance to reduce DON in the HWW grain supply.

Associated Research Activities:

- Increase efficiency of individual breeding programs to develop and release FHB resistant varieties.
- Develop new breeding technologies and germplasm to further enhance short-term and long-term improvement of FHB resistance and to efficiently introgress effective resistance genes into breeding germplasm.
- Test and evaluate regional germplasm to include breeding lines from public and private breeding programs and to include irrigated field nurseries representative of all FHB environments throughout the region.

Objective 2. Evaluate practices enhancing varietal resistance and disseminate information that in association with resistant varieties, leads to reduced DON in the HWW grain supply.

Associated Research Activities:

- Characterize genotype x fungicide treatment responses for enhancing FHB resistance and the reduction of DON.
- Develop a full understanding of specific environmental and biological factors influencing FHB infection and toxin accumulation.
- Enhance communication and end-user education/outreach relating to resistant varieties and effective management practices.