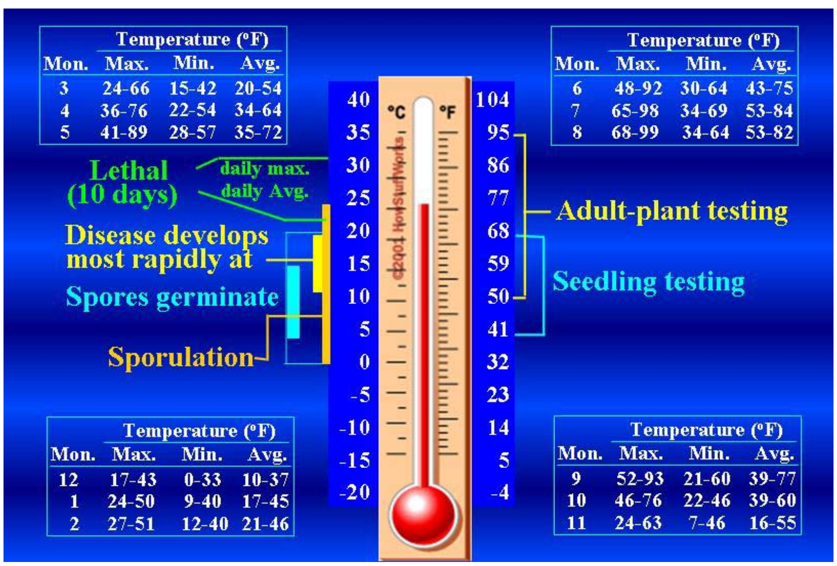
WCC-97 (Initial Draft)
(Research on Cereal Diseases)
2003 Season

The annual meeting was held June 17-18 at Pendleton, Oregon in combination with the Western Wheat Workers. The last time we had a joint meeting was at Davis, CA in 2001

June17, 2003 – Mini symposium on Tuesday morning.

The stripe rust picture – presented by Dr Xianming Chen (USDA/ARS at Washington State University) The disease of concern this year in the Pacific northwest is stripe rust. Infection levels in California, Oregon, Washington and Idaho are very high. Dr. Chen brought the group up to date on what is currently known about the disease cycle and the history of race development.

Dr Chen's complete PowerPoint presentation can be found here



Stripe rust facts: In general –

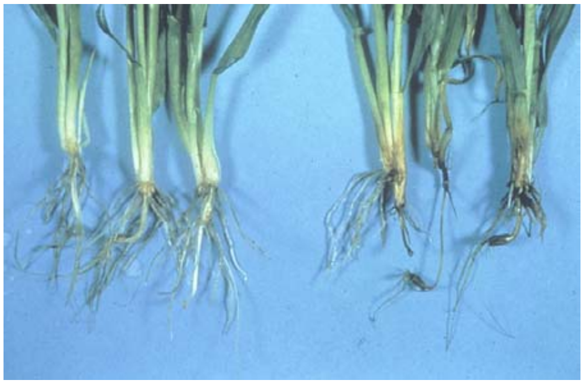
4-15 C is need for spore germination
1-24 C allows for disease development
12-20 C is optimum for disease development
temps above 25C for 10 days are lethal.

When testing for resistance to stripe rust, 5-20C is necessary. Adult plants can be screened at 10-35C.

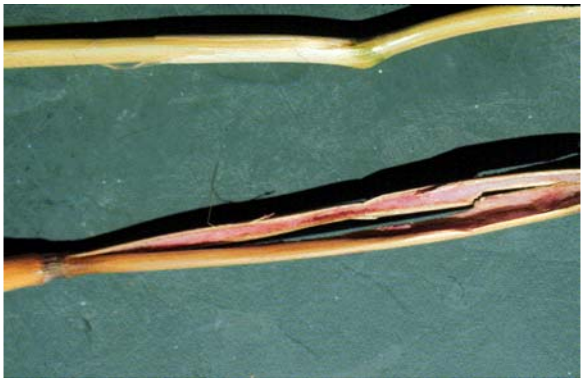
Barley Stripe Rust – First appeared in Europe – then it moved to Columbia, South America, north to Mexico and then to the United States in 1991. Since then it has been found in the following states:

Root and crown rot diseases of wheat presented by Dr. Dick Smiley of Oregon State University as part of a Pacific Northwest Project with Oregon, Washington and Idaho.

Fusarium and common root rot diseases are usually found as a complex on root systems and are impacted by cropping practices. In Oregon, the complex is found in the 10-16 inch rainfall area and represents about 80% of the wheat acreage in Oregon. *Fusarium* is found on early planted winter wheat and is usually Fusarium pseudograminearum –group 1 (the scab organism is found in group 2). *Fusarium culmorum* is found is some areas and can co-exist with *F. pseudograminearum* and common root rot (*Cochliobolus*). No relationship appears to exist between resistance to *Fusarium* crown rot and resistance to *Fusarium* scab.



Common root rot – discolored internodes



Fusarium crown rot – infected stems

Take all can be found on 90% of the annual spring cropping (W-F-W) acreage in Oregon. Symptoms can range from the typical “back sock” symptom associated with
high moisture areas to the “dryland form” found in low rainfall areas. With the dryland form, the crown must be split to observe a darkening of the internal tissues.

Rhizoctonia is widespread in direct or notill seeded plots. *Rhizoctonia oryzae* is more prevalent than *Rhizoctonia solani* Ag8 due to the fact that it is pathogenic on many different crops. Barley tends to be very susceptible to Rhizoctonia

Pythium root rot also tends to be widespread in fields where winter wheat is planted late into cool wet soils. Metalaxyl containing fungicides are a proven control measure.

Root lesion nematode – found in dryland agricultural areas of Oregon. The nematode symptoms can easily be confused with Rhizoctonia symptoms.

Cereal cyst nematode is spreading in Oregon. Crop rotation with a single planting of a dicot will provide effective control. Yield losses in winter wheat can approach 50% and 100% in spring wheat.

Physiological leaf spot is still widespread in the pacific northwest. Chloride fertilizer is an effective way to reduce the incidence. However, after more than 10 years, the disease is still misidentified as a pathogenic leaf spot and treated with foliar fungicides.

Dr. Dan Biggerstaff presented his views on genetically modified organisms and asked the group to support a resolution in favor of the release of GMOs. It was apparent from the discussion that followed that there was as much disagreement within the group as can be found in the general populace.

June 18, 2003 Field Trip

Dr. Jim Peterson - OSU Winter Wheat Breeder - Our first tour stop was the Pendleton site (Ruggs farm) of Oregon State University’s (OSU) winter wheat program, seven miles west of the Columbia Basin Agricultural Research Center.

This well-tended site had numerous replicated yield trials of public and private cultivars and advanced material of soft white, hard white, and hard red winter wheat. One of OSU’s off-station spring wheat sites was located adjacent to these plots. Mary

Verhoeven was the host and tour guide for the spring plots.   Plot maps were provided so all attendees could look at cultivars or lines of interest to them.

Those attendees with an interest in cereal diseases found evidence of numerous diseases at some level, including stripe rust, but none at levels that would be ordinarily considered noteworthy.

Of particular interest were trials that included lines tolerant to the herbicide Beyond (imazamox). Weed control was good to very good at all application rates (4, 6, 12-oz/A). Susceptible lines were essentially dead at all application rates. Jim Peterson and Mark Dahmer, BASF, told the crowd that there was substantial visual crop response after application, especially in the 12-oz/A treatments. At the present time, most plots of tolerant lines sprayed at the 4 and 6-oz/A rate appeared to be doing well. As always, the rest of the story must wait until after harvest.

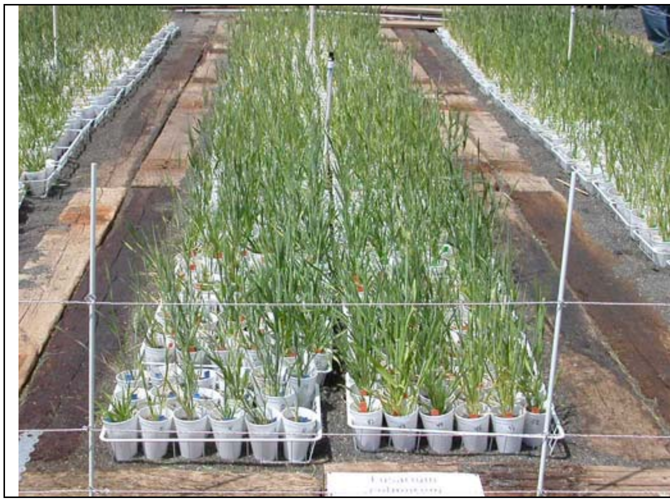
Dick Smiley – Root rot and nematode plots

Root Lesion Nematode: We observed a cultivar response plot with paired plots with and without Temik insecticide. This organism is wide spread in the dryland areas of eastern Oregon. In addition to wheat, crops such as rape and mustard function as hosts. Safflower does not host the organism however. Work in Australia has produced some resistant or tolerant cultivars. There are two species of nematode and cultivars vary in susceptibility to both. Populations of cysts in soil can reach 9000/kg. Parma labs in Idaho can give estimates of cyst populations. Currently there are no viable control measures. The Temik plots were planted as a control tool to relate the Australian data to Oregon. The nematode can complete an egg to egg cycle in 4-5 weeks. Cysts in roots can be observed with acid fuschin stain. In general clay-loam soils have higher populations compared to sandy soils.

Control Plots   Inoculated Plots

Root Rot and crown rot plots – Stop number two was to observe a cultivar trial using paired plots either with or with out *Fusarium pseudograminearum* inoculum. The trial was inoculated with 9 grams of inoculum per 10 feet of row composed of 5 isolates grown on millet seed. The inoculum was intended to produce a moderate level of infection from which tolerant cultivars could be selected. In certain years yield reductions in winter wheat can approach 43%. Planting depth appears to be a factor in disease development and deep forming crowns are more susceptible.

In contrast to the field plots which require much field space, early screening of cultivars can be accomplished using a sand bed and small pots. Sixteen ounce cups, with the bottom removed, are placed on a sub-irrigated sand bed which is watered with overhead misters until plant emergence and can be used as an early screening tool. Seeds are planted with 4 Fusarium infected millet seeds per pot. Infections levels are usually high enough to kill susceptible plants at maturity.



Cereal cyst nematode: Heterodera avenae cysts hatch in April – June and can cause severe damage on winter and spring wheat. In those cases where wheat is grown in rotation with seed potatoes or sugar beets, the cysts are dormant until a cereal crop is planted. Corn may function as a trap crop- it will exhibit a hypersensitive reaction.

Cephalosporium stripe – Dr. Chris Mundt

White heads from Cephalosporium

Chris spent time explaining his Cephalosporium cultivar test which evaluates the reaction of Oregon cultivars to naturally occurring Cephalosporium stripe. We were also able to observe the reaction of some winter barley cultivars, which like club wheats tend to be more resistant than other winter wheats to Cephalosporium infection.

Winter Wheat Cultivar trials – Dr. John Burns and Dr. Dale Clark.
We observed one of 20 trials planted in Washington where cultivars are evaluated for yield, quality and disease resistance.

John Burns **Dale Clark**

State Reports

California - Lee Jackson

General. Small grains in California are sown in the fall and are comprised primarily of hard red spring and durum wheat, 6-row spring feed barley, triticale and oat. A small acreage of fall-sown winter wheat and winter barley and spring-sown spring wheat and spring barley also is grown in the intermountain area of NE California. Planted acreage of small grains in 2003 in California is estimated at 742,000 acres of wheat (including 132,000 acres of durum wheat), 130,000 acres of barley and 250,000 acres of oat. Triticale acreage isn't estimated, but over 50,000 acres are grown in the state, primarily in the San Joaquin Valley. Main common wheat varieties in 2003 are Yecora Rojo (135,000 acres), Express (98,000 acres), Bonus (60,000 acres), Summit (57,200 acres), Stander (37,000 acres), and Dirkwin (37,000 acres). Hard white wheat was sown on about 33,000 acres and included the varieties Klasic (20,000 acres), Blanca Grande (13,000 acres), and Plata (4,100 acres). Main durum varieties in 2003 are Kronos (76,000 acres), Mohawk (24,500 acres) and Orita (15,000 acres). About 200,000 acres of wheat and triticale are harvested as green-chop forage for dairies in California's Central Valley.

Wheat stripe rust. A severe epidemic of wheat stripe rust occurred this season. The combination of mild winter temperatures and early sowing (particularly of wheat for forage for dairies) resulted in very early infections, about 6 weeks earlier than I can remember detecting stripe rust in California. Cool conditions then persisted much longer in spring than usual and stripe rust reached very high severity throughout the Central Valley. I even detected one small focus of infection in a nursery in the Imperial Valley where a plot of the common wheat variety Cavalier had an area of 10-20 plants with stripe rust severity approaching 70%. I'm not aware of previous reports of stripe rust on wheat in the Imperial Valley. Spike infections were common throughout the Central Valley. I observed active sporulation through the 4th week of May. Grain harvest has started and the most susceptible varieties in plots in some areas have near zero grain yield; seed is extremely shriveled. The stripe rust reactions of the main common wheat varieties grown in California, based on my observations in the University of California statewide tests, are as follows: Highly Susceptible: Dirkwin, Bonus, Yecora Rojo, Brooks, Eldon, Yolo, Kern; Susceptible: Anza, Serra; Moderately Susceptible: Express; Moderately Resistant: Stander; Resistant: Summit, Blanca Grande, and Plata. Some varieties, including Serra and Express, showed a necrotic reaction with little sporulation. Of the main durum varieties Kofa, Mohawk, and Orita are Susceptible and Kronos is Moderately Resistant (with necrosis). Statewide losses due to wheat stripe rust last season were 6%. Losses this season are likely to be much greater since the disease was much more widespread than it was in 2002. For common wheat varieties in the Central Valley other than Summit, Stander, Express, Blanca Grande, and Plata, and not cut as green-chop forage for dairies, the loss could be 50% or more for fields not treated with either Tilt or Quadris fungicides. This year, more fungicide applications than probably ever before were made and the entire California supply of Quadris was exhausted. At the end of last season 12 races of wheat stripe rust were identified from collections from California. Based on the infection of wheat varieties this season, additional and different races probably are now present. Infection of wheat stripe rust differentials in the Winter and Spring Cereal Disease nurseries at UC Davis this season showed that the genes Yr1, Yr2, Yr3a, Yr4a, Yr7, Yr9, Yr13, Yr17, Yr18, Yr20, Yr21, Yr22, and Yr23 were not effective.

Barley Stripe Rust. Barley stripe rust appeared much later than wheat stripe rust this season. The Barley Stripe Rust nursery at UC Davis, which contained germplasm from programs throughout the U.S. and world, had high levels of stripe rust on susceptible lines by late April. The spreader variety Max was severely diseased by early May and severity had reached 100% on susceptible lines by late May. I observed only very low stripe rust severity in commercial fields since the predominant varieties, UC 937 and UC 933, are resistant to current races. However, susceptible varieties in the statewide tests such as Max and Commander had 100% severity by late May in yield trials in the Central Valley. I submitted 10 collections of barley stripe rust from California for race identification last season. Seven races were identified from those collections, including several new combinations of virulence (new races). Statewide losses due to barley stripe rust last season were 2%. Losses should be less this season.

Wheat Leaf Rust. Wheat leaf rust became severe on susceptible varieties in yield trials and fields in the Central Valley by mid-to-late May. High levels occurred on some of the few varieties that were not affected by stripe rust, but several known leaf rust susceptible varieties that had been severely damaged by stripe rust had no green tissue remaining for leaf rust to infect. Among wheat varieties, Stander and Plata were most affected by leaf rust. Severe leaf rust also occurred in several commercial durum wheat fields in the Imperial Valley. Fields of Orita, at the soft dough stage, had 70-80% severity in early May. Later (early June) severe leaf rust occurred on California's predominant durum wheat variety Kronos. I'm not aware of previous reports of leaf rust from the Imperial Valley. No leaf rust was detected on durum wheat in the Central Valley.

Barley leaf rust. Barley leaf rust became severe on susceptible lines in nurseries at Davis in mid-late May. Low levels of barley leaf rust also occurred on susceptible varieties in yield trials in the Central Valley.

Other Diseases. Oat crown rust was severe in plots of susceptible varieties (Montezuma, Kanota) at Davis by mid May. Oat stem rust was severe in plots of the susceptible variety Swan at Davis by mid May. Septoria tritici blotch of wheat occurred in a few areas, but levels were obscured by the severe levels of stripe rust. Barley scald and barley yellow dwarf virus were severe on barley germplasm not adapted to the California's Central Valley (particularly on lines grown at UC Davis in the barley stripe rust screening nursery and the western regional spring barley nursery).

Budget and Personnel. The University of California is facing severe budget reductions due to the huge deficit (estimated at $38 billion through the next fiscal year) faced by the state of California. Agricultural research (University of California's Agricultural Experiment Station (AES)) and Cooperative Extension (CE) have been targeted for large budget reductions, projected at 10% for AES and 30% for CE. Since the largest part of the budgets for AES and CE is for salaries and benefits, positions will be lost. At UC Davis, the College of Agriculture and Environmental Sciences Dean Neal Van Alfen envisions "collapsing" 75 positions in AES and CE (this number doesn't include the Farm Advisor positions that also will be lost throughout the state). Although the May revise of the budget from Governor Davis didn't introduce any new cuts for UC, there are legislative proposals for additional cuts ranging from $80-400 million. The full State Senate and Assembly should vote on the budget sometime in June, and any differences in their versions have to be resolved by a Joint Legislative Conference Committee on the Budget. The final budget could be sent to the Governor by the beginning of the fiscal year (July 1), but last years budget wasn't signed until September 5. UC hasn't announced what specific steps will be taken to meet the reductions to the UC budget.

Colorado – Did not attend this year

Idaho - Did not attend this year.

Kansas - William W. Bockus (in absentia)

Personnel news. The biggest news in Kansas State University's wheat program is the hiring of Dr. Jim Stack (formerly at the Univ. of Nebraska) as our Extension Wheat Pathologist to replace Dr. Bob Bowden who moved to USDA over a year ago. Jim will begin at KSU around the first week of July. Dr. Doug Jardine, Extension State Leader for Plant Pathology, has been handling the wheat extension duties during this interim period.

Wheat crop condition. As of the writing of this report (June 23, 2003), about a third of the Kansas wheat crop is harvested. Grain yields are the highest they have been in several years and there are reports of many fields going in the 70 bushel per acre range. The acreage planted in fall 2002 was about 10.2 million acres which was the highest total since 1998. The most prevalent wheat variety was again Jagger which was planted on about 45% of the acres. Other important cultivars included 2137 (13%), TAM 110 (4%), Karl 92 (3%), and 2174 (3%). Blends of cultivars occupied 12.8% of the total making them the third most popular "cultivar".

Disease loss estimates for 2002. [Data from Jon A. Appel (Kansas State Department of Agriculture) and Robert L. Bowden (USDA)]

Table 2. Wheat disease losses in Kansas

Disease	Loss in 2001	Loss in 2002	20-year avg.
Barley yellow dwarf	0.001%	1.4%	1.34%
Wheat streak mosaic	0.001	1.3	1.76
Leaf rust	0.4	1.0	3.96
Tan spot	1.9	0.5	1.36
Septoria complex	0.1	0.2	1.60
Root and crown rots	0.1	0.1	0.22
Scab	0.001	0.01	0.24
Stripe rust	7.3	0.01	0.39
Take-all	0.001	0.01	0.52
Powdery mildew	0.001	0.01	0.26
Bunt & loose smut	0.05	0.01	0.02
Soilborne, spindle streak	0.05	0.001	0.79
Strawbreaker	0.001	0.0001	0.12
Stem rust	0.001	0.0001	0.30
American wheat striate	0.001	0.0001	0.00
Cephalosporium stripe	0.001	0.0	0.10
Bacterial leaf diseases	0.001	0.0	0.04
Snow mold	0.0	0.0	0.0

Potential wheat disease losses for 2003. Although final estimates of wheat disease losses during 2003 have not yet been produced, it is anticipated that stripe rust and leaf rust will be the most important diseases in the state this year. Until 2001, stripe rust caused only minor losses in Kansas and more than trace amounts only occurred about every 20 years. However, it was the most important disease in 2001 (causing 7.3% loss statewide) and will again be very important in the state in 2003. Something is allowing that fungus to potentially be important in the Great Plains on a more regular basis. Leaf rust continues to be important because the most popular cultivar (Jagger) is susceptible to prevalent races. Other notable diseases during 2003 include tan spot and speckled leaf blotch.

Minnesota - Ruth Dill-Macky & Char Hollingsworth

2002 season

Following a mild winter, drier soil conditions allowed for crop planting to start ahead of the average for the past several years. Cold spring temperatures delayed crop emergence and freezing temperatures in mid-May (which killed some 65,000 acres of newly emerging sugarbeets) caused some damage to small grains although no replanting was undertaken.

Heavy storm rains that fell between June 8 and 10 dumped up to 5 inches of rain on parts of the Red River Valley. Flooding was worst in Roseau County where the Roseau River has flooded 340,000 acres (80-90% of the county's crop land). Flooding also occurred on the Wild Rice River in Norman County around and south of Ada and in Marshall County near Warren. Water damage varied from saturated soils to submerged crops.

The impact of the flooding in small grains production areas was reflected in reduced harvested acreages and below normal yields. The 2002 spring wheat crop at 1.8 million acres was the same size as the 2001 crop, however yields averaged only 34.0 bushels per acre, down 10 bushels from last year. The durum wheat crop, at 5,000 A (average yield, of 35 bu/A) more than twice the size of the 2000 and 2001 crops. Minnesota's barley acreage was 165,000 acres, an increase over the record low crop of 145,000 acres in 2001. The average barley yields were however disappointing at just 39 bu/A. The oat acreage, at 285,000 A, was 75,000 A larger than the 2001 crop but yields down; averaging 56 bu/A which was 4 bu/A less than in 2001.

The wet weather conditions in June promoted some development of foliar diseases, notably tan spot and Septoria leaf spots in the later part of the growing season however conditions were generally drier after heading and foliar diseases were generally not problematic. Disease pressure from Fusarium head blight was light to moderate.

2003 season

The 2003 season started early following a fall and winter with below average precipitation. Small grains crops were seeded ahead of the 5-year average and emerged well. Spring rains have provided some needed soil moisture across the state, and for the first year in many it seems that over 80% of Minnesota has adequate (neither too much nor too little) soil moisture. Estimate acreages for spring wheat (1.95 million acres), barley (180,000 A) and oat (210,000 A) are down in 2003 on the 5-year average, reflecting ongoing difficulties in small grains production. Minnesota acreages of corn and soybeans are up, presumably in response to the reduced small grains plantings. The crop is tillering. Chlorotic and necrotic lower leaves on wheat, barley and oat plants are common and are assumed to be symptoms of a stressful early-season growing environment. Some tan spot is present, but other foliar diseases are insignificant at this time.

Overview of Present Research Programs

Fusarium head blight (FHB) research in Minnesota continues as a large collaborative effort. Faculty from the four departments of the College of Agriculture, Food and Environmental Sciences, three University of Minnesota Research and Outreach Centers and two USDA-ARS units (Cereal Disease Laboratory & Plant Science Research Unit) are involved in FHB research on wheat and barley. While many researchers in Minnesota have projects funded by the USWBSI, researchers have also been supported by state funding. The research being conducted in Minnesota includes breeding for resistance to FHB in wheat and barley utilizing classical and molecular techniques, studies aimed at improving the efficiency of breeding methodologies and selection of resistance, investigations on the pathogenic variation in *Fusarium graminearum*, examinations into the pathways of entry by Fusarium head blight, and the chemical and cultural control of FHB.

Dr Yue Jin started recently at the USDA-ARS Cereal Disease Laboratory where he will focus his research on the genetics of stem rust resistance in wheat.
Research on the foliar diseases of cereals is being conducted by Ruth Dill-Macky (tan spot of wheat; net blotch of barley; loose smut of oat), Char Hollingsworth (Septoria tritici blotch and aster yellows of wheat), and Brian Steffenson (Septoria speckled leaf blotch, spot blotch and stem rust of barley)

Personnel changes in Minnesota

Departures:
William R. Bushnell, USDA-ARS Cereal Disease Laboratory, Research Plant Pathologist – retired May 2003.
New Personnel:
Yue Jin, USDA-ARS Cereal Disease Laboratory, Research Plant Pathologist – started May 2003.

Publications

Culler, M.D. and Dill-Macky, R. (2003). Influence of irrigation during grain development on deoxynivalenol concentration in *Fusarium*-infected wheat kernels. *Phytopathology*, **93**:S19.

Salas, B., Dill-Macky, R., and Wilhelm, K.P. (2003). Previous crop affecting soil populations of Fusarium head blight pathogens in Minnesota.. *Phytopathology*, **93**:S75.

Dill-Macky, R. and Evans, C.K. (2003). Fusarium head blight of wheat and barley: epidemics and control strategies in Minnesota. In: *Proceedings of the 8th International Congress of Plant Pathology, Volume 2 – Offered Papers*, Christchurch, New Zealand, February 2-7, 2003, p. 293, <Abstract no. 22.18>.

Dill-Macky, R. (2003). Fusarium head blight of wheat and barley: epidemics and disease management in the United States. In: *Proceedings of the 9th International Fusarium Workshop*, Sydney, Australia, January 27-30, 2003, p. 21.

Mesfin, A., Smith, K.P., Dill-Macky, R., Evans, C.K., Waugh, R., Gustus, C.D., and Muehlbauer, G.J. (2003). Quantitative trait loci for Fusarium head blight resistance in barley detected in a two-rowed by six-rowed population. *Crop Science*, **43**:307-318.

Impacts
Cooperation in research resulting from WCC-97 contacts:

Obtained isolates of *Fusarium pseudograminearum* from Richard W. Smiley (Oregon State University) for use in a comparative study of US and Australian fungi inciting Fusarium head blight of wheat.

Sent isolates of F. graminearum to William E. Grey (Montana State University) as a standard for identification of Fusarium species isolated from wheat in Montana.

Montana – Bob Johnston and Bill Grey

Personnel updates

The department has been given the ok to reopen search for Don Mathre's position. Primary responsibilities will be investigating soil borne diseases (80%) and teaching (20%)

Effective July 1, the Dean and Director will be resigning her post at MSU. Dr. Jeff Jacobsen from Land Resources and Environmental Sciences will assume the duties of dean as of June 30, 2003.

May 1, 2003 - Dr Norm Weeden stepped down as Dept Chair and Dr John Sherwood takes over the Dept reins. John joined the old Plant Pathology Dept in 1988 and currently is a Full Professor with research interests in molecular biology of smut fungi and *Fusarium* scab.

Current diseases of interest

Some **wheat streak mosaic virus** on winter wheat in the triangle area of Montana. Infected plants came in early May, but not reports since then. It has been cool and wet since then and the infection levels may not change much until it warms up. Typical situation where the previous seasons volunteer is infected and the infection is moving to this seasons winter wheat.

Some **scald** on barley was observed around the first of June. Plants also had typical symptoms of frost damage as well.

Nusky - new soft white winter wheat - very susceptible to eyespot. Inoculated 10 feet of row with 30 ml scoop of *Tapesia yullandae* grown on oat kernels. Inoculated October 26, 2001. Plots sprayed May 1, 2002 with high rates of 3 fungicides to test for possible control.

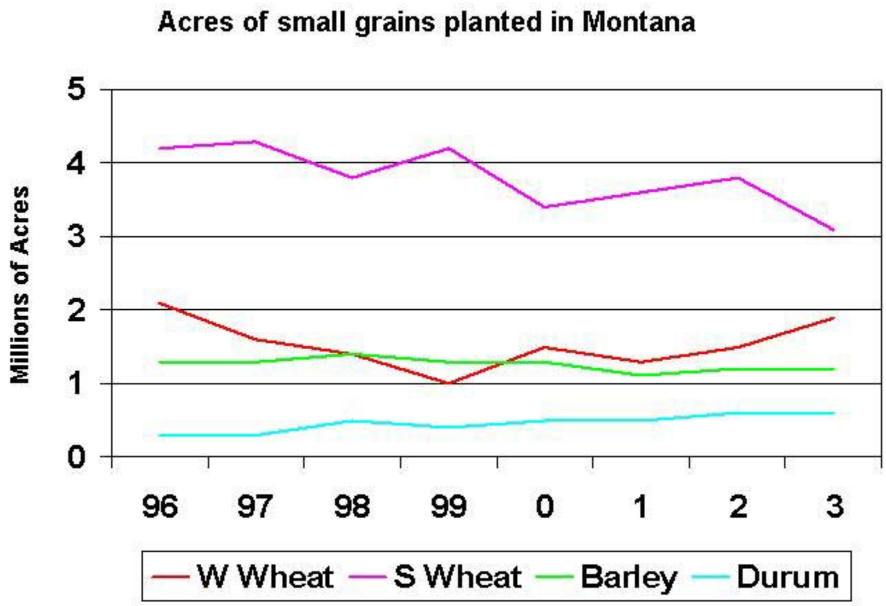
Treatment	oz/acre	White Heads per 10 feet	Infected tillers per Meter	Bu/a
Non Inoculated	-	0	7	68 a
Inoculated	-	10	119	38 cd
Benlate	6.25	0	1	64 ab
Tilt	18.0	19	128	51 bc
Quadris	24.3	44	186	32 d

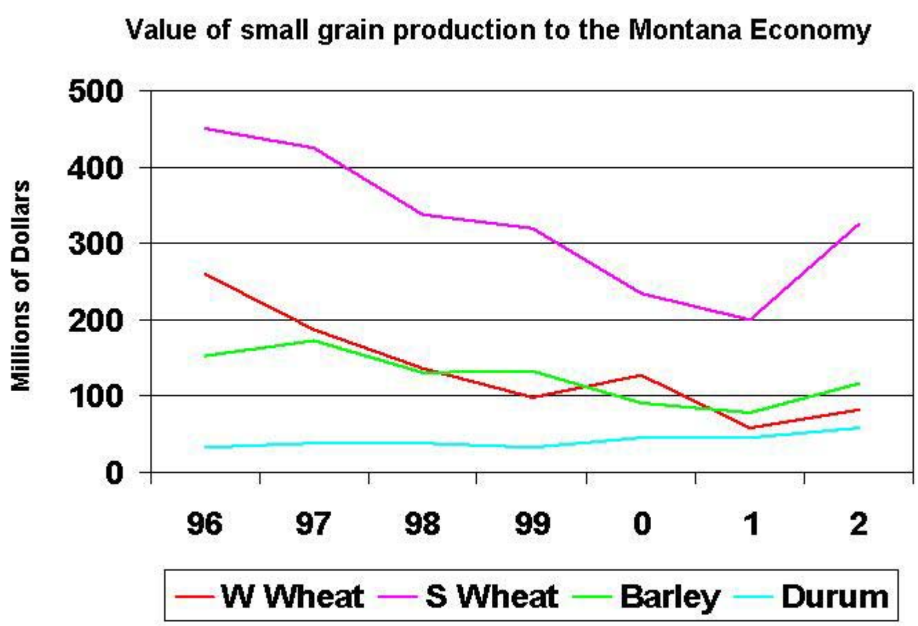
Fusarium Crown rot remains the number one disease problem on small grains in MT.

Effect on winter survival on the Bozeman Post Farm – In a winter wheat cultivar susceptibility test to *Fusarium culmorum* the inoculated plots exhibited ~50% stand loss compared to the healthy controls. Going into the winter, no observable difference were evident between control and inoculated plots.

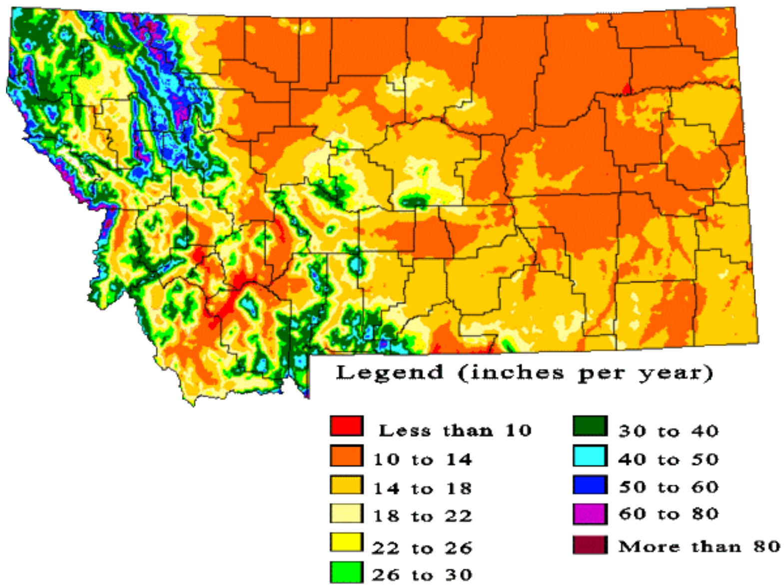
Impact on small grain production on the economy of Montana

MT Ag Statistics Service reports that winter wheat production in the state could total 65 million bushels this year. This is three times the yield (21M) harvested in 2001 and could be the highest yield since 1994 with 38 bu/a





The majority of small grain production in Montana occurs in a 10-18 inch rainfall area



Fusarium crown rot: A drought induced disease of small grains
William Grey, Robert Johnston and Andrew Lenssen

Fusarium crown rot is a wide-spread disease of cereals in Montana and is most severe when plants are experiencing drought stress. The fungal pathogen survives in the soil or on the plant residue and it's prevalence may be closely related to leaving residue above ground for conservation of soil and moisture in the Great Plains of U.S. and Canada. The keys to management of Fusarium crown rot in small grain cereals is to minimize plant moisture stress through reduced tillage, avoiding crops that extract excessive soil moisture and utilizing a protective seed fungicide. Other practices that may reduce Fusarium crown rot include adjusting the seeding rate for the available moisture and the selection of tolerant varieties.

The three locations in the Sustainable Pest Management study represent wheat producing areas of Montana that have been affected by an extended drought. We have documented significant grain yield losses due to Fusarium crown rot at Havre, Moore and Froid on bread wheat, durum and barley. At Havre, the average number of severely diseased plants was 11.6% across 9 crop rotations and two tillage systems (Table 1). The yield loss was estimated to be 1.6 bu / acre or 8 % disease loss in a crop with a yield potential of 19 bu. The yield loss estimate is based on a negative relationship, that for each 10% increase in number of diseased plants there is a corresponding loss of 1.4 bu (Figure 1). The economic impact of this disease can be estimated for the North Central region (Hill, Blaine, Choteau, Liberty, and Toole Counties) where 25 million bushels of wheat were harvested in a drought year. A disease loss of 8% thus represents a yield loss of 2 million bushels or an economic loss of $4.5 to $9.5 million dollars ($2.25 to $4.75 bu wheat).

The analysis can be used to estimate economic impacts due to Fusarium crown rot at other locations in Montana that have experienced drought. At Moore MT, the percentage of severely diseased spring wheat plants was 24% across four crop rotations and conventional or reduced herbicide levels. The yield loss was estimated to be 2.6 bu / acre or 14% disease loss in a crop with a yield potential of 18.3 bu. At Moore, for each 10% increase in number of diseased plants there was a 1.1 bu yield loss (Figure 2). Once again, the economic impact of Fusarium crown rot on spring wheat can be estimated for the total wheat production in the Judith Basin area with a 16% bushel loss to this disease.

The losses to Fusarium crown rot in durum are far higher than in the bread wheats. The location at Froid has only been in experimental production for one year, 2002, but this was a severe year for Fusarium crown rot, with 43% diseased plants. The yield loss was estimated to be 10 bu / acre or 29% bushel loss to disease in a crop with a yield potential of 35.9 bu (Figure 3). The losses in durum can be estimated at 2.4 bu for each 10 % diseased plants. Durum is significantly impacted by this disease when compared to the spring wheat crops at Havre or Moore (Figures 1 and 2). The economic impact can be estimated by the slope of the line for yield loss and severity.

Table 1. Fusarium crown rot of spring wheat in 9 crop rotations and two tillage systems, Havre 2002.

Wheat in rotation cycle	Conventional tillage	Zero tillage
	% diseased plants	
Wheat **- wheat (**continuous)	8.2 b	5.9
Fallow **- wheat**	19.2 b	0.0
Wheat-fallow- **wheat** (year 1 wheat)	12.3 b	1.3
Fallow-wheat- **wheat** (year 2 wheat)	18.4 b	5.5
Lentil - **wheat**	14.3 b	5.0
Fallow - mustard- **wheat**	18.8 b	1.2
Pea - fallow **- wheat**	17.0 b	11.4
Sunflower - pea **- wheat**	11.2 b	8.8
Fallow - chickpea- **wheat**	31.2 a	3.4
Safflower - fallow **- wheat**	34.1 a	6.2
Mean	18.8	4.9

Figure 1. Fusarium Crown Rot and spring wheat yield relationship across 9 crop rotations in two tillage systems, Havre 2002.

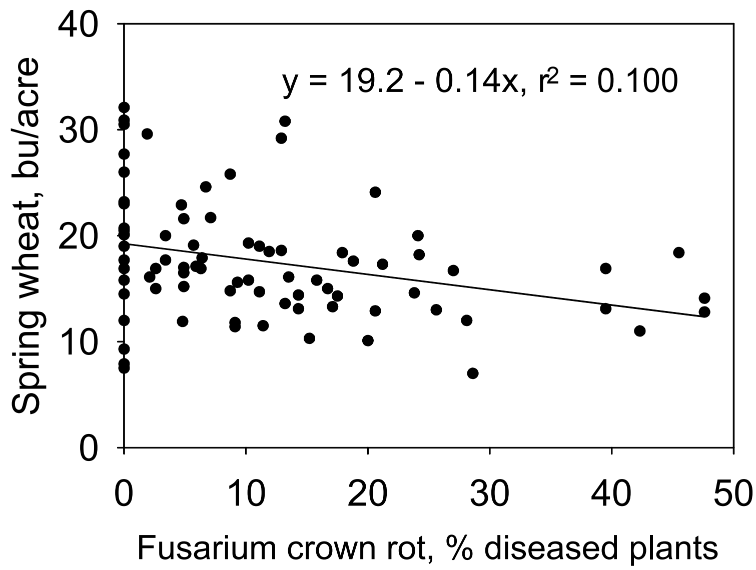


Figure 2. Fusarium crown rot and spring wheat yield across four crop rotations and two input levels at Moore, MT, 2002.

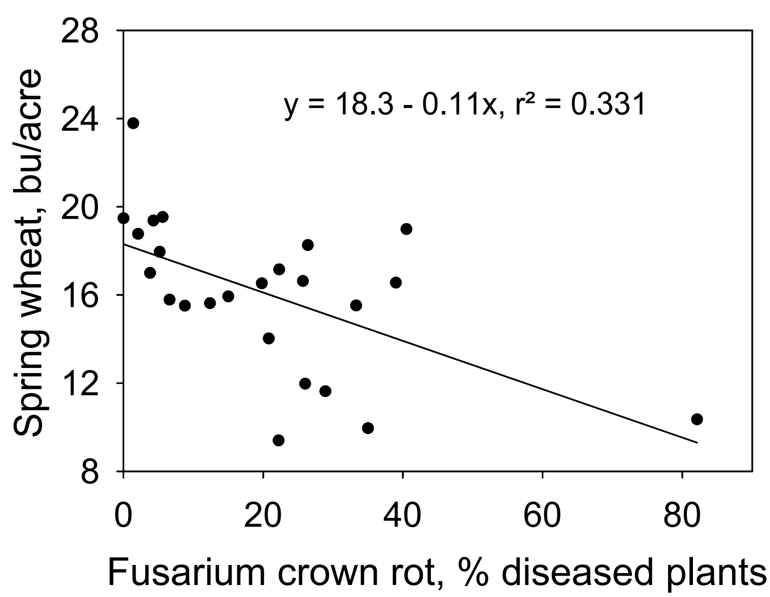
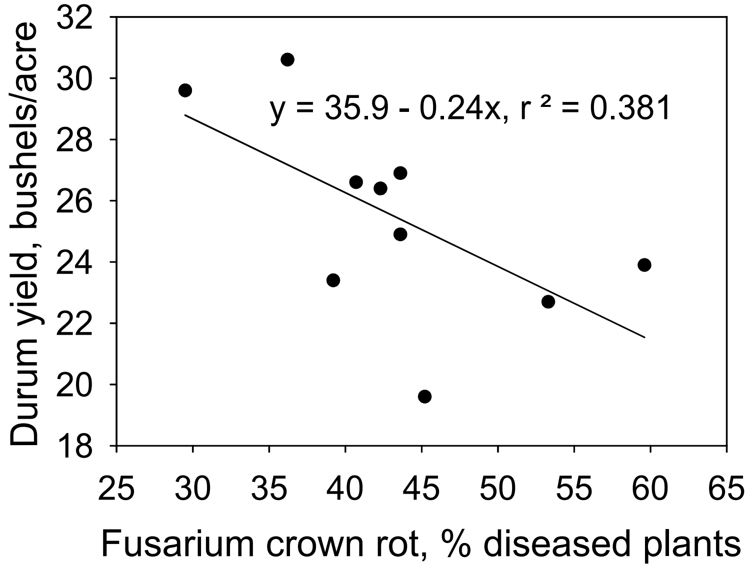


Figure 3. Fusarium crown rot and durum yield relationship at Froid, MT, 2002.



Recommendations

The disease impact of Fusarium crown rot on spring wheat in a drought weather cycle can be reduced by adopting a no-tillage system to conserve soil moisture. A crop rotation that involves wheat-fallow or similar water efficiency will minimize losses to disease. Over-seeding or delayed seeding as a weed management strategy may be detrimental to the economic crop by the combined stresses of moisture and disease. The weather forecast is for continued drought in Montana into the 2003 crop season. The adoption of solutions for management of Fusarium crown rot is a means to reduce the economic losses due to this drought-induced disease.
Appendix figures Winter Wheat

Year	Total						
	Acres		Production		Value		
	Planted (000)	Harvested (000)	Yield Per Acre Bu.	Total Bushels (000)	Price Per Bu. Dols.	Value of Production (000) Dols	Value Per Acre Dols.
2003	1,850	1,700		61,200			
2002	1,450	750	28	21,000	3.90	81,900	109
2001	1,300	870	22	19,140	3.07	58,760	68
2000	1,500	1,350	33	44,550	2.87	127,859	95
1999	1,050	970	38	36,860	2.67	98,416	101
1998	1,400	1,250	39	48,750	2.80	136,500	109
1997	1,600	1,450	38	55,100	3.40	187,340	129
1996	2,150	1,980	31	61,380	4.24	260,251	131

Spring Wheat

Year	Total						
	Acres		Production		Value		
	Planted (000)	Harvested (000)	Yield Per Acre Bu.	Total Bushels (000)	Price Per Bu. Dols.	Value of Production (000) Dols	Value Per Acre Dols.
2003	3,100						
2002	3,750	3,450	22	75,900	4.30	326,370	95
2001	3,550	2,850	23	65,550	3.06	200,583	70
2000	3,350	3,100	25	77,500	3.03	234,825	76
1999	4,150	4,000	27	108,000	2.97	320,760	80
1998	3,800	3,600	30	108,000	3.13	338,040	94
1997	4,250	4,100	29	118,900	3.58	425,662	104
1996	4,200	4,100	26	106,600	4.22	449,852	110

Barley

Year	TOTAL						
	Acres		Production		Value		
	Planted (000)	Harvested (000)	Yield Per Acre Bu.	Total Bushels (000)	Price Per Bu. Dols.	Value of Production (000) Dols.	Value Per Acre Dols.
2003	1,200						
2002	1,200	950	42	39,900	2.90	115,710	122
2001	1,100	720	41	29,520	2.65	78,228	109
2000	1,250	950	40	38,000	2.38	90,440	95
1999	1,300	1,150	50	57,500	2.32	133,400	116
1998	1,350	1,200	48	57,600	2.27	130,752	109
1997	1,250	1,150	53	60,950	2.83	172,489	150
1996	1,250	1,150	43	49,450	3.07	151,812	132

Durum

Year	Total						
	Acres		Production		Value		
	Planted (000)	Harvested (000)	Yield Per Acre Bu.	Total Bushels (000)	Price Per Bu. Dols.	Value of Production (000) Dols	Value Per Acre Dols.
2003	600						
2002	590	565	23	12,995	4.50	58,478	104
2001	510	495	24	11,880	3.80	45,144	91
2000	480	470	28	13,160	3.52	46,323	99
1999	360	350	27	9,450	3.45	32,603	93
1998	450	430	28	12,040	3.23	38,889	90
1997	300	290	26	7,540	5.18	39,057	135
1996	290	280	25	7,000	4.65	32,550	116

Nebraska - John Watkins (in absentia)

Drought conditions significantly reduced wheat yields in the Nebraska Panhandle and west central Nebraska in 2002. Approximately 1.2M acres out of 1.7M statewide acres of wheat are grown in these two areas. Fall and spring rains and snows improved the droughty conditions for the 2003 winter wheat crop, although subsoil moisture levels remain inadequate for many areas in western Nebraska.

Except for extreme western Nebraska where inadequate moisture for fall growth occurred, wheat emerged from the winter in relatively good condition. Winter kill and crown and root rot were not a factor in stand emergence. Nitrogen deficiency was widespread in the Nebraska Panhandle because of the drought, farmers were reluctant to spend additional money on fertilizer. This oversight was definitely going to impact yields on some farms.

Four diseases were prominent in Nebraska in 2003. These were soil-borne wheat mosaic, stripe rust, leaf rust and tan spot.

Cool, wet weather in April and May extended the symptom expression window for soil-borne wheat mosaic. The incidence was high in southeast and south central Nebraska with some of the more susceptible varieties showing definite stunting. Impact on yields are difficult to measure with this disease and statewide impact on production will be minimal because only about 320K acres of wheat are grown in the soil-borne area.

Stripe rust was the most significant disease in 2003 and was equally severe from the Iowa/ Missouri border to the Wyoming border. The disease became evident in mid-

May and because of cool temperatures and frequent rains developed rapidly. This year's epidemic appears to be more severe than the 2001 epidemic. Varieties that were rated as moderately resistant in 2001 are appearing moderately susceptible to susceptible in 2003. The incidence of foliar fungicide application to irrigated fields and seed production fields was higher this year than it has been in the past several years. Growers should see a good return on their investment in foliar fungicide application. Those non-treated fields with susceptible varieties could have yields reduced 20-30% due to stripe rust.

Leaf rust severities were moderately high; however, it developed late and will probably not impact yields. Leaf rust occurred primarily in southeast and south central Nebraska.

Wherever wheat was grown in close proximity to wheat residue from the 2002 crop, tan spot incidence was high. It moved onto flag leaves but due to the high severity of stripe rust on the flag leaf, there wasn't much room for tan spot.

Pockets of wheat streak mosaic occurred in the south west and in the Panhandle, but the disease was not a major player in wheat production in 2003 as it was in 2002. With the wheat in the mid- to hard-dough stage, Fusarium head blight is showing up in some fields in south east and south central Nebraska. I observed a field near Lincoln with approximately 1% of the heads with head blight. This field had been planted into corn residue which probably supplied the inoculum. Another disease noted on the heads was Septoria glume blotch. Septoria leaf blotch and *Septoria nodorum* were also present on leaves on plants in plots near Lincoln. A late freeze in mid- May followed by 100F temperatures in late May in western Nebraska produced both freeze injury and heat injury in the same fields. Powdery mildew occurred in irrigated wheat, but the incidence and severity were light.

In 2002 Nebraska had its lowest wheat production since 1943 because of the drought. The opposite has occurred with 2003 being estimated to be one of the better wheat production years, although stripe rust will undoubtedly impact yields and total production figures.

North Dakota – Did not attend this year.

Oregon – Chris Mundt

Our biggest constraint to small grain production in recent years has been drought. More normal rainfall this past year has improved the situation. However, dry June weather will likely reduce yields to at least some extent.

Late sowings of winter wheat caused by drought, and non-conducive weather, has reduced severity of Cephalosporium stripe and eyespot. In addition, resistant cultivars are often grown in areas conducive to eyespot. At the time of the meeting, stripe rust had not become an issue on wheat or barley. Winter wheat will likely be protected from stripe rust by high-temperature adult plant resistance. There is still time for spring wheat to be impacted, and fields of spring wheat were sprayed for stripe rust last year. The spring wheat cultivar Zak has remained resistant to stripe rust so far in the Pendleton area, in contrast to what has been seen in Washington. Adoption of relatively resistant barley cultivars has reduced damage to barley stripe rust. In the Willamette Valley, Septoria leaf blotch has become important again now that acreage has rebounded from low prices of a few years ago. The moderately resistant cultivar Foote has become very popular. This resistance to Septoria has left an open niche for leaf rust, though leaf rust generally comes in late enough to avoid devastating epidemics. Dry conditions may result in losses due to Fusarium foot rot.

Budget cuts in Extension may have a substantial impact. Russ Karow's position in Extension Cereals Agronomy has not been replaced. Effects on Extension Plant Pathology have not yet been determined.

South Dakota – Did not attend this year

Texas - Did not attend this year

Washington –Timothy Murray and Xianming Chen

<u>Acreage estimates</u>.

Total - nearly 3.0 million acres

- Winter wheat - 1.80 million acres in 2003 (+50,000 ac over 2002); 2003 yield is est. at 62 bu/ac (+3 over 2002). Total production is estimated to be up 8% over 2002.
- Spring wheat - est. 600,000 ac in 2003 (-20,000 ac below 2002); 2002 yield was 43 bu/ac. 2003 yield to be released 7/11/03.
- Barley – est. 310,000 ac in 2003 (-40,000 below 2002); 2003 yield to be released 7/11/03.
- Oats – 35,000 ac in 2003 (no change from 2002); 2003 yield to be released 7/11/03.

<u>Growing Conditions</u>

Overall the winter wheat crop is in good condition and yields are expected to be higher than last year, but well below records. The dry spring weather with moderate temperatures provided good conditions for seeding and establishment of spring crops.

<u>Fall 2002</u>. Dry conditions were prevalent during autumn with little or no rainfall until late October. In the high-rainfall region, much winter wheat was sown into dry soil and emerged slowly following rain in November. In the intermediate- and low-rainfall regions, seedbed moisture was greater and seeding and emergence occurred on time or delayed only slightly. Autumn temperatures were average to above average until the second week of October when very cold temperatures, resulting in frozen soil, started much earlier than normal and lasted to early November. From the second week of November, 2002 to February, 2003, the temperatures were much above normal,

resulting a very mild winter.. Very little snow fell in the high-rainfall region until late February and early March 2003. In north-central Washington, snow fell near Christmas and persisted for about 90 days. Mild temperatures resulted in good winter survival throughout the state.

Spring 2003. Early spring weather was cool and moist with relatively few days of warm, dry weather. Recent temperatures have been above average and the crop is developing rapidly. Seasonal precipitation for most of the wheat-producing area is average to above-average, with Pullman being a notable exception at 51% of normal.

Disease problems

Soilborne pathogens

Cephalosporium stripe is appearing in some areas, but it is not expected to be as serious as previous years due to dry autumn weather and the early freeze, which limited early infection.

Eyespot is present in fields that were sown and emerged early in the low- and intermediate-rainfall areas, but the incidence and severity are low due to dry autumn weather that limited pathogen dispersal and infection.

Pink snow mold was present in fields in the traditional snow mold area of north-central Washington, but not severe enough to cause significant damage. Speckled snow mold was also present, but not severe enough to cause significant damage. Bruehl club wheat was again sown widely in the snow mold areas and is expected to minimize losses.

Foliar pathogens

Stripe rust (wheat and barley): Winter and spring weather has been very favorable to stripe rust, and it will be severe rust on susceptible varieties if the weather continues to be favorable.

As normal, stripe rust was developing during the winter in western Washington because of the extremely favorable weather conditions to the rust. By late March, up to 50% stripe rust was found on susceptible entries in the winter wheat disease nurseries, and 10% stripe rust on susceptible entries in the winter barley nurseries at the Mt. Vernon location. By late April, susceptible wheat entries had over 90% stripe rust and susceptible barley had over 30% stripe rust in the nurseries. Light stripe rust occurred in commercial wheat fields in the Skagit valley because resistant or moderately resistant cultivars were grown.

In eastern Washington (areas east of the Cascade Mountains), severe stripe rust occurred much early in susceptible winter wheat fields. In late April, several fields grown with hard red winter wheat 'Hatton' had 80% plants in entire fields infected by stripe rust with severity levels ranging from 15 to 60%. From late April to early May, Most of the susceptible hard red winter wheat fields in Franklin and Adams counties were sprayed with fungicides. By May 8, wheat stripe rust was widespread in winter wheat fields in Whitman, Garfield, Columbia, Walla Walla, Franklin, and Adams counties with various levels of severities and reactions depending upon susceptibility of cultivars. Stripe rust started showing up in spring wheat fields under irrigation near Connell and Othello. By May 16, stripe rust was developing rapidly in spring wheat fields grown with "Scarlet' and 'Express' in the irrigation regions. Fungicide was applied in these fields. In late May, wheat stripe rust was developing rapidly on susceptible winter wheat in the Palouse region. Susceptible entries had up to 20% stripe rust in our winter wheat nurseries. Commercial fields grown with susceptible hard red winter wheat 'Columbia 1' had 5 to 10% stripe rust. Fungicide was applied in these fields. In late May, light stripe rust was found on winter barley near Othello and trace rust was found on spring barley near Othello, Dusty, and Pullman.

By early June, leaf rust and stem rust have not been found yet because they occur in late stages of crop growth.

Powdery mildew was severe on susceptible entries in the winter wheat nurseries at Mt. Vernon. In eastern Washington, the disease was only found in low canopy in some irrigated fields.

Physiological leaf spot is a widespread problem yet this year, although many growers now apply chloride, which limits development of this disorder.

Barley yellow dwarf was reported in the Skagit valley and also very severe in winter wheat nurseries at Central Ferry, but has not been reported as a significant problem in central Washington where wheat is typically sown very early making it vulnerable to infestation by cereal grain aphids that oversummer in corn fields.

Personnel.
Hanu Pappu joined the faculty in Pullman as the Samuel H. Smith Endowed Professor in Plant Virology.