

**Progress Report to the Agricultural Research Foundation
Oregon Wheat Commission**

PROJECT: Development of wheat varieties adapted to Oregon production with enhanced disease resistance, stress tolerance, and superior end-use qualities

PROJECT LEADER: C. James Peterson, OSU Crop and Soil Science Dept.

COOPERATORS: Andrew Ross
Chris Mundt
Oscar Riera-Lizarazu
Craig Morris
Dave Shelton

FUNDING HISTORY:

2001-2002	164,992
2002-2003	120,000
2003-2004	200,816

ABSTRACT:

The goal of the OSU Wheat Breeding program is to develop varieties that can increase economic returns to Oregon growers through improved grain yield, disease resistance, and enhanced end-use qualities for marketing. 'ORCF-101', OSU's first soft white winter wheat with CLEARFIELD* herbicide tolerant technology, was released in 2003. ORCF-101 was released primarily for its utility in control of grassy weeds with application of Beyond™ herbicide. Seed of ORCF-101 was released to 15 seed companies through an innovative non-exclusive licensing agreement with OSU that grants permission to produce, sell, and promote seed of the variety. A second SWW CLEARFIELD* selection, OR2010007, is currently on limited Foundation seed increase and will be considered for release in 2004. The primary advantage of OR2010007 appears to be improved tolerance to root diseases, particularly Cephalosporium stripe and Strawbreaker footrot, and superior performance under drier production conditions. Two soft white winter wheat selections, OR9900553 and OR9801757, were advanced to Breeder seed increase. Both lines are noted for their exceptionally soft grain texture, superior milling quality, and superior cookie quality. OR9900553 is a shorter semidwarf, targeted for high yield conditions, while OR9801757 appears better adapted to drier production areas of Sherman, Gilliam, and Morrow counties. A total of 11 experimental lines were entered in state or Regional Nursery trials, seven of which are soft winter wheat selections. Two of these lines are selections from Hybritech germplasm. A modified state-wide variety testing program was initiated and incorporated into our breeding trials for 2004. The Oregon Winter Elite Yield Trial (OWEYT) was designed to support breeding efforts, end-use quality testing, variety release decisions, variety quality recommendations, and provide performance data to growers. Two major research studies are underway to investigate end-use quality improvement of hard white wheats. The first investigates the impact of moisture stress and N management on protein composition and

Asian noodle quality. The second investigates the genetic relationships between protein composition, protein quality, and Asian noodle quality. Collaborations with the OSU Wheat Quality Lab, the Wheat Marketing Center, and ARS-WWQL are continuing to identify hard and soft wheat selections with superior end-use quality and improve marketability and demand for Oregon wheat.

OBJECTIVES:

1. Develop and release new wheat varieties with superior disease resistance and enhanced tolerance to abiotic stresses that minimize production risks and increase economic returns to growers.
2. Provide growers with up-to-date information on near-release and newly released varieties in comparison to currently grown varieties through field days and print and web media.
3. Increase demand and marketability of PNW wheat through development of soft and hard wheat varieties with superior end-use qualities. Identify germplasm, genes, and traits that contribute value-added or product-specific qualities and provide new marketing opportunities for wheat growers.
4. Identify germplasm, genes, and traits that will contribute to superior varietal performance and enhanced yield stability under diverse production conditions. Incorporate these new genetic resources and products of biotechnology into adapted varieties through efficient use of field and laboratory evaluation methods.
5. Integrate Hybritech winter wheat breeding stocks into the OSU breeding program for use in pureline variety development efforts in the PNW. Evaluate selected populations and advanced lines for yield potential, agronomic traits, winterhardiness, response to Stripe rust, and end-use quality.

PROCEDURES:

For 2003-04, due reduced funding of state extension programs, a modified state-wide variety testing program was initiated and trials were incorporated into our breeding trials. The Oregon Winter Elite Yield Trial (OWEYT) and Oregon Spring Elite Yield Trial (OSEYT) were designed to collect important performance data needed for breeding, variety release and co-release decisions, and reports to the seed industry and Oregon growers. New varieties and variety candidates, both public and private, from throughout the region are evaluated in the trials. Grain samples from the OWEYT and OSEYT are used for end-use quality analyses to support wheat quality improvement efforts, release decisions, variety recommendations, and information for future marketing activities.

Varieties and breeding materials must be evaluated under a wide array of environmental and management practices to characterize performance and adaptation. Early generation breeding materials (F1 through F5) are evaluated through a shuttle between Hyslop and Pendleton (Ruggs) to identify broadly adapted, disease resistant selections. Mid-late generation materials, (preliminary and advanced lines of F6 through F9) are evaluated in replicated trials at our core nursery sites at Pendleton (Rugg-Barnett), Moro (Sherman County Experiment Station), and Corvallis (Hyslop Research Farm). In addition, six

‘satellite’ testing nurseries are used to more rapidly characterize performance of our breeding lines. Each site includes three replications of the OWEYT, one or two replications of Advanced SW and HW nurseries, and unreplicated plots or observation rows of lines in preliminary and advanced yield trials (F6 through F8 generations). In fall 2003, the nurseries were planted at sites near Moro (Chris Kaseberg), Condon (Jeff Nelson), Arlington (Eric Anderson), Lexington (Chris Rauch), Hermiston (Kent Madison), and Moses Lake, (John LaFave, for winterhardiness testing). These sites were chosen to represent a very diverse array of production conditions; from very low rainfall to full irrigation, shallow to deep soils, and low residue to high residue management practices. With these diverse experimental locations we expect to more rapidly characterize performance of our breeding lines and parent stocks for adaptation, yield potential, stress tolerance, and disease resistance.

As example of breeding trials established for 2004, a list of trials at each of the **satellite locations** is included. There were no separate ‘Hybritech yield trials’ for 2004, as the Hybritech germplasm stocks have been fully integrated into our advanced breeding trials.

Oregon Winter Elite Yield Trial (OWEYT): Elite soft-seeded lines and check varieties. (40 entries, three replications); included variety candidates from ID and WA and private companies.

SWADV I – Advanced soft white selections with checks (40 entries, F8 generation, one replication)

SWADV II– Advanced soft white selections with checks (40 entries, F8 generation, one replication)

SWADV III – Advanced soft white selections with checks (40 entries, F8 generation, one replication)

Hard White Elite: Elite hard-seeded lines with check varieties. (20 entries, two replications)

Hard White Advanced: Advanced hard-seeded selections with check varieties (40 entries, one replication)

IMIADV: Advanced Clearfield herbicide tolerant selections. (33 entries, one replication)

OR-ID Irrigated Yield Trial: Advanced lines from OR and ID breeding programs with potential for irrigated wheat production. Planted at Hermiston, OR, and Parma, Hazelton, and Aberdeen, Idaho; conducted in cooperation with Ed Souza and Bob Zemetra, University of Idaho. (26 entries, 3 replications)

Nickerson Elite: OSU selections from materials provided by the Nickerson breeding program. Planted at Hermiston. (60 entries, 2 reps)

Observation Nurseries: A single replication of one- or two-row plots for each of the following sets of advanced lines:

SWRPN-1	Soft White Replicated Prelim Nursery (80 entries, F7 generation)
SWRPN-2	Soft White Replicated Prelim Nursery (80 entries, F7 generation)
SWRPN-3	Soft White Replicated Prelim Nursery (80 entries, F7 generation)
SWPYT	Soft White Preliminary Yield Trial (560 entries, F6 generation)

Germplasm collaborations and exchange are continuing priority. In 2004, we will be evaluating over 200 new varieties and germplasms from the Nickerson breeding programs, which are located in England and France. Sixty lines from Nickerson that were screened in 2001 through 2003 have been advanced to multilocation replicated yield trials for more detailed characterization of adaptation, yield potential, and disease resistance. Sixty-five winter wheats were imported from Turkey as candidates for the Eastern European Regional Yield Trial. Colleagues in Martonvasar, Hungary provided us with a dozen new hard red wheats for 2004. Evaluation and characterization of nearly 300 new spring wheat germplasms from CIMMYT continues, including those selected on-site in Obregon in 2001.

REPORT OF ACCOMPLISHMENTS:

Status of New Varieties: This past year marked the release and licensing of ‘**ORCF-101**’, OSU’s first soft white winter wheat with CLEARFIELD* herbicide tolerant technology. ORCF-101 was released for its utility for grassy weed control with applications of Beyond™ herbicide. ORCF-101 is a semidwarf soft white winter wheat derived from the three-way cross ‘CV-9804’//‘Malcolm’//‘Stephens’//‘Madsen’. ORCF-101 is adapted to production areas of northeast Oregon, southeast Washington, and Idaho and possesses adult-plant resistance to stripe rust (*Puccinia striiformis*). ORCF-101 is moderately susceptible to most major diseases of the PNW, including Strawbreaker (*Pseudocercospora*) footrot, *Septoria tritici*, crown rot (*Fusarium pseudograminearum*) and Cephalosporium stripe (*Cephalosporium gramineum*). Analyses conducted by the ARS- WWQL suggest that ORCF-101 has good overall milling quality, flour yield, protein content, and baking quality, and performs very similar to Stephens. ORCF-101 has been submitted for Plant Variety Protection with the Title 5 option.

Seed of ORCF-101 was released to the seed industry through an innovative non-exclusive licensing agreement with OSU that grants permission to produce, sell, and promote seed of the variety. The seed licensing agreement and commercialization terms were developed with input and support of the Clearfield Advisory Committee, the Oregon wheat industry, and BASF. Fifteen seed companies have licensed ORCF-101 to date. Over 3,300 bushel of Foundation seed (200,000 pounds) were purchased in fall, 2003. We expect approximately 250,000 bushels of seed stocks, as either Registered or Certified class, to be available in fall, 2004.

OR2010007 is a CLEARFIELD* soft white winter wheat selection currently on limited Foundation Seed increase for potential release in August, 2004. It has the pedigree ‘Madsen/FS-4//Weatherford’ and has tracked one year behind ORCF-101, largely because of the variability in plant type and need for additional purification. Herbicide tolerance and response of ORCF-101 and OR2010007 are similar, and similar to Clearfirst.

The primary advantage of OR2010007, as compared with ORCF-101 (and Idaho 587), appears to be improved tolerance to root diseases, particularly Cephalosporium stripe and

Pseudocercospora (Strawbreaker). The advantage has become more evident in this past year's yield trials and disease evaluations. In inoculated trials, OR2010007 has been shown to carry the VPM resistance to strawbreaker footrot, with similar disease response to its parents Madsen and Weatherford, that we apparently have missed in ORCF-101. In inoculated *Cephalosporium* stripe trials, OR2010007 has shown tolerance to the disease similar to that of Madsen or Weatherford. In contrast, response of ORCF-101 has been similar to susceptible varieties such as Tubbs or Stephens. Response to *Fusarium* crown rot has been less clear. However, in yield trials at Arlington and Kaseberg's, OR2010007 appears to have better tolerance to crown rot than ORCF-101, Stephens, or Tubbs, and is again more similar to Madsen or Weatherford. In USDA-ARS stripe rust evaluations, OR2010007 has shown good levels of adult plant resistance, similar to Stephens, ORCF-101, or Tubbs.

OR2010007 is taller than ORCF-101 and Stephens. It is also slightly later maturing than ORCF-101 and Stephens, more similar to Weatherford. In 2003, OR2010007 showed a yield advantage over ORCF-101, 67.8 bu/a compared with 63.0 over eight Oregon locations. Over the last 3 years, yield advantage of OR2010007 has been most evident at the drier locations, or sites with significant root disease pressure. End-use quality of OR2010007, as based on available data, would be considered satisfactory. It is scheduled for further evaluation through the Western Wheat Quality Lab and Wheat Quality Council this winter. Grain test weights of OR2010007 have generally been higher than for ORCF-101 or Stephens.

The 2003 data suggests that, as a variety, OR2010007 would be complementary to ORCF-101 (and Idaho 587). OR2010007 appears to have disease tolerances similar to Madsen, and thus by association Clearfirst, and has shown significantly higher grain yield potential as compared with Clearfirst. If approved for release, OR2010007 would be released to the industry through OSU's non-exclusive licensing program, which is already in place for ORCF-101.

'**Tubbs**' soft white winter wheat was released in 2002 for its superior yield potential and broad adaptation. This past year, Tubbs again performed exceptionally well in variety trials throughout the PNW and, by fall, seed stocks were in great demand. We estimate that over 100,000 acres of Tubbs were planted in fall, 2003. This compares with the initial 2002 Foundation seed release of only 80,000 pounds. We expect both Certified and Registered seed stocks will be widely available for planting in fall, 2004.

Results of 2003 Breeding Trials: Breeding stocks were evaluated at a total of 10 locations in 2003, including six 'satellite' sites. Average grain yields of the Soft White Elite Nursery ranged from lows of 19.4 bu/a at Lexington to 128.3 at Hermiston. Dry conditions again impacted the trials at many sites in 2003, but the drought was by far most damaging at the Lexington site. Heat stress was severe in late-June and early-July (mid-late grainfill) and contributed to reduced kernel size and higher grain protein concentrations, particularly at the Pendleton and Condon sites. Fortunately, the Pendleton Rugg's nursery site was previously summer fallowed and it had sufficient moisture for the crop to finish with relatively normal yields, averaging just over 100 bu/a.

The Arlington and Condon nurseries were noted for good early growth and uniform stands. However, both nurseries ran out of moisture during grain fill and finished under significant stress with grain yields in the low 40's. The Arlington and Kaseberg nurseries had a severe and uniform infection of Fusarium dryland crown rot. The infection was helpful to differentiate lines for disease response, with white-head ratings ranging from 0 to 40%. Stands were somewhat more variable than desired at Moro and Kaseberg's, due to dry, deep, and variable moisture conditions at planting.

Grain yields averaged 66 bu/s at Hyslop, less than ½ of normal production levels. Spring rains continued late and waterlogged soils did not dry up until late May. This was followed by periods of severe early heat stress in June and July that impacted yield and exacerbated the damage from root and foliar diseases. An intense stripe rust infection occurred at Hyslop farm and was very beneficial in identifying and eliminating susceptible selections and populations. Yields averaging 128 bu/a were obtained under irrigation at Hermiston, in spite of late heat stress. The high yield conditions were beneficial in evaluating plant type, head fertility, shattering, and lodging resistance. There was no indication of winter injury at the Ritzville site. The site was abandoned prior to harvest due to extreme within-field variability in soil depth and moisture availability, which was further exacerbated by severe heat stress in early July.

Soft White Winter Wheat Improvement: Two soft white winter wheat selections were advanced to Breeder seed increase. OR9900553 is from the cross 'Arminda/3/VPM/MOS951//2*Hill/5/ID#870337'. The last parent, ID#870337, is a selection from complex spring x winter parentage. OR98001757 is from the cross 'Yamhill/Hyslop//Stephens/3/OR7946/Hill//Hill (as selection WSQ910137) /4/Sambo/Heine 4//Stephens/3/Wattines//Yamhill/Hyslop'. In our end-use quality evaluations, both OR9900553 and OR9801757 have been noted for their exceptionally soft grain texture, superior milling quality, and superior cookie quality. OR9900553 was evaluated through the PNW Wheat Quality Council in 2002 and 2003 and was acclaimed for its very soft kernel texture, higher break flour yields, and superior product qualities. OR9900553 is a shorter semidwarf, targeted for irrigated or higher moisture production conditions. Grain yields of OR9900553 have been competitive, but not outstanding. OR9801757 has been noted for its superior agronomic performance in trials from the drier production areas of Sherman, Gilliam, and Morrow counties. They are envisioned as complementary release candidates, of similar superior end-use quality for marketing, but with very different target production areas.

Seven soft white winter selections were advanced to either State-wide Variety Trials or Regional Nursery testing for 2004; including OR2010007 (a CLEARFIELD* selection), OR9900553, OR9801757, OR9900513, OR9901887, ORH010918 and ORH010920. The two selections designated with 'ORH' represent the first of the Hybritech germplasm stocks to reach Regional Nursery testing. ORH010918 and 920 are sister lines from a cross of OSU experimental OR8303765 with a French line designated E81FR. Grain yield and performance data for varieties and selections in the Soft White Elite Yield Trial for 2003 can be found in Table 1.

Hard White Winter Wheat Improvement: There were relatively few elite hard white winter selections evaluated in the 2003 yield trials. This is a reflection of increased selection pressure on our HW germplasm for improved noodle color and improved protein quality. The most promising advanced hard white selection is OR942496 from the cross 'CEBECO148//CNO/INIA//LFN/3/K//PET/RAF/4/ ND/P101//AZT'. OR942496 has been entered in the 2004 Asian Products Collaborative, sponsored by the Wheat Marketing Center. OR942496 has performed satisfactorily in preliminary quality tests, although its soft noodle texture and slightly weak gluten characteristics may yet be a concern.

Four hard white wheat selections were advanced to either state variety trials or Regional Nursery testing; including OR942496, OR953475, OR952577, and OR2010399. Grain yields and performance from the 2003 Hard White Elite Nursery are summarized in Table 2. The majority of lines in the 2003 HW Elite were dropped due to their inability to meet the tight criteria we have established for acceptable HWW quality.

Behind these advanced lines, we are currently fast-tracking high-priority hard white cross combinations. Numerous F3 populations and F4-derived lines are in the field and greenhouse from 3-way crosses of (OSU HWW's) x (Plains HRW and HWW) x OR943575. These combinations should provide us with means to simultaneously improve protein quality, winterhardiness, and noodle color, while capturing the high yield, broad adaptation, low PPO, and footrot resistance of our hard white selection OR943575.

Hybritech germplasm: Of the over 2100 Hybritech purelines first evaluated in 2001, two lines are now entered in Regional Nursery trials and 20 lines are in Elite or Advanced multilocation yield trials. Results from the 2003 Hybritech Elite Yield Trial can be found in Table 3. Over 8,000 headrow selections from the segregating HT populations were evaluated and several hundred lines advanced to first-year yield trials. Relatively high selection intensities have been used to capture the most promising genetic stocks while quickly reducing total number of populations and lines.

Until fall of 2003, the Hybritech stocks were being managed as a parallel breeding effort to our core program. This last fall, the most promising preliminary and advanced lines were merged into common OSU trials for further evaluations. The last of the early generation Hybritech stocks are now in F3 and F4 generations. This means we anticipate large headrow nurseries and preliminary yield trials yet for 2004 and 2005, but we are closer to fully digesting and integrating the most promising of the Hybritech germplasm stocks into our program. Due to high land costs at Hyslop farm, the early generation stocks (F3 bulks and F4 headrows) are all being grown and evaluated at the Rugg's site. In 2003, selection efforts were facilitated by a severe infection of Stripe rust at both Pendleton and Hyslop.

Spring Wheat Improvement: Spring wheat breeding efforts were focused on identifying lines with resistance to the new stripe rust races and improved resistance to the Hessian fly. For 2004, two spring selections have been entered in the Oregon Spring

Elite Yield Trial (OSEYT), both with good resistance stripe rust. OR490230 (chil/wuh3), a hard white, also carries resistance to the Hessian fly and has shown good baking and noodle characteristics in our preliminary tests. The hard red selection, OR4880189 (BJY's' /4/TZPP//IRN46/ CNO67/3/PRT), is noted for its strong dough properties. Three hard white selections will enter Regional Nursery trials in '04, OR4201080, OR4201104, and OR4970018, each derived from CIMMYT spring wheat germplasm.

Initial screening of new CIMMYT spring wheat stocks were completed in 2003 and promising lines will be tested in yield trials for the first time in 2004. Also, selections derived from our first set of dedicated spring x spring crosses made in 2000 will enter yield trials this year.

Early Generations and Crossing: Over 500 soft and hard wheat crosses were made in the field and greenhouse in 2003. A larger proportion of topcrosses were made last year to facilitate introgression of quality traits and disease resistance from red-seeded or unadapted parent lines. Priority parents include French lines that have shown superior yield potential and disease resistance, Plains hard wheats with superior protein quality; and crosses for development of CLEARFIELD* selections. The highest priority F2's are being advanced through the greenhouse using modified single seed descent.

In total, over 11,000 plots, 35,000+ headrows, 240 space plant populations, 500+ bulk F2 and F3 populations, and 640 entries in observation trials were evaluated in 2003 for plant type, maturity, disease resistance, grain yield, grain quality, and end-use quality over 9 locations in Oregon.

End-use Quality: End-use quality research and development efforts involve extensive collaborations with Dr. Andrew Ross, the OSU Quality Lab, the Wheat Marketing Center, USDA-ARS-Western Wheat Quality Lab, USDA-GIPSA-FGIS, and commercial companies. Resulting data and information are distributed in various forms and are too numerous to summarize here. Reports from major programs, such as the APC, OVA, USWRN, or WQC are distributed directly to cooperators and others in the wheat industry. Other information, such as results of breeding trials specific to Oregon, are available on request. Support from Craig Morris and the USDA-ARS Western Wheat Quality Lab in evaluating our preliminary and advanced breeding lines is gratefully acknowledged.

With support and efforts of Dr. Andrew Ross and Jae-Bom Ohm, a new early generation screening protocol was implemented in 2003. The goal was to increase selection pressure for end-use quality in the F4 and F5 generations and identify superior quality lines earlier in the breeding program. Critical quality tests were conducted after harvest of F4 and F5 headrows, but prior to planting of these selections into first year yield trials. In 2003, over 1400 lines were screened for single kernel hardness and polyphenol oxidase activity between harvest and planting. The screening helped to eliminate nearly 34% of our hard white wheat headrow selections prior to planting. Most were eliminated due to high PPO activity, which is an indicator of poor noodle color. The same tests helped to eliminate nearly 16% of SWW selections that had potentially poor milling due to harder grain

texture. Nearly 50% of the hard-grained Hybritech headrow selections were eliminated based on poor PPO. Early generation quality screening at the F4 and F5 generations significantly improves our breeding efficiencies. Visual selection for high grain yield potential in headrows is inherently inefficient. With effective quality screening, more lines can be selected in the field, evaluated in the lab, and then quickly eliminated should they fail to meet quality standards. As the proportion of poor-quality lines that enter first-year yield trials are greatly reduced, additional selection pressure can be brought to bear to improve grain yield, disease resistance, and adaptation.

Two major research studies are underway to improve end-use quality of hard white wheats for the PNW. These are serving as PhD thesis research for Carolina St. Pierre, a Fulbright scholar from Argentina, and Sarah Gehlhar, a student from North Dakota. Carolina St. Pierre is investigating the impact of moisture stress and N management on protein composition and Asian noodle quality of hard white wheat varieties. The first year of her field trials, conducted under line-source irrigation systems at Hermiston and Madras experiment stations, are now complete and laboratory quality analyses are underway. The research will lead to improved hard white wheat management and marketing strategies for the PNW, provide insights into protein quality and processing attributes needed to develop varieties with consistently superior Asian product quality, and characterize the complex interactions between genotype and environment that impact quality. Sarah Gehlhar is investigating the relationships between protein composition, protein quality, and Asian noodle quality of hard white wheats. Gel electrophoresis and size-exclusion HPLC are being used to characterize protein composition of selections from 5 populations of hard white wheats. The populations were derived from crosses of OR943576 with superior bread-quality hard wheats from the Midwest. The research will identify the proteins and biochemical traits that are needed to meet quality needs of both bread and Asian noodle products.

CLEARFIELD* production system research: In collaboration with Dan Ball, we are continuing to evaluate tolerance of new CLEARFIELD* wheat varieties to Beyond herbicide. The research has contributed to release of ORCF-101, provided important information for growers and seed industry regarding herbicide response and potential crop damage, and will be the basis for future publications.

The CLEARFIELD* trait conditions a tolerant, not resistant, response to the Beyond™ herbicide. As such, it is important to characterize and confirm herbicide tolerance in each genetic background before released for commercialization. It is also important to understand how crop tolerance and response may be influenced by crop development stage, crop health, environmental conditions, herbicide rate and chemical adjuvants. CLEARFIELD* varieties were evaluated in the 2001-02 and 2002-03 crop years at the Sherman County Experiment Station (Moro) and at the Rugg's research site near Pendleton. In each trial, Beyond was applied at 4, 6, or 12 oz rates at two crop development stages. In both years, CLEARFIELD* varieties showed significant crop response to Beyond herbicide. The response appears related to post-treatment environmental conditions and crop health, in addition to application rates. Visual response symptoms did not necessarily translate into reduced grain yields, however, and

test weights were generally improved with use of the herbicide. The CLEARFIELD* varieties in these studies responded similarly to varying rates and application dates for Beyond herbicide and there was no evidence of a genetic background effect on expression of the CLEARFIELD* trait.

Other collaborative research: Grain samples from our multilocation elite variety trials are now being used for end-use evaluations in collaboration with the Western Wheat Quality lab. The goal is to develop more comprehensive data on variety quality characteristics for use in variety release decisions, marketing information, and preferred variety lists for Oregon growers. Data will be combined with that of Washington variety trials to investigate Genotype by Environment influences on quality, characterize varietal stability and adaptation, document annual crop quality and provide information necessary to develop grain-shed based marketing strategies.

Dick Smiley is continuing research and evaluations of elite cultivars and novel germplasm for Fusarium foot rot resistance. The 5th year of Fusarium trials are now underway. Chris Mundt is screening elite selections, novel germplasms and resistance genes for reaction to pseudocercospora footrot and Cephalosporium stripe. In addition, Mundt, Peterson, and Riera-Lizarazu are collaborating on a 3-yr STEEP grant for research on Cephalosporium stripe in wheat. The research effort integrates disease screening of novel genetic stocks with molecular marker technologies to identify and manipulate genetic resistances to the disease. Genetic stocks were developed and planted in fall, 2003, to facilitate the first year of research and disease evaluations

In collaborations with the CIMMYT winter wheat program in Turkey, our program supports the quarantine increase, packaging, and distribution of seed stocks for the Facultative and Winter Wheat Observation Nursery (FAWWON) and EEWWRYT Eastern Europe Winter Wheat Regional Yield Trials. The stocks are an important source of new parents for our program and are provided to breeding programs throughout the US and North and South America. Grant funds through the US AID-supported Central Asian Caucuses program cover our costs for managing the nurseries in 2002-03.

IMPACTS:

The soft white winter wheat 'Tubbs' was released to growers in 2002. Over 100,000 acres of production are anticipated for 2004. Tubbs represents a significant improvement in grain yield and will provide direct economic returns to Oregon wheat growers through increased productivity and production efficiency. ORCF-101, a broadly adapted CLEARFIELD* herbicide resistant variety, will reduce economic losses from grassy weeds, increase management options, and further increase production efficiency. Selections with enhanced end-use quality, such as OR9900553 and OR9801757, are expected to increase market demand for Oregon wheat. Investments in wheat breeding continue to contribute to the state agricultural economy through increased grain yield, enhanced yield stability, increased production efficiency, superior end-use quality for marketing and novel quality for market development.

RELATION TO OTHER RESEARCH:

Nine locations of grain samples will be obtained from HW and SW field trials. These samples, in varying stages of variety development, are being used for studies on end-use quality in collaboration with the OSU Wheat Quality Lab, the Wheat Marketing Center, ARS-WWQL, and USDA-GIPSA. Samples from the OWEYT and OSEYT are the basis for the OWC grant-funded end-use quality research of Andrew Ross. The goal is to develop comprehensive multilocation data on variety quality characteristics for use in variety release decisions, marketing information, and preferred variety lists for Oregon growers. As another example, samples from Hybritech nurseries are being used in an M.S. thesis study under supervision of Andrew Ross. The study evaluates application of solvent retention capacity tests as predictors of end-use quality using grain from the 2002 Hybritech Advanced nurseries. Numerous crosses and populations are being developed for collaborative genetic studies on end-use quality, disease resistance, adaptation, and stress tolerance.

OSU wheat breeding and genetics research is conducted in collaboration with researchers throughout Oregon and the PNW. Collaborative projects include those with: Andrew Ross to investigate grain biochemical composition in relation to end-use quality for Asian markets; Oscar Riera-Lizarazu to identify and use molecular markers for improvement of disease resistance and quality traits; Dick Smiley to evaluate varieties and germplasm for resistance to Fusarium foot rot resistance; Wheat Marketing Center on multipurpose end-use evaluations of hard white wheats; and with Chris Mundt on laboratory and field evaluations of Cephalosporium stripe and Pseudocercospora footrot resistance. Herbicide resistant wheat cultivar development and stewardship continues with Dan Ball and BASF. New studies of N management interactions with drought stress and genetic control of protein content in hard white germplasm are being pursued in collaboration with Neil Christensen and Stephen Machado. Trials under direct-seed conditions have been conducted in collaboration with Don Wysocki and Erling Jacobsen. Germplasm development efforts involve collaborations with Nickerson, CIMMYT, Agripro and many others.

ACKNOWLEDGEMENTS:

Our appreciation is extended to the Oregon Wheat Commission and the OWGL for their ongoing support and commitment to the wheat breeding and variety development effort. We also wish to thank Larry Williams, Chris Kaseberg, Jeff Nelson, Eric Anderson, Kent Madison, Chris Rauch, Gary Galbraith, and John LaFave for providing land and support for our field trials. Special accolades go out to Mary Verhoeven, Bruce Hofer, Mark Larson, Dave Schweitzer, and John Bassinette for their efforts and contributions, particularly in management of the HybriTech germplasm and integrating the state-wide variety testing program into the breeding effort.

RELATED PUBLICATIONS AND PRESENTATIONS:

Publications:

Graybosch, R., N. Ames, P.S. Baenziger, and C.J. Peterson. 2004. Genotypic and environmental modifications of Asian noodle quality of hard winter wheats. *Cereal Chem.* 81:19-25.

Peterson, C.J. Release of the new OSU CLEARFIELD* wheat variety ORCF-101. *Oregon Wheat*, March/April, 2003. pg 12-14.

Web sites:

OSU Wheat Breeding and Variety Performance
<http://cropandsoil.oregonstate.edu/wheat/>

OSU CLEARFIELD* Wheat Varieties - Release, Licensing, and Stewardship
<http://cropandsoil.oregonstate.edu/wheat/orcf-101/>

Variety releases and Plant Variety Protection (PVP):

C.J. Peterson, M. Verhoeven, M. Larson, B. Hoefler, W.E. Kronstad, R. Karow, J. Bassinette, C. Morris, D. Engle, A. Ross, J. Ohm, D. Ball, C. Mundt, R. Smiley, Z. Chen, and G. Vollmer. 'ORCF-101' soft white winter wheat. Released January 3, 2003.

PVP application for 'Tubbs' soft white winter wheat. Submitted, June, 2003.

PVP application for 'ORCF-101', a CLEARFIELD* soft white winter wheat. Submitted, June, 2003.

Presentations – local, regional, national, international:

Clearfield variety development and release at OSU. Central Oregon Farm Fair. February 5, 2003. Madras, OR. Invited.

Public-private partnerships and commercialization of OSU's Clearfield wheat varieties. BASF Corp. Triangle Park, NC. March 18, 2003. Invited.

Wheat breeding 101: Fundamentals of wheat breeding and variety development. BASF Corp. Triangle Park, NC. March 19, 2003. Invited.

Developing a public commercialization strategy for OSU's Clearfield wheat variety. BASF Clearfield Symposium. Denver, CO. Nov. 1-2. 2003. Invited.

Performance, commercialization, and licensing of OSU's Clearfield variety ORCF-101. Open meeting for PNW seed industry, OSU Crop and Soil Science. June 23, Pendleton, OR. Host, speaker, and organizer of the ½ day meeting.

Wheat variety development and delivering enhanced end-use quality to the marketplace. Sherman County OWGL meeting. Nov. 7, Grass Valley, OR. Invited.

Update of OSU's Clearfield variety development effort. Washington Crop Improvement Association Annual Meeting. November 19, 2003. Moscow, ID. Invited.

Tolerance of CLEARFIELD* wheat varieties to Beyond herbicide. C.J. Peterson, M. Verhoeven, M. Larson, B. Hoefler, J. Bassinette, D. Ball, and L. Bennett. Poster presentation. OWGL Convention, Dec. 1-2, Tigard, OR.

OSU Wheat Breeding - Progress Update. OWC Research Review. March 5, 2003, Boardman, OR.

Field day presentations - OSU Sponsored: CBARC; CBARC/Wheat breeding update at Rugg's nursery site; Sherman County Experiment Station, Moro; Morrow County Crop Tour, Lexington; Hyslop Field Day, Corvallis.

Western Regional Wheat Workers meeting and field plot tour. June 17 and 18, Pendleton, OR. Local host and member of organizing committee.