2010-11 Washington Grain Commission
Funded Research Project Summaries

End-Use Quality Assessment of Washington State University Wheat Breeding Lines

Researcher: Byung-Kee Baik

This project intends to increase the competitiveness of Washington wheat in the global market by developing wheat varieties possessing desirable end-use quality characteristics. Each year they carry out end-use quality testing of more than 1000 wheat breeding lines of WSU winter and spring breeding programs based on physical characteristics and chemical composition, milling quality and end-product performance. The data and information generated from this project are essential for developing new wheat varieties possessing superior and consistent quality attributes.

Quality Evaluation Improvement of the Sponge Cake Baking Test

Researcher: Byung-Kee Baik

The goal of this research project is to develop a simple, fast and reliable sponge cake baking test for determination of end-use quality of soft white wheat for Asian markets. The new method will be simpler and faster than the existing method, and will provide reliable estimation of soft wheat quality. The newly developed sponge cake baking test will mainly target the F6 & F7 generation breeding lines, which are not currently being evaluated by the existing sponge cake baking test. The new test will reinforce the existing sponge cake baking test for evaluation of soft white wheat quality, rather than replacing it.

Building a Mutation Breeding Toolbox for Wheat

Researcher: Brian Beecher and Camille Steber

This project proposes to develop TILLING as a tool for reverse genetics and mutation breeding in Pacific Northwest wheat. Advances in molecular genetics have identified genes controlling important traits in wheat and in model organisms. This knowledge about gene function can be applied to wheat improvement and to wheat research using methods such methods such as genetic transformation and generation of mutations in target genes through TILLING, a "reverse" genetics technique. TILLING and genetic transformation are both important tools for our genetic toolbox, and both are needed to keep Washington wheat genetic research and breeding programs competitive. Specifically, this project will develop an efficient and cost-effective TILLING resource for use by Washington researchers.

Weed Management in Wheat

Researcher: Ian Burke

This project is working to identify improved management strategies for troublesome weeds including Russian thistle, kochia, prickly lettuce, Italian ryegrass, and downy brome in wheat and chemical fallow, through new and expanded herbicide label options, application timings, or increased knowledge of the biology and ecology of the weeds.

Pursuit Carryover and Osprey Tolerance in Winter Wheat
Researcher: Ian Burke
This project is working to identify the amount of Pursuit soil residue necessary to cause a yield loss in winter wheat in a legume/winter wheat rotation, and identify susceptible wheat varieties and the environmental conditions that cause Osprey injury to winter wheat.

Evaluation of and Selection for Cold Tolerance in Wheat
Researcher: Kim Garland Campbell
The purpose of this project is to assay cereal variety trials and regional nurseries for cold tolerance. In addition, the project will assay breeder samples for cold tolerance. They have completed the initial testing of the WA winter wheat extension trials and the Western Regional Winter Trials. The project is starting to test winter wheat breeder samples (ID, OR, WA, and ARS). The goal is to improve winter survival of winter wheat in the Pacific Northwest.

Development of Winter Wheat Varieties Resistant or Tolerant to Fusarium Crown Rot Resistance
Researcher: Kim Garland Campbell
The purpose of this project is to identify breeding lines and cultivars with better performance in fields infected with Fusarium crown rot. Methods to assay Fusarium tolerance in the seedling and adult plant stages have been developed. They are completing screening of two mapping populations that will identify the number and location of genes for Fusarium resistance in the Australian wheat cultivar, Sunco. They are backcrossing several sources of Fusarium resistance into adapted PNW breeding lines and these populations will be screening using the newly developed methods starting in the fall on 2009. The second year of the project they will complete a large survey of Fusarium species present in the PNW. This information will be useful so that they can target breeding efforts to locations where Fusarium is present and to quantify the amount of Fusarium present in fields.

Club Wheat Breeding
Researcher: Kim Garland Campbell
The purpose of this project is to develop soft white club wheat cultivars for the PNW with resistance to multiple diseases and end use quality desired by importers. They planted trials in 11 locations in WA, ID and OR. They have abandoned two locations (Lind and Harrington) due to poor stands because of extreme dry conditions at planting but have good stands at all other locations. They are conducting marker assisted selection for resistance to stripe rust, strawbreaker foot rot, preharvest sprouting, barley yellow dwarf resistance, and to Hessian fly. They are completing our early generation evaluation of club end use quality. Two breeding lines, with excellent end use quality, resistance to stripe rust and strawbreaker foot rot and competitive grain yield and test weight, ARS970075-3C (soft white club) and ARS960277L (soft white common) have been approved for preliminary breeder seed increase at Othello in 2009.

Evaluation of Wheat Breeding for Management of Hessian Fly in the PNW
Researcher: Kim Garland Campbell
The purpose of this project is to screen the Western Regional Nurseries and advanced breeder nurseries for resistance to Hessian Fly. They are currently subsampling those nurseries and working out evaluation dates. They will screen them this summer. The object of the project is to provide data so that wheat breeders can introgress different sources of resistance to Hessian Fly into their cultivars and to document the extent of Hessian Fly infestation on spring wheat at locations in Idaho and Eastern Washington.

Field Breeding Hard White and Red Winter Wheat
Researcher: Arron Carter
This project is focused on the development of broadly adapted, high yielding hard red and hard white winter wheat varieties with high yield stability, durable disease resistance, rapid emergence, and improved end-use quality.

Field Breeding Soft White Winter Wheat
Researcher: Arron Carter
The focus of this project is the development of improved varieties of soft white winter wheat. They seek to improve the sustainability of wheat production in the state through the use of increased genetic diversity, utilization of wild wheat germplasm and through changing the wheat plant itself to function better in more sustainable systems.

Biotechnology for Wheat Improvement
Researcher: Arron Carter
This project is designed to identify novel sources of resistance and end-use quality that can be used in rapid forward breeding to supplement the conventional breeding program projects such as HRW, HWW, SWW and Club. Through the use of laboratory assessments such as cytogenetic evaluation, DNA amplification, sequencing, mapping, and gel-electrophoresis, we have sped up and will continue to speed up breeding.

QTL Identification and Deployment through Graduate Student Training
Researcher: Arron Carter
This project is designed to develop research projects centered on graduate student training to enable the education of future plant researchers as well as enhance cultivar development efforts.

Control of Stripe Rust, Leaf Rust, and Stem Rust of Wheat
Researcher: Xianming Chen
The research goal is to prevent major losses in wheat yield and quality caused by stripe rust, leaf rust, and stem rust, and assures stable, sustainable wheat production. They conduct both basic and applied studies to understand how rust epidemics occur and develop integrated strategies to control the diseases. Their specific studies include monitoring disease development and rust race changes; developing forecasting models for better predict rust epidemics; identifying new chemicals for use to reduce damage; and more effort on identifying new sources and genes for rust resistance, developing

molecular markers for resistance, understanding how resistance works, and supporting breeding programs for developing new cultivars with adequate and durable resistance.

Wireworm Control in Cereal Grains
Researcher: Aaron Esser and Keith Pike
The goal of this project is to help eastern Washington cereal grain producers profitably manage wireworm (Limonius spp.) using cultural controls and current labeled insecticides, and examine new insecticides with potential to control wireworms and gain label approval. Wireworm populations and crop damage in cereal grains have increased across eastern Washington even when seed applied insecticides have been used.

Development of Two-gene Clearfield' Wheat Varieties Using Marker- assisted Background Selection
Researcher: Kulvinder Gill
The main objective of this project is to transfer resistance to imidazolinone herbicides such as 'Beyond'™ into current and upcoming winter, spring and club wheat Washington varieties using marker-assisted background selection.

Wheat Improvement by Genetic Modification (GMO) and Plant Transformation
Researcher: Kulvinder Gill
The main problem that this project will address is farm profitability. Current estimates show that growing GMO crops (corn, soybean, canola and cotton) has increased farm incomes by $34 billion. They expect that introduction of GMO wheat in the PNW will increase farm profitability in wheat as well. Since it takes a long time to release a variety by any method, they are starting GMO wheat research at WSU in order to establish a GMO cultivar pipeline by the time GMO wheat cultivation becomes acceptable.

Development of Superior Wheat Varieties Using Forward Breeding and Gene Pyramiding Approaches
Researcher: Kulvinder Gill
The key objective of this project is to develop superior wheat varieties harboring multiple gene combinations controlling various agronomic traits. This project proposes to transfer two-gene Clearfield resistance, high yield, stripe rust, and grain quality in various combinations.

Evaluation of Wheat and Barley Varieties
Researcher: Stephen Guy
The WSU Extension Uniform Cereal Variety Testing Program provides growers, the agribusiness industry, university researchers, and other interested clientele with comprehensive, unbiased information on the adaptation and performance of winter and spring wheat and barley cultivars across the climatic regions of eastern Washington. The number of variety trail locations are: 11 for spring barley, 21 for soft white winter wheat, 11 for hard red winter wheat, and 14 for all classes of spring wheat. Results from this program are disseminated by Extension programming to provide unbiased

information about variety performance to empower clientele in making economically desirable variety selection decisions.

Off-Season Wheat Seeding – Spring or Winter Varieties
Researcher: Stephen Guy
This project will investigate off-season, late fall or early spring, wheat seeding of spring versus winter varieties to characterize crop survival, performance, and potential use. During off-season wheat seeding (late fall or early spring) either spring or winter wheat cultivars could be used, but advantages and drawbacks to that choice are not well defined, especially in the more temperate growing areas of Washington. Some possible outcomes are: spring wheat may be favored when seeding late in the fall to shorten the growing season enhancing water utilization, re-seeding hard red winter wheat after poor establishment or winter survival gives poor performance due to limited vernalization, hard red spring wheat seeded into hard red winter will mix classes, and facultative winter wheat or cold tolerant spring cultivars could give better performance for reseeding or late fall seeding after moisture is available.

Engineering resistance to rusts by pathogen-derived genes
Researcher: Scot Hulbert
The main goal of the project is to find a method of engineering durable resistance to rusts in cereals. Three species of Puccinia rusts attack wheat, P. graminis pv. tritici causes stem rust, P. triticina causes leaf rust and P. striiformis causes stripe rust. While the method of engineering resistance we will attempt should work equally well against all of the rusts, we will focus on P. striiformis because it is the most important in Pacific Northwest (PNW) wheat growing regions.

Quality of Varieties and Pre-release Lines: Genotype & Environment – "G & E" Study
Researcher: Craig Morris
The goal of this project is to obtain robust, statistically-valid comparisons of the quality of new varieties and pre-release lines, including those from both private and public breeding programs; build a database of quality data for different environments/regions. This is done by providing thorough and complete quality evaluation data to support other studies.

Supplemental Support for Assessing the Quality of Washington Wheat Breeding Samples
Researcher: Craig Morris
This research is designed to increase the competitiveness of Washington wheat in the global market by developing and promoting agronomically superior varieties that also possess desirable end-use quality characteristics. This is accomplished by providing supplemental seasonal support for assessing the milling, baking and end-use quality of breeding samples so that a greater number of samples can be analyzed and done in a more timely basis.

Control of Strawbreaker Foot Rot and Cephalosporium Stripe in Winter Wheat
Researcher: Tim Murray
The primary goals of this project are to evaluate advanced breeding lines and winter wheat cultivars for resistance to Cephalosporium stripe and Strawbreaker foot rot diseases in field plots, to find new sources of resistance to these diseases in wild relatives of wheat, and to identify the specific genes for resistance so they can be used by breeding programs to improve resistance. The research continues to evaluate new candidate fungicides for strawbreaker control, as well as improving performance through optimal timing based on plant growth stage. All of these activities are ongoing in the program.

Enhancing Resistance to Snow Mold Diseases in Winter Wheat
Researcher: Tim Murray
This project objective is to transfer new snow mold resistance genes from the resistant Austrian variety Münstertaler into PNW-adapted winter wheat varieties using marker-assisted selection and growth chamber tests to speed-up the development of new varieties. Münstertaler has been crossed with Masami and Xerpha in the greenhouse and work is now in progress to advance generations as rapidly as possible. Advanced generations will be evaluated with molecular markers associated with resistance and tested for snow mold resistance in the growth chamber, so that only the most resistant lines are field-tested. The ultimate goal is to deliver winter wheat lines with improved resistance to snow mold that could be easily integrated into winter wheat breeding programs.

Modification of Coleoptile Length in Wheat via Manipulation of the AHL Gene Family
Researcher: Michael Neff
The goal of this project is to enhance winter wheat seedling emergence when planted deeply in low-rainfall dryland cropping regions (generally less than 10"/year). This can be achieved by developing varieties that have long coleoptiles as seedlings while maintaining semi-dwarf growth characteristics as adults.

An Integrated Approach to Development of Resistance in Wheat to Root-lesion Nematodes
Researchers: Timothy Paulitz, Axel Elling, and Kim Garland-Campbell
The long-term goal of this research is to develop durable genetic resistance/tolerance to root-lesion nematodes in wheat varieties adapted to growing conditions in Washington. This will be done in two ways: 1) identify and characterize resistance genes to root-lesion nematodes from an Iranian landrace (AUS28541) by classical breeding, using mapping and QTL analysis and 2) identify root-lesion nematode effector genes that are necessary for infection and that can be developed as new control targets in future studies using marker assisted selection or genetic engineering. This project will set the foundation for a nematology research program in small grains in Washington.

Management of Root Diseases of Wheat and Barley: Pre-Breeding, Risk Assessment and Cultural Control
Researchers: Timothy Paulitz, Patricia Okubara, and Scot Hulbert
This multi-researcher proposal will take three approaches to management of root diseases of wheat: 1) Screen wheat synthetic hexaploids and mutational breeding lines for tolerance to Rhizoctonia; 2) develop disease thresholds to relate soil inoculum levels (measured by our molecular techniques) to disease and crop loss; 3) Continue to assess time of herbicide sprayout, stage of weed development and weed species in relation to Rhizoctonia greenbridge control.

Wheat Head Army Worm
Researchers: Keith Pike and Diana Roberts
The wheat head army worm is an emerging pest on wheat and barley in Lincoln County, where it reduced test plot yields about 35% in 2007 and 2008. The armyworm has the potential to become damaging across all the cereal grain producing counties. In this project, they will track the life cycle of the pest, conduct pesticide efficacy studies, and identify the beneficial parasitic species attacking wheat head army worm and their potential as biological control agents.

Improving Spring Wheat Varieties for the Pacific Northwest
Researcher: Michael Pumphrey
The goal of this project is to increase the profitability and sustainability of Pacific Northwest spring wheat production via a comprehensive variety development effort. Washington production environments vary considerably across relatively small geographic distances, while four market classes of spring wheat are produced with variable end-use quality characteristics. Changing production systems, disease and insect pest problems, market preferences/end-uses, and variable weather patterns all demand a long-term integrated effort to respond to and improve yield potential/protection and grain quality.

Molecular Selection of Pest Resistance, Agronomic and Grain Quality Traits for Spring Wheat Variety Development
Researcher: Michael Pumphrey
The goal of this project is to develop and/or implement laboratory techniques and genetic information to directly support stripe rust, Hessian fly, and end-use quality trait improvement in the spring wheat variety development program. Hessian fly infestation and stripe rust epidemics represent a greater than $10 million annual loss threat in Washington spring wheat without adequate variety resistance. As with any plant pests, genetic resistance is the preferred control mechanism. Stripe rust and Hessian fly populations have troubling potential to overcome resistance, thus new sources of resistance in production varieties are an urgent priority to maintain diversity of resistance (reduce vulnerability). Breeding for grain quality is challenging due to quantitative inheritance and variable characteristics within each market class, and is expensive and capacity-limited using conventional methods.

Improving Winter Wheat Seedling Emergence from Deep Sowing Depths
Researcher: Bill Schillinger
The purpose of this project is to improve the seedling emergence of winter wheat planted deep into summer fallow. The project will replace the Rht1 and Rht2 dwarfing genes that impede emergence with genes from Australia or elsewhere that do not impede emergence. The goal is to provide the variety Xerpha with seedling emergence just as good as or better than the variety Moro.

A Genetic Arsenal for Wheat Production Under Drought: Mutation Breeding for Resistance to Drought, Rhizoctonia, and Roundup
Researcher: Camille Steber
The objective of this project is to use EMS treatment to increase the genetic variation and identify plants with the desired traits. Rhizoctonia root rot tolerant lines Scarlet-Rz1 and others were identified and found to resist both species of Rhizoctonia and Pythium. Drought tolerant lines were identified based on increased sensitivity to ABA. And lines giving tolerance to 2x application rates of Roundup were isolated.

Barley Improvement Program Research Technologist
Researcher: Steve Ullrich
The objective for this project is to fund an agricultural research technologist position to maintain and improve the efficiency, effectiveness, and volume of material in the barley breeding program's field, seedhouse, laboratory, and greenhouse operations.

Barley Improvement for Yield, Adaptation and Quality
Researcher: Steve Ullrich
This is the backbone project that funds the operations of the WSU Barley Breeding Program. The overall goal of the barley improvement program is to make barley a more profitable crop by developing improved germplasm and releasing improved cultivars to Washington grain growers. In addition, this project is also working to release new barley varieties resistant to herbicides used in wheat that have plant-back restrictions on barley and varieties resistant to Rhizoctonia root rot. Given that there are no known such resistances, chemical mutagenesis is employed to induce resistant mutants and incorporate them into variety development efforts.

Testing Advanced Breeding Lines for High Production Areas in the PNW
Researcher: Bob Zemetra
The purpose of this research is to identify advanced breeding lines of soft white winter wheat from the breeding programs in the Pacific Northwest that are adapted to the high productions areas (irrigated and high rainfall) of Eastern Washington. The objective is to develop a tri-state irrigated nursery trial with advanced wheat lines provided by the public and two private wheat breeding programs in the Pacific Northwest that would be planted in two irrigated and one high rainfall production areas in Eastern Washington.