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**2004
Field Day
Abstracts:
*Highlights of
Research
Progress***

Dedicated to Roger Veseth

Department of Crop and Soil Sciences

Technical Report 04-2

Full articles on the Web at <http://css.wsu.edu>

WSU Dryland Research Station, Lind · June 10, 2004
WSU / USDA-ARS Palouse Conservation Field Station, Pullman · June 24, 2004
WSU Wilke Farm, Davenport · June 30, 2004

John Burns, Editor



World Class. Face to Face.

Welcome to our 2004 Field Days!

As the Chair of the Department of Crop and Soil Sciences, I am proud to introduce the 2004 Field Day Abstracts: Highlights of Research Progress. This publication has a simple purpose: to introduce you to over 35 research programs conducted in 2004 by WSU faculty and USDA/ARS research scientists working as part of or in cooperation with the Department of Crop and Soil Sciences.

The Department of Crop and Soil Sciences mission states that we will “discover and develop principles of crop and soil sciences through scientific investigation and apply these principles to the development of new crop varieties and new crop, soil and water management practices in agricultural, urban and natural environments; teach principles and applications to undergraduate and graduate students; and disseminate accumulated knowledge through resident instruction, continuing education, extension, publications, and professional contacts.”

As you will see in the abstracts, we have exciting new and ongoing research activities. Our 2004 departmental sponsored field days are just one way for us to help you learn more about the latest developments in our research programs.

Sincerely,

A handwritten signature in black ink, appearing to read "W. L. Pan".

Dr. William L. Pan, Chair
Dept. of Crop & Soil Sciences

DEDICATION TO ROGER VESETH

Roger Veseth, Extension Conservation Tillage Specialist, passed away on September 9, 2003 in Moscow, Idaho at the age of 51 years, the result of a sledding accident in March 2003 that paralyzed him from the neck down. Roger had the unique distinction of serving in a dual appointment with the University of Idaho (UI) and Washington State University (WSU) for 19 years.

Roger was born and raised on a ranch 60 miles south of Malta, Montana in Phillips County. Malta is a small town on US Highway 2 in northeast Montana. His dad emigrated from Norway and his mom emigrated from Canada, both around 1915. Living on a remote ranch in the Montana prairie with his parents and an older brother and sister, Roger developed the values and work ethic that followed him the rest of his life, according to his wife Claire. Throughout grade school, Roger attended one-room schools and graduated from 8th grade at Second Creek School with three other classmates—considered one of the larger graduating classes. From there he entered Malta High School graduating in 1971. Because of the 60 mile distance between school and his ranch home, Roger boarded with his older sister in Malta during the week while attending high school, traveling home on weekends to help with the farm work. When his sister graduated from high school he boarded with another local family.

Roger attended college at Montana State University (MSU) in Bozeman, Montana and graduated with B.S. and M.S. degrees in Agronomy and Soil Science, respectively. Roger met Claire Barreto while both were graduate students in Agronomy at MSU and were married in 1982. Following graduate school Roger and Claire moved to Rugby, in north central North Dakota, where they together worked for an agricultural consulting firm. Claire developed an interest to pursue a nursing degree, which brought them to the PNW in 1983 at which time she enrolled at the Intercollegiate Center for Nursing Education in Spokane, Washington. Roger interviewed for a newly created Extension Specialist position for conservation tillage jointly with UI and WSU, and was selected for the position in 1984, which he held until the time of his death.

Roger enjoyed playing the mandolin. He played by ear and could pick up any tune. He loved to social dance, something he picked up as a child growing up, and he and Claire took every opportunity to dance that they could. Roger was fond of the outdoors, especially cross-country skiing, running, hiking and biking with his family. His greatest joy was their children and the time he spent with them. Roger is survived by his wife Claire and their four children, Rachel, 18 yrs; Brian, 16 yrs; Julia, 14 yrs; and Anne, 12 yrs; at their home in Moscow, Idaho.

Roger was passionate in his position as conservation tillage specialist and derived his energy and initiative from literally hundreds of farmers he worked with to extend the development, transfer and awareness of new farming and conservation practices. He was a talented and prolific writer that produced extension documentation by publications, computer access, award-winning brochures and information packages. One of his most notable accomplishments was co-authoring Wheat Health Management, with Dr. R.J. Cook, USDA/ARS plant pathologist. This was, and still is, one of the most comprehensive reference publications that presented easily understood discussions about the interactions of agronomic practices with insects, diseases, nematodes and weeds in wheat production systems. His organizational skills were unparalleled and exemplified by his development of the Pacific Northwest (PNW) Direct Seed Conference that annually attracted hundreds of participants from throughout the USA and Canada to interact on subjects that fostered integration of new technologies to protect soil and water resources. He readily assumed leadership roles in such programs as STEEP (Solutions to Environmental and Economic Problems), and the Columbia Plateau PM10 Project. He developed and published a PNW Steep Extension Conservation Tillage Handbook in the early 1990's that continues to serve as a cornerstone of research information focusing on conservation tillage production systems.

Roger received numerous awards, including the Kenneth J. Morrison Extension Award and the WSU College of Agriculture, Natural and Resources Sciences Faculty Excellence Award. His many contributions advanced conservation science and practice on farmlands throughout the Pacific Northwest, U.S., and worldwide to provide a legacy to conservation knowledge and foundation that will serve as guidance for many years.

2004 FIELD DAY ABSTRACTS: HIGHLIGHTS OF RESEARCH PROGRESS

* indicates full article available on the Web: <http://css.wsu.edu>

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CUNNINGHAM AGRONOMY FARM

In 1998, a team of Washington State University and USDA-ARS scientists launched a long-term direct-seed cropping systems research program on 140 acres of the WSU-own Cunningham Agronomy Farm located 7 miles NE of Pullman, WA. The goals are to:

- Play a leadership role through research, education and demonstration in helping growers in the high-precipitation areas of the Inland Northwest make the transition agronomically and economically to continuous direct-seeding (no-till farming) of land that has been tilled since farming began near the end of the 19th century.
- Provide databases and understanding of the variable soil characteristics, pest pressures, and historic crop yield and quality attributes over a typical Palouse landscape as the foundation for the adoption and perfection of precision-agriculture technology in this region.

These two goals are intended to facilitate the greatest technological changes for Northwest agriculture since the introduction of mechanization early in the 20th century. Growers and agribusinesses are recognizing both the need for and opportunities presented by these changes.

The past 3 years have been used to obtain site-specific data and develop physical maps of the 140-acre farm, with the greatest detail developed for a 90-acre watershed using 369 GPS-referenced sites on a nonaligned grid. Maps are available or being developed from archived samples for soil types and starting weed seed banks, populations of soilborne pathogens, and soil water and nitrogen supplies in the profile. This has been achieved while producing a crop of hard red spring wheat in 1999, spring barley in 2000, and initiating six direct-seed cropping systems (rotations) starting in the fall of 2001. Yield and protein maps were produced for the crops produced in 1999 and 2000.

The 90-acre portion of this farm is unquestionably the most intensively sampled and mapped field in the Inland Northwest. Some 20-25 scientists and engineers are now involved in various aspects of the work started or planned for this site. A 12-member advisory committee consisting of growers and representatives of agribusiness and government regulatory agencies provide advice on the long-term projects and the day-to-day farming operations, both of which must be cutting edge to compete scientifically and be accepted practically. This farm can become a showcase of new developments and new technologies while leading the way towards more profitable and environmentally friendly cropping systems based on direct seeding and precision farming.

HISTORY OF THE DRYLAND RESEARCH STATION

The Washington State University Dryland Research Station was created in 1915 to "promote the betterment of dryland farming" in the 8-to 12-inch rainfall area of eastern Washington. Adams County deeded 320 acres to WSU for this purpose. The Lind station has the lowest rainfall of any state or federal facility devoted to dryland research in the United States.



Buildings and grounds of the WSU Dryland Research Station at Lind.

Research efforts at Lind throughout the years have largely centered on wheat. Wheat breeding, variety adaptation, weed and disease control, soil fertility, erosion control, and residue management are the main research priorities. Wanser and McCall were the first of several varieties of wheat developed at the Lind Dryland Research Station by plant breeding. Twenty acres of land can be irrigated for research trials. The primary purpose of irrigation on the Dryland Research Station is not to aid in the development of wheats for higher rainfall and irrigated agriculture, but to speed up and aid in the development of better varieties for the low-rainfall dryland region.

Dr. M. A. McCall was the first superintendent at Lind. McCall was a gifted researcher given somewhat to philosophy in his early reports. In a 1920 report he outlined the fundamental reasons for an outlying experiment station. He stated: "A branch station, from the standpoint of efficiency of administration and use of equipment, is justified only by existence of a central station." The Lind station has followed the policy of studying the problems associated with the 8-to 12-inch rainfall area.

The facilities at Lind include a small elevator which was constructed in 1937 for grain storage. An office and attached greenhouse were built in 1949 after the old office quarters burned down. In 1960, a 40' x 80' metal shop was constructed with WSU general building funds. An addition to the greenhouse was built with Washington Wheat Commission funding in 1964. In 1966, a deep well was drilled, testing over 430 gallons per minute. A pump and irrigation system were installed in 1967. A new seed processing and storage building was completed in 1983 at a cost of \$146,000. The Washington Wheat Commission contributed \$80,000 toward the building, with the remaining \$66,000 coming from the Washington State Department of Agriculture Hay and Grain Fund. A machine storage building was completed in 1985, at a cost of \$65,000, funded by the Washington Wheat Commission.

Growers raised funds in 1996 to establish an endowment to support the WSU Dryland Research Station. The endowment is managed by a committee of growers and WSU faculty. Grower representatives from Adams, Franklin, Benton, Douglas, Lincoln, and Grant counties are appointed by their respective county wheat growers associations. Endowment funds support facility improvement, research projects, equipment purchase, and other identified needs. Also in 1996, the state of Washington transferred ownership of 1000 acres of adjoining land to the WSU Dryland Research Station.

Since 1916, an annual field day has been held to show growers and other interested people the research on the station. Visitors are welcome at any time, and your suggestions are appreciated.

PALOUSE CONSERVATION FIELD STATION

The Palouse Conservation Field Station was established as one of 10 original erosion experiment stations throughout the United States during the period 1929 to 1933. The station consists of a number of buildings including offices, laboratories, machine shop, a greenhouse, and equipment buildings, as well as a 200-acre research farm. Scientists and engineers from the USDA/ARS and Washington State University utilize the Station to conduct research projects ranging from soil erosion by wind and water to field-scale cropping and tillage practices on the steep slopes common on the Palouse.

Several persons are employed at the Station by both the federal and state cooperators. The Station has a full-time manager who lives on-site and maintains the busy flow of activities which characterize the farm. This includes the day-to-day routine items, farm upkeep, maintaining the complex planting and harvest schedule to meet the requirements of the various cropping research, and operating the machine shop



Aerial view of the Palouse Conservation Farm

which fabricates a majority of the equipment used in the research projects. There

are also a number of part-time employees, many of whom are graduate students, working on individual projects. Along with the many research projects, a no-till project at the Palouse Conservation Farm was initiated on bulk ground in the fall of 1996. The objective of this project is to determine if it is technologically possible and economically feasible to grow crops in the eastern Palouse under no-till. The ARS Units at Pullman are focusing on technologies and research needed to make no-till farming possible in this region.

HISTORY OF SPILLMAN AGRONOMY FARM

In the fall of 1955, 222 acres of land were acquired from Mr. and Mrs. Bill Mennet at the arbitrated price of \$420 per acre. The money for the original purchase came as the result of a



William J. Spillman, breeding plots at Pullman, 1900

fund drive which raised \$85,000 from industry and wheat growers. In addition, \$35,000 came from the Washington State University building fund, \$11,000 from the State Department of Agriculture, and another \$10,000 from the 1955-57 operating budget. The dedication of the new facility took place at the Cereal Field Day July 10, 1957. In 1961, the Agronomy Farm was named Spillman Farm after the distinguished geneticist and plant breeder at Washington State University in the late 1880s.

Through the dedicated efforts of many local people and the initiative of Dr. Orville Vogel, arrangements were made to acquire an additional 160 acres north of the headquarters building in the fall of 1961. This purchase was financed jointly by the Wheat Commission and Washington State University. The newly acquired 160 acres were fenced and the wetland drained; it became an integral part of the Agronomy Farm, now consisting of 382 acres.

The headquarters building, which is 140 feet long and 40 feet wide, was completed in 1956. A 100- by 40 foot addition was built in 1981. In 1957, a well that produced 340 gallons per minute was developed. In 1968, the Washington Wheat Commission provided funds for a sheaf storage facility that was necessitated by the increased research program on the farm. At the same time the Washington Dry Pea and Lentil Commission provided \$25,000 to build a similar facility for the pea and lentil materials. The facilities of the Spillman Agronomy Farm now range in value well over a half million dollars.

The Spillman Agronomy Farm was developed with proper land use in mind. A conservation farm plan which includes roads, terraces, steep slope plantings, and roadside seedings has been in use since the farm was purchased.

In addition to the original development of the farm utilizing conservation farming practices breeders are utilizing acreage to develop cropping systems that will include opportunities to include organic, perennial and biotechnological components in cereal and legume breeding programs.

WILKE RESEARCH AND EXTENSION FARM

The Wilke Research and Extension Farm is located on the east edge of Davenport, WA. The 320-acre farm was bequeathed to WSU in the 1980's by Beulah Wilson Wilke for use as an agricultural research facility. A local family has operated the farm for approximately 60 years. Funding for the work at the Wilke Farm comes from research and extension grants and through the proceeds of the crops grown. Goals for research at the Wilke Farm are centered around the need to develop cropping systems that are economically and environmentally sustainable. Focus is on systems that reduce soil erosion by wind and water, improve the efficiency and net return of farming operations, enhance soil quality, and reduce stubble burning.

The Wilke Farm is located in the intermediate rainfall zone (12-17 inches of annual precipitation) of eastern Washington in what has historically been a conventional tillage, 3-year rotation of winter wheat, spring cereal (wheat or barley), followed by summer fallow. Wheat is the most profitable crop in the rotation and the wheat-summer fallow rotation has been the most profitable system for a number of years.

The farm is split in half by State Highway 2. The north side has been in continuous winter or spring cereal production for approximately 10 years and being cropped without tillage for the past 5 years. Since 1998, the south side has been dedicated to the Wilke Research Project that is testing a direct seed, intensive cropping system. The south side of the Wilke Farm was divided into 21 separate plots that are 8 to 10 acres in size and farmed using full-scale equipment. There are three replications of a 4-year rotation (winter wheat, spring cereals, a broadleaf crop, and a warm season grass), and three replications of a 3-year rotation (winter wheat, spring cereals, and a broadleaf crop). Crops grown in the rotation have included barley, winter and spring wheat; canola, peas, safflower, sunflowers, and yellow mustard for broadleaf crops; and proso millet for the warm season grass. Data on soil quality, weed and insect populations, diseases, crop yield, and economics are being collected. The farm provides research, demonstration, education and extension activities to further the adoption of direct-seeding systems in the area. The Wilke Farm is a collaborative approach to develop direct seed systems that include local growers, WSU research and extension faculty, NRCS, agribusiness, Lincoln County Conservation District, and EPA. In addition, the Wilke Farm is used increasingly for small plot research by WSU faculty and private company researchers for small plot cropping systems research.

Due to its location and climate, the Wilke Farm complements other WSU dryland research stations in the Palouse area and at Lind and other locations in the region such as north central Oregon.

I. Breeding, Genetic Improvement, and Variety Evaluations

WINTER WHEAT BREEDING, GENETICS AND CYTOLOGY

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Masami (WA007916), a soft white common winter wheat received full release approval in February 2004. It was released for its excellent grain yield, cold hardiness, end-use quality and disease resistance. Masami is named in honor of Masami “Dick” Nagamitsu, a retired WSU wheat researcher.

Masami is targeted to replace Eltan and Madsen in all precipitation zones of eastern WA as it consistently produces higher grain yields, especially in those areas where foot rot is a problem for Eltan and cold hardiness is a problem for Madsen. It should replace Rod in the low and intermediate precipitation zones and may work well as a mix with Rod as it has a higher test weight and excellent foot rot resistance.

WA007936 is a hard white winter variety developed through the backcross-breeding program. It has superior dual purpose hard white quality and was approved for Breeder Seed increase in the fall of 2003. Statewide Variety Testing summarized results for 2002 show WA007936 has yield, test weight, and all other agronomics similar to Eltan. USDA-ARS Western Wheat Quality Lab analyses of WA007936 show it has good bread and noodle quality. It was evaluated by the Pacific Northwest Quality Council in 2004 and found to have acceptable quality for domestic hard white winter wheat uses.

WA007939 is a hard red winter variety with good bread and noodle quality. Statewide Variety Testing summarized results indicate it consistently outperforms Finley and has phenotypic and agronomic characteristics very similar to Eltan. It was approved for Breeder Seed increase in the fall of 2003. WA007939 was evaluated by the Pacific Northwest Quality Council in 2004 and found to have acceptable quality for domestic hard red winter wheat uses.

SPRING WHEAT BREEDING AND GENETICS

K. Kidwell, G. Shelton, V. DeMacon, M. McClendon, J. Baley and R. Higginbotham

In February 2004, two lines were approved for variety release. **WA7921** (soft white) has high grain yield potential with exceptional end-use quality, partial resistance to the Hessian fly and high temperature adult plant (HTAP) resistant to stripe rust. WA7921 has excellent potential as the Zak and Alpowa replacement in the high rainfall region. The grain yield of WA7921 typically equals or exceeds Zak, Alpowa and Wawawai, and the end-use quality of WA7921 is superior to Zak.

WA7931 (hard white) is a high yielding, partial waxy wheat with partial resistance to the Hessian fly, as well as seedling and HTAP resistances to stripe rust. The grain yield of WA7931 equals or exceeds Lolo, Idaho 377s and Macon across production zones. WA7931 has far better bread making quality than Lolo and Idaho 377s, and it has excellent noodle color and texture. The bread making quality of Macon is superior to WA7931. WA7931 is an outstanding compliment to Macon in that it is much taller and has higher test weight, making it more suitable for production in the semi-arid and intermediate rainfall zones.

In collaboration with Dr. Paulitz, we assessed tolerance levels of a diverse array of wheat germplasm to two *Pythium* isolates previously identified as the most virulent on wheat. Significant differences in susceptibility were detected among genotypes in the presence of both *Pythium* species, and ‘KS93U161’, ‘OH708’ and ‘Sunco’ were the most tolerant to this disease. Efforts to genetically characterize the tolerance identified in the spring wheat cultivar Sunco are underway. In collaboration with Dr. Steber, efforts also were initiated to identify potential gene donors for *Rhizoctonia* root rot resistance through mutation breeding. To date, two Scarlet mutants demonstrated high levels of tolerance to *Rhizoctonia solani* AG-8 in initial screening trials.

***BARLEY IMPROVEMENT RESEARCH**

S.E. Ullrich, V.A. Jitkov, J.A. Clancy, and Judy Cochran

Collaborators: A. Kleinhofs, D. von Wettstein, J.W. Burns, X. Chen, T.C. Paulitz, R.J. Cook, and B.-K. Baik with Research Associates, Technicians and/or Graduate Students

The overall goal of the WSU Barley Improvement Program is to make barley a more profitable crop. Specific objectives are to improve agronomic and grain quality factors and pest (disease and insect) resistance for dryland and irrigated production. The emphasis is on spring hulled barley with additional efforts on spring hulless and/or waxy, and winter types. One new two-row spring cultivar each was released in 2001 (Farmington), 2002 (Bob), and 2003 (Radiant in collaboration with D. v. Wettstein). See Wettstein in this document for more detail. Bob and Radiant have yields similar to Baroness across eastern Washington, while Farmington yields best in med.-high rainfall zones. Based on results from the Extension State Uniform Spring Barley Nursery and others across eastern Washington., Farmington (93 loc-yr), Bob (59 loc-yr), and Radiant (55 loc-yr) yielded 94, 99, and 98% of Baroness, respectively. Overall and for most individual nurseries, the yields of these cultivars were statistically equal or greater than Baroness. All produce relatively high test weights and Bob high kernel plumpness. Farmington and Bob have partial resistance to barley stripe rust. Radiant has potential for malting designation with testing underway. Current collaboration in the North American Barley Genome Project involves fine mapping dormancy and malting quality genes and molecular breeding for malting barley improvement. Molecular breeding of two-row and six-row spring types is underway. Combining the high yield of Baroness and high malting quality of Harrington using molecular marker assisted selection has yielded several promising breeding lines, which is reported in detail by Schmierer et al. in this document. Collaborative projects in evaluating barley for food use and pest resistance are also underway. New breeding lines have been identified with resistance to barley stripe rust, Russian wheat aphid, and Hessian fly. Work on screening for resistance to soil borne pathogens is in progress.

***MOLECULAR MARKER-ASSISTED SELECTION FOR ENHANCED YIELD OF TRADITIONAL MALTING BARLEY CULTIVARS**

Deric Schmierer, Nejdett Kandemir, David Kudrna, Berne Jones,
Steven Ullrich, and Andris Kleinhofs

The Midwest malting barley crop is being devastated by the *Fusarium* head blight disease, rendering it unsuitable for malting. Washington State is capable of growing high quality malting

barley, but lacks high yielding cultivars with the malting qualities desired by brewers. In an attempt to provide high quality lines adapted to the PNW, quantitative trait loci (QTL) conferring high yield on chromosomes 2HL and 3HL from cv. Baronesse have been targeted for introgression into cv. Harrington. Six lines were selected for inclusion in the Washington Spring Barley State Uniform Nursery (SUN) in 2003. All lines have previously demonstrated acceptable malting quality. Yield data from this trial indicated that all lines yielded statistically equal to Harrington. Eight additional lines were included in the 2003 Preliminary SUN (PSUN). Two lines, 00-131 and 00-148, produced yields equal to Baronesse and greater than Harrington. Both lines have acceptable malting quality when compared to Harrington in past years. Sixteen of 28 lines grown in a 2003 supplemental nursery in Pullman produced yields equal to Baronesse.

Experiments are currently being conducted to develop new lines using the Harrington/Baronesse germplasm. One involves inter-crossing selected lines to combine all possible putative yield QTL. Another involves backcrossing to develop better near isogenic lines by eliminating unwanted residual Baronesse fragments from the genome. Molecular markers were used to analyze hundreds of backcross progeny. Fifteen of these progeny lines have been included in a yield trial in 2004 at Spillman Farm in Pullman. Six other lines have been included in the 2004 SUN. Two are holdovers from the 2003 SUN, 00-170 and NZDK7, while one is from the 2003 PSUN, 00-131. The other three were the top yielding lines in the 2003 Pullman nursery. A nursery containing 28 additional lines, including 00-148, was also planted in Pullman.

***CONTROL OF WHEAT AND BARLEY RUSTS 2003 PROGRESS REPORT**

X.M. Chen, D.A. Wood, P. Ling, V. Pahalawatta, G.P. Yan, and L. Penman

Rusts of wheat and barley were accurately forecasted in 2003 based on predictive models, monitoring data, and cultivar resistance. Fungicide application was implemented to control stripe rust on both winter and spring wheat crops, which prevented major losses. The stripe rust epidemic on wheat in 2003 was due to the abundant stripe rust inoculum produced on the previous spring wheat crops, susceptible winter and spring wheat cultivars, mild winter, and favorable weather in the spring. The dry weather from early June and fungicide application slowed down the disease development. High-temperature, adult-plant (HTAP) resistance to stripe rust, which is in most winter wheat and the major spring wheat and barley cultivars, continued to be the most effective and durable type of stripe rust resistance. Without HTAP resistance, the stripe rust epidemic would have been much more widely spread. More than 13,000 wheat and 6,900 barley entries were evaluated for stripe rust resistance, from which new germplasms and advanced breeding lines with stripe rust resistance were identified. The information was provided to breeding programs for developing and releasing new cultivars with adequate resistance. To more efficiently incorporate stripe rust resistance into commercial cultivars and to understand mechanisms of resistance, crosses were made to identify genes, develop molecular markers for genes, and use the markers to transfer genes for resistance. Molecular markers were identified for several genes in wheat and barley for resistance to stripe rust and other diseases. A bacterial artificial chromosomal (BAC) library was constructed for cloning rust resistance genes. BAC and cDNA libraries were constructed to initiate research on genome and functional genomics of the stripe rust pathogen. Foliar applications of Folicur, Tilt,

Quadris, Quilt, Headline, and Stratego were effective for controlling stripe rust when sprayed at the right time. Profitability of fungicide application on various cultivars of wheat and barley without and with different level of stripe rust resistance was determined. Growing resistant cultivars as the primary approach and application of foliar fungicide as a supplementary method have effectively prevented major losses of yield and quality due to stripe rust in the PNW.

***WASHINGTON STATE UNIVERSITY WHEAT QUALITY PROGRAM**

Brady Carter, Cereal Chemist. Tracy Harris, Laboratory Technician

Cooperators: Steve Jones, Kim Kidwell, Kim Campbell, and Craig Morris

The goal of the Washington State University Wheat Quality Program (WSUWQP) is to increase the competitiveness of Washington wheat in the global market by developing and promoting varieties that are superior for both agronomics and end-use quality. This goal is primarily accomplished by the annual testing of over 4000 breeder lines for end-use quality. Testing thousands of lines for quality is very time consuming and labor intensive and can only be accomplished efficiently through the cooperative efforts of the WSUWQP and the Western Wheat Quality Lab.

The strategies and methods used to test breeder lines for quality are continually modified and updated. For instance, this year the WSUWQP developed a system to easily access historical data for any breeding line using statistical analyses and the SAS program. In addition, noodle texture is now being used to analyze all flour samples. Other procedures being considered for addition to the standard set of quality tests are: farinograph, micro-extensigraph, water activity, NIR calibration development and wheat ash.

The WSUWQP has established lines of communication with wheat markets, both domestic and foreign, through meetings and personal visits. Exposure from these meetings has resulted in a high level of interest by the industry in several new WSU varieties. In addition, the WSUWQP has worked hard to establish lines of communication with growers of the state by giving talks at grower meetings and field days.

In the global market, wheat buyers have imposed tighter quality specifications and are demanding wheat varieties that possess flour functionality characteristics that ideally suit them for use in specific products. The future success of the wheat industry in Washington depends on cooperation by the researcher, grower, and end-user to produce a wheat crop that requires less input and possesses superior, consistent end-use quality.

WSU EXTENSION CEREAL VARIETY TESTING PROGRAM – 2003

J. Burns, P. Reisenauer, and J. Kuehner

The goal of the WSU Extension Cereal Variety Testing Program is to provide a uniform replicated testing program that provides comprehensive, objective and readily available information on the performance of public and private cereal varieties to Washington growers. The diversity of growing regions characteristic of Eastern Washington for wheat and barley production necessitates using a large number of testing locations. In addition, multiple market classes of wheat grown commercially and both feed and malting barley require unique testing locations. The Variety Testing Program established 95 separate nurseries at 25 locations in

2003. A combined total of 157 different wheat and barley varieties/experimental lines were evaluated (73 winter wheat, 44 spring wheat and 40 spring barley). Approximately 25% 30% of all entries were from private breeding programs.

Components of the Variety Testing Program that enhance value to plant breeders and producers are:

1. Harvest data specifically for winter wheat is provided within 3-days after harvest. Spring data is provided within three weeks of harvest. Extensive use of information technology is used to provide data on both an E-mail server list as well as the Variety Testing Web site: <http://variety.wsu.edu>
2. Sub-samples from variety testing winter and spring wheat nurseries are utilized for Genotype by Environment wheat quality evaluations by USDA and WSU cereal chemists in the USDA/ARS Western Wheat Quality Lab, Pullman, WA.
3. Formal agreements are in place with the Federal Grain Inspection Service to provide market class grade evaluations of all new lines of winter and spring wheat entered in the Variety Testing Program. Over 930 samples of winter and spring wheat were evaluated in 2003.
4. The Variety Testing Program provides other research programs with variety seed procurement for satellite varietal evaluations. An example is providing complete soft white winter wheat nursery sets for Cephalosporium stripe, stripe rust and Eyespot (Strawbreaker) foot rot disease trials.
5. Crop season variety evaluations are an integral component of the program. Data is collected on emergence, winter regrowth, heading, and unique seasonal conditions (such as disease outbreaks). These evaluations are taken from each plot in each replication and provided to plant breeders and producers to provide additional agronomic evaluation data during the production season.
6. Twenty four formal nursery tours/field days were held in 2003 with a recorded attendance of 1215 individuals that averaged 39 individuals per tour excluding major field days. At 14 of the tours WSU extension agents, producers and/or agribusiness co-sponsored the tour and provided BBQ meals. This high level of support enhanced the visibility and educational experience for the tours.
7. The Washington State Crop Improvement Association (WSCIA) and the WSCIA Foundation Seed Service are key partners in the program. All data entered in the Variety Testing Program for two consecutive years is automatically included in the WSCIA Seed Buying Guide.

NEW DIRECTIONS OF THE GRAIN LEGUME BREEDING PROGRAM

F.J. Muehlbauer, K.E. McPhee, W. Chen, R.W. Short, C.D. Hoagland and S.L. McGrew

The grain legume breeding program is focused on producing new improved varieties of dry pea, lentil, chickpea and fall-sown winter-hardy pea and lentil. Emphasis has been placed on development of edible types of winter peas and winter lentils that can be direct-seeded in the fall into cereal stubble or in reduced tillage situations. All types of edible grain legumes must be environmentally adapted, high yielding and market acceptable. Meeting these demands has necessitated accelerating the breeding process. The breeding efforts directed at each of the individual legume crops are described below.

Dry peas: The dry pea breeding program is focused on developing improved varieties of green and yellow cotyledon spring and winter peas as well as marrowfat types adapted to all suitable U.S. production regions. Goals of the project address production constraints including disease resistance, harvestability, agronomic adaptation, yield and quality. Several new varieties of green cotyledon peas have been released over the past five years. The most recent release was ‘Stirling’ in February 2003. It was released as the first semi-leafless lodging resistant green dry pea from the USDA-ARS program and, like the previous varieties; it has excellent resistance to seed bleach and powdery mildew. The first white-flowered, clear-seeded winter feed pea variety, ‘Spector’ (selection PS9830F009), is slated to be released in 2005. Breeder seed will be increased during the summer of 2004 and Foundation seed will be produced during the winter of 2004/2005 and made available to producers in the fall of 2005.

Lentils: The lentil industry of the U.S. competes in the world market and must have cultivars that produce acceptable quality of the various market classes. Until very recently, the Palouse region produced only one type of lentil, the so-called Chilean type (‘Brewer’) with large, yellow cotyledons. The trend has been toward several additional types including: Spanish Brown, Turkish Red, Eston and Richlea. Recently, a large yellow cotyledon lentil with uniformly green seed coats, ‘Pennell,’ was released the industry. The variety has good standing ability, large non-mottled seeds and higher yields when compared to Brewer. Another large-seeded yellow lentil ‘Meritt’ was also released and is expected to be a replacement for ‘Brewer.’ A new large green (yellow cotyledon) lentil selection, LC860616L, has performed well in the past three years in trials and has been proposed for increase of breeder seed. A release of this selection is planned pending performance in 2004 field trials. The release of ‘Morton’, a red cotyledon lentil with winter hardiness is the first of its kind and has provided improved yields when compared to commonly grown spring varieties. There were difficulties in crop establishment of Morton in the fall of 2003 due to the extremely dry conditions.

Chickpeas: Ascochyta blight is a devastating disease of chickpea in the Palouse area and has caused serious problems with crop production. Recently, we released an improved variety ‘Sierra’ that has better resistance to Ascochyta blight, larger seeds, improved yields and quality. Two additional selections (CA9990I604C and CA9990I875W) may be released this coming winter based on performance in 2004 trials. The former is a café type and the latter is a Spanish White type; both have fern type leaves and improved resistance to Ascochyta blight.

For more information, please refer to the Grain Legume Research Unit website at: <http://pwa.ars.usda.gov/pullman/gl原因/>

II. Crop Management and Direct Seed Systems

OPTIMIZING SEEDING RATE AND PHOSPHORUS FERTILITY TO ENHANCE YIELDS OF RECROP, LATE-SEEDED WINTER WHEAT

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Traditional dryland wheat production in the <12-inch annual rainfall zone is based on a winter wheat-fallow rotation. Recent advancements in direct seeding equipment, improved knowledge of cropping systems and weed management, environmental pressures, and economic demands have generated interest in alternatives to winter wheat-fallow. Annual cropping of spring wheat has generally been less profitable than winter wheat-fallow. Annual cropping with more years in winter wheat may produce higher yields and economic returns than annual cropping spring wheat. Annual cropping would mean delayed winter wheat planting until fall rains create more favorable seed zone moisture conditions. Delayed planting of winter wheat generally reduces grain yields. Therefore, overcoming yield reductions with late-planted winter wheat is important to improve the feasibility of recrop winter wheat. Research on seeding date, seeding rate, and fertility (mainly phosphorus) management suggests a potential to manage seeding rate and fertility to overcome late-planted winter wheat yield reductions. Phosphorus fertility was relatively more effective than increasing seeding rate in producing more spikes per area, the major yield component limited by late planting. Another documented role of phosphorus is to improve water use efficiency of grains under drought conditions. Although this latter finding has not been exploited in current management systems, this suggests an additional opportunity to improve yield in the low rainfall area of the Columbia Plateau through phosphorus management. This project will evaluate recrop winter wheat responses to five phosphorus and two seeding rates. Research will commence in fall 2004 at three locations in the < 12-inch rainfall zone. One location will be on the Lind Dryland Research Station. Funding for the project is through the Otto and Doris Amen Dryland Research Endowment and the Columbia Plateau Wind Erosion/Air Quality Project.

DIRECT STUBBLE SEEDING EFFECTS ON INFILTRATION

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With conventional tillage-based seeding practices that mix and stir the soil and destroy macro-pores in the tilled layer, soil freezing can create an impermeable layer that curtails infiltration and results in runoff and the opportunity for erosion. The process is well-documented in plot and field studies. Continuous direct stubble seeding that leaves surface layer macro-pores intact has been demonstrated to improve infiltration when the soil is not frozen. However, little data has been collected to determine the effect of these macro-pores on infiltration when the soil is frozen. A study was established at the Washington State University Cunningham Agronomy Farm to collect runoff data, and hence infer infiltration, from direct stubble seeded and conventionally tilled and seeded treatments under natural rainfall and snowmelt conditions during the winter season.

Three standing stubble and one tilled treatment were established in fall of 2001. The stubble treatments were placed on the north and south slopes of two east-west ridges, with one

plot of each treatment on each slope. Four replicate plots of the tilled treatments were placed on a southeastern slope and four on a northwestern slope in 2001/2002; four tilled replicates were placed on a northwestern slope in 2002/2003. Similar treatments were established in the fall of 2003.

Data from the winters of 2001/2002 and 2002/2003 have been analyzed. In 2001/2002, a year with drifting snow, aspect of the stubble treatments had more effect than the treatment itself. North slopes had more snow and greater runoff, 10mm vs. 2mm, although there was large variation in the data. On the tilled plots, the northwest aspect plots had 23mm runoff and the southeast aspect only 8mm runoff. In 2002/2003, the stubble treatments were again placed on the north and south sides of two east-west ridges. There was less snow and aspect was not important in the results, with 0mm runoff from the north plots and 1mm runoff from the south plots. None of the stubble treatments had over 6mm runoff. The mean runoff from the four tilled plots was 28mm.

Runoff was greater from conventionally seeded treatments than from continuous direct stubble seeded treatments during the winter seasons of 2001/2002 and 2002/2003. In neither season was infiltration and runoff dominated by a deep freeze and rapid melt event.

***DRYLAND CROPPING SYSTEMS RESEARCH AT LIND**

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Cropping systems research that compares intensive cropping using no-till vs. the traditional winter wheat – summer fallow rotation with tillage has been ongoing at the WSU Lind Dryland Research Station since 1998. Annual spring cropping was not economically competitive with winter wheat - summer fallow from 1998 to 2003. On average, soft white spring wheat grain yield was less than half of grain yield for soft white winter wheat after summer fallow (i.e., one crop every two years). Recrop winter wheat after two years of spring wheat has yielded significantly more grain than continuous annual spring wheat in 3 of 4 years. In addition, Russian thistle infestation in recrop winter wheat is minimal whereas Russian thistle infestation is generally severe in spring wheat. In 2003, winter wheat after summer fallow produced 32 bu/ac compared to 24 bu/ac for winter wheat after chemical fallow, 16 bu/ac for recrop winter wheat, and 8 bu/ac for continuous spring wheat.

ROTARY SUBSOILING TO REDUCE EROSION AND IMPROVE INFILTRATION IN NEWLY-PLANTED WINTER WHEAT AFTER SUMMER FALLOW

John D. Williams, Stewart B. Wuest, William F. Schillinger, and Hero T. Gollany
USDA-ARS, Pendleton, Oregon, and Dept. of Crop and Soil Sciences, WSU

Water erosion and runoff can be severe due to poor infiltration through frozen soil in the dryland wheat (*Triticum aestivum* L.) production region of the inland Pacific Northwest (PNW), USA. For more than 70 years, farmers and researchers have used various methods of subsoiling to reduce runoff and erosion and to improve infiltration and soil water storage. The practice and equipment have evolved from chiseling continuous open channels across hillslopes to the rotary subsoiler that pits the soil. Farmers often subsoil wheat stubble after harvest, but do not employ

this practice on newly-planted winter wheat fields. These fields are especially vulnerable to erosion because of meager residue cover after a year of fallow. A 6-year field study was conducted in eastern Washington to determine the effect of rotary subsoiling in newly-planted winter wheat on over-winter water storage, erosion, infiltration, and grain yield. There were two treatments, rotary subsoiling and control. The rotary subsoiler created one 16-inch-deep pit with 0.98-gallon capacity every 7.5 ft². Natural precipitation did not cause rill erosion in either treatment because of mild winters during the study period. Net change in water storage was significantly ($P < 0.05$) improved with rotary subsoiling compared to the control in 2 of 6 years. Grain yield was not affected by treatments in any year or when averaged over years. In 2003, we simulated rainfall for approximately 3 hr at a rate of 0.72 inch/hr on both subsoiled and control plots to determine runoff and erosion responses on frozen soils. Rotary subsoiling reduced runoff ($P < 0.01$) by 38 percent. Rotary subsoiling also significantly reduced erosion ($P < 0.01$) during the 20- to 45-min period after runoff had begun. The total quantity of eroded soils were 0.58 and 1.52 ton/acre for the subsoiled and control treatments, respectively, with inter-rill the dominant erosion process. The average infiltration rate for the control treatment (0.13 inches/hr) was half of the rate for the subsoiled treatment (0.26 inches/hr), at the end of the 3-hr simulation. Rotary subsoiling of newly-planted winter wheat can increase soil water stored over-winter and reduce runoff and soil loss on frozen soils, but the benefit of this practice for increasing grain yield has not been proven.

SOIL WATER IS STRANDED IN RHIZOCTONIA PATCHES

Bill Schillinger, Harry Schafer, Steve Schofstoll, and Tim Paulitz
WSU and USDA-ARS

Continuous annual no-till soft white spring wheat at the long-term cropping systems study at the Ron Jirava farm near Ritzville is considered an economic (but risky) success, even though an average of 8% of land area was in bare patches caused by Rhizoctonia root rot during the last five crop years (1999-2003). How are the relatively high spring wheat grain yields achieved with such a high level of bare patch disease? Are healthy wheat plants extracting soil water from within the bare patches, thus possibly minimizing or negating the patching effect on wheat grain yield? To find out, we installed neutron probe access tubes in several locations inside and outside of Rhizoctonia patches in all four replications of the continuous annual soft white spring wheat treatment and measured soil water throughout the spring and summer in 2003. Six access tubes were placed in each plot: 10 ft inside a patch (i.e., no healthy wheat within a 10-ft

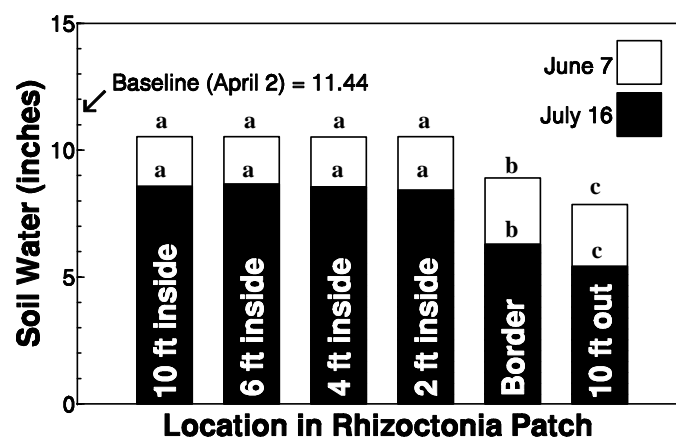


Figure 1. Soil water content in the 6-ft soil profile in June and July of 2003 as affected by the location inside, at the border, and outside of Rhizoctonia bare patches.

radius), 6 ft within a patch, 4 ft within a patch, 2 ft within a patch, at the border of the patch and healthy wheat, and 10 ft into healthy wheat (i.e., no bare patch within a 10-ft radius).

Results strongly suggest that wheat roots do not extract soil water from within *Rhizoctonia* bare patches (Fig. 1). Healthy spring wheat growing 10 ft from the nearest bare patch had used significantly more soil water than wheat on the border of a patch on both June 7 and July 16 measurement dates. Similarly, soil water content at the border of patches was significantly lower than from within the patch. Water content within patches was the same regardless of location of the access tube within the patch. Note that wheat did not extract soil water even from just 2 ft inside the border (Fig. 1). This experiment is being repeated in 2004.

***MAPPING RHIZOCTONIA BARE PATCH DISEASE IN DIRECT-SEEDED CROPPING SYSTEMS**

Bill Schillinger, Harry Schafer, Tim Paulitz, and Jim Cook
WSU and USDA-ARS

The soil-borne fungus *Rhizoctonia solani* AG-8 is a major concern for farmers who practice direct seeding (i.e., no-till) in the inland Pacific Northwest. Bare patches caused by *Rhizoctonia* first appeared in 1999 during year 3 of a long-term direct-seed cropping systems experiment on the Ron Jirava farm near Ritzville, Washington (11.5 inch annual precipitation). The extent and pattern of patches were mapped each year from 1999-2003 at the 20-acre study site with a backpack-mounted global positioning system equipped with mapping software. The average percentage area of bare patches ranged from 7.5% in 1999 to 11.7% in 2002. Comparison of patterns over years show that some patches increased in size, new patches formed, and some patches disappeared. Bare patches appeared each year in winter and spring wheat, spring barley, yellow mustard, and safflower. Crop rotation had no effect on the occurrence of bare patches caused by *Rhizoctonia* during the first five years of the experiment, but continuous annual spring wheat had significantly greater area with bare patches compared to spring wheat following spring barley in a 2-yr rotation in 2002 and 2003. Research is underway or planned to determine why some bare patches disappear with time and on management practices to help alleviate the severity of the disease.

***HOW CAN I MISS YOU WHEN YOU WON'T GO AWAY? POST-HARVEST MANAGEMENT OF RUSSIAN THISTLE IN SPRING WHEAT**

Bill Schillinger, Harry Schafer, Bruce Sauer, and Steve Schofstoll
Dept. of Crop and Soil Sciences, WSU

We have completed four years of research at the WSU Dryland Research Station at Lind on post-harvest management of Russian thistle in continuous annual spring wheat. Our study compares three post-harvest Russian thistle control treatments. These treatments are: 1) Surefire herbicide (paraquat + diuron) at 24 to 32 ounces/acre applied 7-10 days after wheat harvest; 2) tillage with overlapping adjustable-pitch 32-inch-wide V-blade undercutter sweeps on 28-inch centers conducted 7-10 days after wheat harvest, and; 3) check (do nothing, let the Russian thistles grow). Measurements are: Soil water to a depth of six feet at wheat harvest, after killing frost in the fall, and again in early spring; above-ground Russian thistle dry matter, seed production, and

germination at wheat harvest and after killing frost in the fall; and spring wheat grain yield. Experimental design is a randomized complete block with four replications.

To date, results show that tillage with a low-disturbance undercutter V-sweep is more effective than herbicide for post-harvest control of Russian thistle. The check (no control) is by far the least desirable of the three treatments. Use of the undercutter V-sweep results in a complete kill of all Russian thistle with absolutely no subsequent seed production (Table 1). With contact herbicide, some Russian thistle grow-back and/or escapes generally occur and seed production averaged over 4 years is more than 300 seeds per square meter (Table 1). The

Crop Year	Post-harvest control method	Soil Water (inches)			Russian Thistle				Grain yield (bu./ac.)
		After harvest	After frost	Early spring	After harvest biomass (g/ m ²)	After frost biomass (g/ m ²)	Seeds (per m ²)	Germination (%)	
1999-2000	Check	2.76	2.37 b	4.91	77	135 a	8857 a	56.0 a	17.2
	Herbicide	3.09	3.06 a	5.04	32	7 b	0 b	0 b	21.5
	Tillage	3.06	3.06 a	4.90	21	5 b	0 b	0 b	19.0
2000-2001	Check	2.35 b	2.50 b	3.32 b	161	174	1548 a	76.7 a	2.8 b
	Herbicide	3.40 a	3.20 a	3.20 b	243	189	148 b	55.2 a	7.8 a
	Tillage	3.66 a	3.16 a	4.50 a	244	180	0 b	0 b	12.0 a
2001-2002	Check	2.83 ab	2.28 b	5.54	102	---	---	---	8.6
	Herbicide	2.52 b	2.30 b	5.11	75	---	---	---	9.7
	Tillage	2.98 a	2.97 a	6.02	58	---	---	---	9.1
2002-2003	Check	2.18 c	2.23 c	6.84	133 a	162 a	5662 a	45.3 a	11.1 b
	Herbicide	2.47 b	2.64 b	6.93	124 a	108 b	785 b	49.5 a	11.6 b
	Tillage	2.89 a	3.09 a	7.20	71 b	43 c	0 b	0 b	14.8 a
Average	Check	2.53 c	2.35 c	5.15 b	118	157 a	5356 a	59 a	9.9 b
	Herbicide	2.87 b	2.80 b	5.07 b	119	101 b	311 b	35 b	12.6 a
	Tillage	3.17 a	3.07 a	5.66 a	99	76 b	0 b	0 c	13.7 a

check treatment had a 4-year average of more than 5000 seeds produced per square meter. The check treatment had a significantly greater number of viable Russian thistle seeds (59%) compared to the herbicide treatment (35%) (Table 1).

Method of post-harvest Russian thistle control has had a significant effect on soil water status. Use of the undercutter V-sweep resulted in significantly more water in the 6-ft soil profile at time of wheat harvest, after killing frost in October, and in mid-March compared to the herbicide and check treatments (Table 1). Spring wheat grain yield averaged over 4 years was significantly less in the check (9.9 bu/ac) compared to the herbicide (12.6 bu/ac) and undercutter V-sweep (13.7 bu/ac) treatments (Table 1). This study will continue for at least two more years.

GREENHOUSE STUDIES OF RHIZOCTONIA BARE PATCH DISEASE IN SOILCORES FROM DIRECT-SEEDDED FIELDS

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Rhizoctonia bare patch, caused by the soilborne fungus *Rhizoctonia solani* AG-8, can be a problem in direct-seeded small grains in rainfed areas of the inland Pacific Northwest. Plants within patches are extremely stunted. The purpose of this work was to 1) compare *Rhizoctonia* populations at different positions within the patch and at different soil depths and 2) to see if patches would be maintained in the *R. solani*-infested cores over successive plantings in the greenhouse. Eight patches were sampled at two locations near Ritzville and Starbuck, WA. Soil cores (6 x 10 inches) were removed from the four positions within each patch- center, inside edge of the patch boundary, outside edge, and outside (healthy plants). Cores were planted with

five crops of spring barley (*Hordeum vulgare* L.) over an 11-month period in a greenhouse at 60°F. Relative activity of *R. solani* AG-8 was monitored with a toothpick baiting technique. At the first planting, activity of *R. solani* was higher in the center and inside edge, but after the second planting, there were no differences among the patch positions. Based on plant height, patches were maintained in only 6 out of 16 sets of cores. *R. solani* activity was similar at all soil depths from 1 to 8 inches. These results indicate that a natural suppression may develop with monocropping of a susceptible crop, and may explain why patches disappear over time in a field.

SOIL QUALITY AND WATER INTAKE IN CONVENTIONAL-TILL VS. NO-TILL PAIRED FARMS IN WASHINGTON'S PALOUSE REGION

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Many farmers in the steeply-sloped Palouse region of eastern Washington and northern Idaho practice no-till (NT) farming because water erosion on partially frozen soils is often severe when residue cover is lacking. Several soil quality and water intake parameters were assessed in standing wheat stubble along summit, back, and toe slope positions in a 2-year study at three paired-farm sites under conventional-till (CT) vs. NT management. Paired sites had similar south-facing slope and aspect and NT fields had not been tilled from 2- to 20 years. Soil organic carbon in NT was greater than in CT, especially in the 0-to 2-inch surface depth. Two sites had calcium carbonate (caliche) evident at the back-slope position of CT and pH was higher in CT compared to NT. Soil microbial activity, measured as dehydrogenase enzyme activity, was stimulated with CT, mainly due to the exposed caliche layer and higher pH; not due to higher organic carbon, indicating the necessity to use several quality parameters to evaluate soils. Differences in time in NT at the three sites altered the composition of the microbial communities as seen by fatty acid methyl ester analysis and phospholipid fatty acid analysis. Microbial communities in CT at back-slope and toe-slope positions were different from those in NT, while differences in the soil microbial communities from the summit were not as apparent. There were no differences in over-winter soil water storage or in ponded water infiltration rate in undisturbed standing wheat stubble between CT and NT within any paired farm or when averaged across farms and years, indicating that soils with equivalent quantity of standing stubble have similar over-winter soil water storage and ponded water infiltration rate regardless of tillage history. However, significant over-winter soil water storage differences were measured among slope positions with toe > back > summit. These data represent an important step to further quantify soil quality and soil water dynamics as affected by long-term tillage management on cropland in the Palouse.

***LONG-TERM CROPPING SYSTEMS RESEARCH AT THE
RON JIRAVA FARM: YEAR 7**

Bill Schillinger, Ron Jirava, Harry Schafer, Tim Paulitz, Doug Young,
Ann Kennedy and Steve Schofstoll, WSU and USDA-ARS

We are in the eighth year of an ongoing cropping systems research project at the Ron Jirava farm near Ritzville, Washington. Annual precipitation was less than the long-term average in six of the first seven years. The 7-year average yield for annually cropped no-till soft white spring wheat (SW) is 33 bu/acre. Rhizoctonia root rot 'bare patch' disease first appeared in 1999 and is an ever-increasing problem. Phase II of the project, which began in the 2001 crop year, includes two 4-year rotations that contain recrop soft white winter wheat (WW). For the first time in three years, 2003 WW yields in rotations were greater than grain yields for SW. Although downy brome heavily infested WW in 2001 and 2002, this winter annual grass weed was only a minor problem in 2003. There is firm evidence of Rhizoctonia suppression in spring wheat (SW) following spring barley (SB) in the SW-SB rotation compared to continuous annual SW. The long-term cropping systems research project at the Jirava farm will continue for the foreseeable future.

**EXTRA SURFACE RESIDUE ONLY MARGINALLY INCREASES SEED-ZONE
WATER CONTENT IN CHEMICAL SUMMER FALLOW**

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A study was initiated at the WSU Dryland Research Station at Lind in 2003 to determine the effect of surface residue on seed-zone water content in chemical summer fallow. Surface residue loads of 1000 (check), 4000, and 8000 lbs/acre were superimposed on chemical summer fallow in April 2003 and water content was measured monthly during the spring and summer. Experimental design was a randomized complete block with four replications of the three residue loads. Although high levels of surface residue helped retard loss of water somewhat during the summer, seed-zone water content in chemical summer fallow was insufficient for early-September planting of winter wheat regardless of surface residue level (Fig. 1). In contrast, seed-zone water was more than adequate for early-September planting of winter wheat in the tilled summer fallow treatment (Fig. 1). This study is being repeated in 2004.

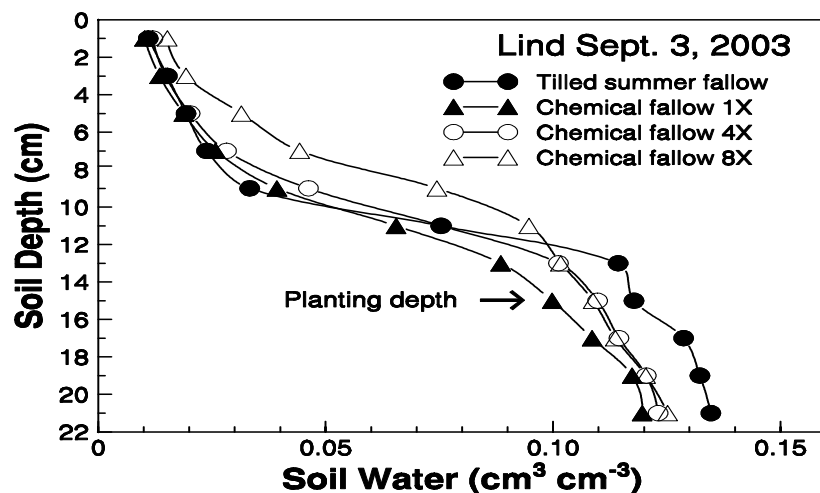


Fig. 1. Seed-zone water content in chemical summer fallow vs. tilled summer fallow in early September. Chemical fallow had three rates of surface residue cover: i) 1x = 1000 lb/acre; ii) 4x = 4000 lb/acre, and; iii) 8x = 8000 lb/acre.

IRRIGATED CROPPING SYSTEMS RESEARCH AT LIND

Bill Schillinger, Harry Schafer, Bruce Sauer, Tim Paulitz, Ann Kennedy, Doug Young,
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WSU and USDA-ARS

We have completed the first three years of a planned six-year irrigated cropping systems study at the WSU Dryland Research Station at Lind. The crop rotation is 3-year winter wheat - spring barley - winter canola sown

i) directly into standing stubble, *ii)* after mechanical removal of stubble, or *iii)* after burning the stubble. The traditional practice of continuous annual winter wheat sown after burning and moldboard plowing is also included as a check treatment. There have been no within-crop grain yield differences as affected by residue management, except winter wheat in 2003 when the burn/plow treatment had significantly less yield due to Take All disease compared with no-till winter wheat in rotation.

Stand establishment and weed control for all crops is almost always best in the burn treatment, but burning negatively affects over-winter precipitation storage efficiency (Table 1). Green bridge carryover from volunteer barley caused serious disease pressure in winter canola seedlings which necessitated replanting to spring canola during two years. We have implemented a new planting method for winter canola to reduce green-bridge-related disease pressure. Annual testing of soil shows that soil quality in no-till plots is increasing rapidly compared with the burn/plow treatment. Over three years and across residue management treatments average grain yield was: winter wheat, 92 bu/acre; spring barley, 2.48 t/acre; and canola, 1971 lb/acre. This study will continue for three more years.

Table 1. ANOVA combined over three years for plant stand, over-winter precipitation storage efficiency (SE), weeds, and grain yield as affected by residue management (standing, bailed, or burned) and crop (winter wheat, spring barley, and canola).

Source	df	Plant Stand	Precip. SE	Weeds	Grain Yield
Residue mgt. (R)	2	***	**	**	NS
Crop (C)	2	***	***	NS	***
R X C	4	NS	NS	NS	NS

,* Significantly different at the 0.01 and 0.001 probability levels, respectively.

Table 2. Grain yields of irrigated winter wheat, spring barley, and canola at Lind in 2001, 2002 and 2003 as affected by various stubble and soil management practices.

	Winter Wheat (bu/a)			Spring Barley (ton/a)			Canola (lb/a)		
	2001	2002	2003	2001	2002	2003	2001 ^A	2002	2003 ^A
Stubble burned	85	106	113 a	2.88	2.21	2.39	2574	2502	1027
Stubble bailed	67	110	96 a	3.03	2.33	2.24	2486	2226	1135
Standing stubble	69	107	101 a	2.88	2.26	2.08	2282	2188	1326
Burn and plow	75	97	74 b						
LSD (0.05)	NS	NS		NS	NS	NS	NS	NS	NS

Within-column wheat yields in 2003 followed by the same letter are not significantly different $P < 0.05$. NS = no significant differences. A: spring canola planted in 2001 and 2003 when winter canola failed.

*LATE FALL DORMANT PLANTING OF CEREALS USING POLYMERS

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Dormant planting is a practice where spring crops are sown in late fall or during the winter instead of the traditional March or April. Potential benefits of dormant planting include faster spring growth to compete with Russian thistle and other broadleaf weeds, reduced heat and water stress,

and higher yields. Dormant planting is not without risks. Warm temperatures after late-fall planting may result in emergence of spring wheat seedlings that may easily winter kill.

We are evaluating four cereal cultivars: 1) dark northern spring wheat (Scarlet); 2) soft white spring wheat (Alpowa); 3) spring barley (Baronesse) and; 4) soft white winter wheat (Eltan) with and without polymer seed coating. The polymer "ExtenderTM" has been developed to prevent seed from imbibing water until soil temperatures begin to warm in late winter - early spring. The trial, conducted at the WSU Dryland Research Station near Lind was planted in the last week of November in 1999, 2001 and 2002 and again in mid March in 2000, 2002, and 2003. The experiment was not conducted in the 2000-2001 crop year due to early snow cover. The four cereal entries were planted with and without the polymer coating into undisturbed spring wheat stubble with a Cross-slot drill equipped with a cone seed feeder. Planting rate for all entries is 70 lbs/acre and fertilizer rate was 40 lbs N, 10 lbs P, and 10 lbs S per acre. Experimental design is a split plot in randomized complete block arrangement with four replications.

For the 2003 crop year, plant stand establishment for all entries (except Eltan winter wheat) tended to be better when spring planted compared to fall planted. Polymer coating had no effect on any fall or spring planted entry except for Scarlet where polymer coating significantly increased stand for spring planting. Grain yield data for 2003 show that November planting was generally superior to spring planting for all entries except for Baronesse barley. Spring planted Eltan did not vernalize and therefore produced no grain. Fall planted Alpowa, and to a lesser extent fall planted Scarlet, produced considerably higher grain yield compared to fall planted Eltan.

When data are combined over the three years, we see few consistent trends in plant stand establishment as affected by planting date or polymer coating. Although there is a trend for greater grain yield when planted in the fall vs. the spring, within-entry grain yield differences averaged over years have not been significantly different except for Eltan winter wheat which, of course, has much lower yield when planted in the spring due to vernalization problems. We plan to conduct this experiment for three more years. The study compliments related research on dormant planting of wheat that is ongoing west of Ritzville, WA.

III. Profitability and Risk Management

***ECONOMICS OF SIX NO-TILL ROTATIONS AT THE CUNNINGHAM AGRONOMY FARM**

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Six 3-year rotations have been grown for three years under direct seeding at the Cunningham Agronomy Farm, Pullman, Washington in a 19-21 inch rainfall zone. Hard red spring wheat (HRSW) and hard red winter wheat (HRWW) were always the first and second rotation crops followed by six different alternative crops: winter barley (WB), spring barley (SB), winter peas (WP), spring peas (SP), winter canola (WC), and spring canola (SC). All six complete rotations were grown every year to accurately reflect a producer's annual income from a diversified rotation. Crops were not replicated within years. Crop yields from 2002 and 2003 were used in this preliminary report. Crop yields were not available from all crops in 2001.

Standard enterprise budgeting was used to compute average costs and returns for all rotations. Total costs include all variable costs and fixed costs including a return for the operator's labor and land. Average prices used were HRWW at \$3.70/bu, HRSW at \$4.10/bu, barley at \$100/t, and peas and canola at \$0.11/lb. All costs and revenues are reported on a rotational acre basis to provide a consistent unit of measurement over rotations.

HRSW-HRWW-WB averaged the highest net returns over total costs of \$3.38 per rotational acre. This rotation was followed by HRSW-HRWW-SB at -\$2.62. HRSW-HRWW-SC and HRSW-HRWW-WP averaged -\$7.01 and -\$8.54, respectively. The fifth ranked rotation was HRSW-HRWW-SP at -\$20.58. HRSW-HRWW-WC came in last at -\$53.24. The two rotations with lowest average net returns, HRSW-HRWW-SP and HRSW-HRWW-WC included alternative crops that were not harvested in 2002. These economic results are preliminary. They are based on only two years data and are subject to strong influence from unique weather conditions and the early stage of the experiment. Future analysis might also provide a more precise measure of long run cropping system costs.

***MINIMIZING FINANCIAL RISK THROUGH APPROPRIATE LAND ALLOCATION AND DRILL INVESTMENT DECISIONS FOR THE DIRECT SEEDING TRANSITION IN EASTERN WASHINGTON**

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Financial risk during the transition to direct seeding is increased by the required drill investment and the direct seeding "learning curve". Farmers may buy, rent and/or custom hire no-till drills. In this study, five potential no-till drill investment options and two adoption speeds are evaluated. The objective is to provide growers with required terminal yield levels of direct seeding relative to conventional seeding so that the two systems have the same (breakeven) investment risk. Yield premiums were computed both to equalize short run risk (two consecutive years of negative cash flow) and long run risk (cumulative negative cash balance at the end of

transition). Results are evaluated for four eastern Palouse representative farms of two sizes combined with two equity levels.

A farm's annual net after-tax cash flows were simulated based on historical yield and price risk pattern for 500 "risky runs" and six transition years. The farm received government payments, as eligible. Expenditures included cash crop production costs, debt repayments, property and income taxes, insurance, overhead, and family living withdrawals.

Speed of adoption had a larger effect on navigating the direct seeding transition successfully than did the drill acquisition method. Farmer still learning to make direct seeding work should go slow in acreage expansion. Higher equity farmers required lower yield premiums. If large farmers have the cash or financing, rapid purchase of a direct seeding drill has a reasonable chance of success; however, gradual acreage expansion is still recommended until any yield penalty is eliminated. Small low equity farmers experienced higher risk. Farmers renting a high proportion of their cropland may want to wait until they can pay cash for a (possibly lower cost) direct seeding drill. Custom and rental drill acquisition in early years of the transition is recommended for small farmers.

***CONSERVATION CROPPING SYSTEMS IN THE CANADIAN PRAIRIES**

Doug Young, Dept. of Agricultural and Resource Economics, WSU

Both the U.S. Great Plains and the Canadian Prairies have experienced more success in increasing conservation tillage than the U.S. Pacific Northwest. For example, Saskatchewan, Canada's leading wheat producing province, quadrupled no-till during 1991-2001, with 39% of the total cropland under the practice by 2001. In contrast, Washington farmers were no-tilling 8.2% of cropland by 2000. Nationwide, U.S. no-till adoption, which is dominated by the large Corn Belt and the Great Plains cropland areas, reached 17.5% in 2000. Over 30% of Canadian cropland was no-tilled.

Canada has had success in profitably incorporating broadleaf oilseeds and pulses into rotations with no-till spring wheat. Indeed, canola sometimes "carries" spring wheat economically in Canada, whereas winter wheat is the economic mainstay in U.S. Pacific Northwest. Pulses have also moved northward and eastward. Until the late 1970's, eastern Washington and northern Idaho dominated the North American lentil market. Since then much of the acreage for this desirable rotation crop has expanded to the Canadian prairies, and in recent years also to North Dakota. Canadian farmers and scientists attribute part of their success with no-till to the use of agronomically beneficial and profitable broadleaf crops in rotation with cereals. Canadians have adapted cultural practices appropriate to their conditions, such as swathing prior to harvesting. They have also been successful in breeding varieties adapted to their conditions and now are reaping cost savings with GMO ("Roundup ready") canola. Canada's success with conservation tillage in diversified crop rotations reinforces the incentives for research to develop or identify alternative crops and cultural practices for no-till adapted to Pacific Northwest conditions.

***LANDLORD INFLUENCE ON MORE INTENSIVE ROTATIONS OR DIRECT SEEDING ADOPTION IN EASTERN WASHINGTON**

Cory Walters and Doug Young

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Data for this study came from a small survey of participants at field days and farm meetings in Benton, Lincoln, and Whitman Counties during 2003. The sample included 27 farmer-tenants and 11 landlords. Logit regression analysis was conducted to statistically measure how closely different farm and farmer characteristics were related to the farmer's perception of landlords' support for direct seeding. Significant variables indicated that farmers with larger acreages and with a higher proportion of wheat tended to be more pessimistic about landlords' attitude toward direct seeding. Cash renting tended to make farmers more optimistic about landlords' attitudes. Of course, landlords share no yield risk with cash leases.

Seventy two percent of the 11 surveyed landlords viewed direct seeding as an advantageous practice, while 28% of the landlords considered it disadvantageous. Some landlords felt that "income risk" and "weed infestation" were disadvantages. Generally, farmers were more pessimistic regarding landlords' acceptance of direct seeding than were landlords themselves. Only 44 percent of surveyed farmers saw landlords as favoring direct seeding, but 72 percent of landlords characterized themselves as favoring direct seeding. However, fewer landlords reported willingness to cut rents to tenants who direct seeded. Farmers and landlords generally agreed that more intensive rotations or direct seeding could decrease erosion, but both groups feared income risk. Future research should consider both landlord and producer objectives in developing conservation farming technologies that can appeal to both groups. Because this survey included only voluntary participants who were attending field days and farm meetings, it cannot be generalized to the entire eastern Washington farmer or landlord populations. However, the results may provide some useful insights.