WSU FIELD DAYS

June 19, 1986
Dry Land Research Unit, Lind

June 26, 1986
Palouse Conservation Station
Field Day, Pullman

July 10, 1986
Spillman Farm, Pullman

Because of reduced budgets it is necessary to partially offset the cost of this brochure with a $2 charge.

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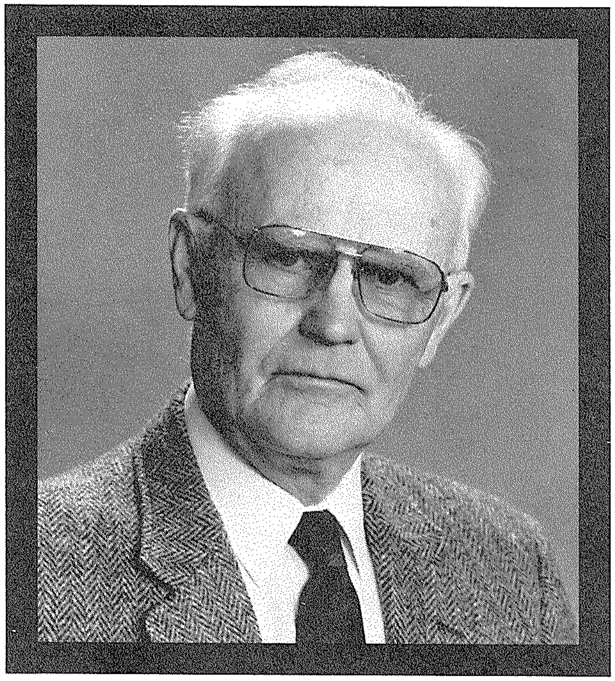
DEDICATION



Alfred R. Halvorson

In recognition of his 28 years of service at Washington State University, we are pleased to dedicate the 1986 Field Day brochure to Dr. Alfred R. Halvorson. Al Halvorson retired on January 31, 1986.

A native of Minnesota, Dr. Halvorson earned a B.S. degree in Chemistry and a Ph.D. in Soil Science at the University of Minnesota. He spent 5 years as Assistant Superintendent of the Klamath Falls (Oregon) Agricultural Experiment Station and 3 years as Extension Agronomist at Purdue University in Indiana before joining WSU in 1957.

His title of Extension Soil Scientist does not truly convey Al's assignment in Soil Fertility Management or his dedication to soil testing as a most effective tool to achieve maximum fertilizer efficiency. He organized Washington State University's Soil Testing Laboratory and managed it until financial problems led to its closure a few years ago. Throughout his career he championed the importance of accurate soil sampling, the careful use of laboratory techniques and judicious advice on fertilizer use, based on research plot correlations and experience.

Dr. Halvorson's value to Washington farmers was not limited to soil fertility matters. His sound training and scientific curiosity, coupled with years of trouble shooting and problem solving, made him a data bank of information in most aspects of crop production.

His retirement was well-earned, but we expect to call upon that invaluable data bank when our own resources can't solve problems which occur on individual farms or areas.

HISTORY OF DRY LAND RESEARCH UNIT

On April 1, 1915, Experiment Station Director I. D. Cardiff announced the establishment of the Adams Branch Experiment Station. It was "created for dissemination of information and conduction of demonstrations and experiments in the semi-arid portion of the state."

Adams County has played an important part in the history of the station. The county donated $6000 to start the station and the land has been donated by the county. In the early 30's during the depression, Adams County kept the station alive with a small appropriation until the College could fund the operation again. In 1965 Adams County deeded 318 acres to Washington State University: two acres were previously deeded to make a total of 320 acres in the Dry Land Research Unit.

The first superintendent was the late Dr. M. A. McCall. 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." For over sixty years this station has followed this policy of studying the problems associated with the 8 to 12 inch rainfall area.

In 1947 the station was named the Dry Land Experiment Station. This name was changed again in 1965 to the Dry Land Research Unit. In 1972 the administration of the station was moved into the Department of Agronomy and Soils. Although the administration was changed, the station is still devoted to dry land research. This experiment station has the lowest rainfall of any research station devoted to dry land research in the United States.

The present facilities include a small elevator that was constructed in 1937 for grain storage. A modern office and attached greenhouse were built in 1949 after the old office quarters were burned. In 1960 a 40' x 80' metal shop was constructed with WSU general building funds. In 1964 an addition to the greenhouse was built with a Washington Wheat Commission grant of $12,000 to facilitate breeding for stripe rust resistance. In 1966 a new deep well was drilled testing over 430 gallons per minute. A pump and irrigation system were installed in 1967. The addition of a 12' x 60' trailer house, and improvements in 1966 and 1967 amounted to over $35,000 with more than $11,000 of this from Wheat Commission funds and the remainder from state funds. In 1983 a new seed processing and storage building was completed 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. The old machine storage built shortly after the station was established was removed this year.

The major portion of the research has centered on wheat. Variety adaptation, wheat production management including weed and disease control, and wheat breeding are the major programs of research in recent years. Twenty acres of land can be irrigated for research trials. Although many varieties of wheat have been recommended from variety trials by the station, Wanser and McCall were the first varieties developed on the station by plant breeding.

Since 1916 an annual field day has been held to show farmers and interested businessmen the research on the station. This year marks the 69th field day. Visitors are welcome at any time. Their suggestions are appreciated.

IRRIGATION AT THE DRY LAND RESEARCH UNIT

Every year the question is raised as to why irrigation is used on an experiment station which is located in, and devoted to, research for the wheat-summerfallow area of Eastern Washington.

In the research conducted on the station, irrigation serves one or more of five purposes: 1. Insures the establishment of a good stand of wheat where the main purpose of the research would fail with an inadequate stand. Instances of this use are the dryland foot rot trial where plants must be stressed to fully express the disease, fertilizer trials, and disease nurseries. 2. Foliar diseases, leaf rust and stripe rust, are much more severe under irrigation, due to the heavier foliage and the fungi's requirement of free water on the plant leaves for infection. The foot rots, strawbreakers and take-all (a problem only under irrigation) are more severe and it is easier to obtain infection with the aid of water management. 3. Irrigation aids in stand establishment and in increasing the volume of seed harvested where a limited quantity of seed is available for testing and increase as in the case of seed from individual seeds or plants. 4. Certain agronomic traits, such as lodging resistance, shatter resistance, tillering capacity, potential yield capacity, and plant height are more readily determined from one or two seasons under irrigation than from many years of testing on dry land. 5. With an increase in irrigation and supplemented irrigation in the area, there is a need for research in these areas. The irrigated winter wheat trials are designed to determine the agronomic trials which cannot be easily determined under dry land conditions as well as test the selections for yield and quality under irrigated culture.

The primary purpose of irrigation on the Dry Land Research Unit is not to aid in the development of hard red winter wheats for higher rainfall and irrigated agriculture, but to speed up and aid in the development of better varieties for the dryland wheat summer fallow region.

HISTORY OF SPILLMAN 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 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 1880's.

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 feet addition was added in 1981. In 1957 a well that produced 340 gallons per minute was developed. In 1968 the Washington Wheat Commission provided funds for a sheath 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, roadside seedings, and a conservation crop rotation including alfalfa and grass has been in use since the Farm was purchased.

Ray Nelson was appointed farm manager in July 1981.

CLIMATIC DATA

The climatic conditions in the low rainfall area of eastern Washington commonly called the Big Bend Area, are unique when compared to Great Plains wheat producing areas. As shown in Table 1, about 90% of the rainfall occurs from September 15 to June 30. This rainfall pattern coincides with the normal winter wheat growing season. In most wheat production areas outside the Pacific Northwest, a spring-summer rainfall pattern occurs. The efficiency of the moisture utilization is greater under our rainfall pattern with lower evaporation-transpiration rates during the months of maximum precipitation in both summerfallow and crop years.

Table 1. Average temperature and precipitation at Dry Land Research Unit, Lind

	Temperature °F.		Precipitation		Precipitation
Month	Max.	Min.	1985	1986	64 yrs. av. (in)
January	34	22	.40	1.86	1.01
February	42	24	.40	1.30	.89
March	53	32	.81	1.43	.77
April	63	35	.18	.65	.67
May	72	42	.22		.78
June	83	45	.57		.85
July	90	52	T		.24
August	90	50	.79		.33
September	79	45	.86		.57
October	65	38	.44		.86
November	47	29	1.20		1.24
December	37	26	.34		1.28
			6.21		9.49

Climatic measurements are made daily with standard U.S. Weather Bureau instruments. Data recorded are maximum and minimum temperature, daily precipitation, relative humidity, daily wind movement, and daily evaporation. In addition, automatic instruments make a continuous record of soil and air temperatures and precipitation.

Table 2. Temperature and precipitation at Palouse Conservation Field Station, Pullman, 1985-1986

Month	Monthly Avg. Temperature (F)		Precipitation (in)				
	Max.	Min.	30-Yr. Avg.*	Monthly	Total Accum.	Deviation from Avg. Monthly	Deviation from Avg. Accum.
1985							
January	27.4	14.6	2.79	0.49	0.49	−2.30	−2.30
February	33.3	19.0	2.06	1.60	2.09	−0.46	−2.76
March	45.9	28.6	1.84	1.64	3.73	−0.20	−2.96
April	60.0	37.2	1.55	0.88	4.61	−0.67	−3.63
May	67.9	42.3	1.53	1.14	5.75	−0.39	−4.02
June	73.4	45.3	1.65	1.55	7.30	−0.10	−4.12
July	89.6	51.7	0.45	0.09	7.39	−0.36	−4.48
August	79.0	48.8	0.64	1.21	8.60	+0.57	−3.91
September	64.6	41.4	1.14	2.14	10.74	+1.00	−2.91
October	56.4	36.1	1.83	1.45	12.19	−0.38	−3.29
November	30.5	17.8	2.66	2.28	14.47	−0.38	−3.67
December	25.9	12.4	2.67	0.62	15.09	−2.05	−5.72
TOTAL	54.5	32.9	20.81		15.09		−5.72
1986							
January	40.0	30.4	2.79	3.35	3.35	+0.56	+0.56
February	41.8	28.2	2.06	3.64	6.99	+1.58	+2.14
March	54.0	36.4	1.84	1.58	8.57	−0.26	+1.88
April	55.6	35.0	1.55	1.09	9.66	−0.46	+1.42
TOTAL			8.24		9.66		+1.42
1985 CROP YEAR Sept. 1985 thru April 30, 1986			16.54		16.15		−0.39

*Thirty-year average for precipitation, 1941-1970

ADAPTED PUBLIC VARIETIES—WHEAT, OATS, BARLEY

AREA	WINTER WHEAT	SPRING WHEAT	OATS	SPRING BARLEY	WINTER BARLEY
EASTERN WASHINGTON 14 Inches or More Rainfall	Nugaines Daws Stephens Tres Hill 81 Lewjain Crew Dusty	Dirkwin Waverly Edwall Owens Penawawa	Cayuse Appaloosa	Steptoe Advance—malting Belford—hay only Andre—malting Cougbar	Kamiak Boyer Showin
EASTERN WASHINGTON Less Than 14 Inches Rainfall	Wanser McCall Hatton Sprague Lewjain Batum Moro Tres Crew	Wampum Waverly Dirkwin Edwall Owens Penawawa		Steptoe	Kamiak
CENTRAL WASHINGTON Under Irrigation	Daws Stephens Hill 81 Lewjain Dusty	Wampum Waverly Dirkwin Owens Penawawa	Cayuse Appaloosa	Andre Klages Steptoe Belford—hay only Cougbar	Boyer Hesk Showin
Snow Mold Areas	Sprague John				

WHEAT, BARLEY, AND OATS

Kenneth J. Morrison
Washington State University

Winter Wheat

Dusty

Dusty is a semidwarf soft white winter wheat developed for production in Washington, Idaho and Oregon. The variety has a common-type head with white chaff. It has a better yield record than Daws and Nugaines. The test weight is slightly less than Nugaines but higher than Daws. The straw strength of Dusty is weaker than that of Daws and Stephens, and it may lodge under high production. It is similar to Lewjain in winterhardiness, but is considerably less winterhardy than Daws. The variety does initiate growth earlier in the spring than Daws. Dusty is resistant to common bunt and has adult plant resistance to stripe rust. It is moderately susceptible to leaf rust, *Cephalosporium* stripe, and flag smut. It is susceptible to dwarf bunt, snow mold, stem rust, and *Cercosporella* foot rot. Dusty has satisfactory milling and baking quality.

Dusty was developed by USDA-ARS and Washington State University.

Tres

Tres is a soft white club winter wheat. It is a semidwarf with awnlet compact heads, white glumes and straw.

Tres has intermediate resistance to stripe rust, leaf rust and powdery mildew. Tres is moderately susceptible to strawbreaker foot rot. It is highly susceptible to flag smut, *Cephalosporium* stripe, and most races of the dwarf bunt.

Tres has high yield potential with a better yield record than other club wheats grown in the area.

Tres has heavier test weight than other club wheat varieties. It is less coldhardy than Tyee, and emerges more slowly than Moro or Paha. Tres has typical club wheat milling and flour qualities.

Tres was developed by USDA-ARS and Washington State University.

Crew

Crew was the first multiline, wheat cultivar to be released in North America. Crew is a multiline developed to lessen the genetic vulnerability of the region's club wheat crop to stripe rust. Crew is made up of 10 separate lines. It appears to be more generally adapted to the club wheat region than other club wheats such as Paha and Faro. It is less damaged than current club wheat varieties to leaf rust and mildew.

All of the 10 components possess seedling resistance and some have adult resistance to stripe rust.

Crew is susceptible to strawbreaker foot rot. The variety is resistant to common bunt but it is susceptible to flag smut and *Cephalosporium* stripe. Crew yields more than Elgin, Moro, and Paha and is comparable to Barbee, Faro, Tyee and Jacmar in yield. The yields of Crew are less than Daws.

The test weight is higher than Barbee, Tyee and Faro but it is lower than most common white wheat varieties.

The emergence of Crew is similar to Faro but less than Moro, but it is better than Tyee and Daws. The cold hardiness of Crew is similar to Faro, Moro and Elgin but it is inferior to Daws and Jacmar for regrowth after freezing.

Crew is similar to Faro in milling and baking quality. In bad rust years Crew mills better than most clubs because it has higher test weight.

Lewjain

Lewjain is a semidwarf white winter wheat with good dwarf bunt resistance. The variety has a common type head with white chaff. The test weight of Lewjain is similar to Luke, being slightly lower than Nugaines and about the same as Daws. The straw of Lewjain is weaker than Daws and Nugaines. Lewjain is similar to Luke in winterhardiness, being slightly less winterhardy than Nugaines and considerably less than Daws. It has excellent resistance to stripe rust and is more tolerant to *Cercosporella* foot rot than Nugaines or Daws. The variety has excellent resistance to local races of common and dwarf bunt. Lewjain is more susceptible to flag smut than Nugaines. It is moderately resistant to *Cephalosporium* stripe.

Lewjain shatters slightly more than Daws and Nugaines but it is easy to combine and thresh. Reel speed should be held to a minimum to avoid excessive loss from head snapping.

Lewjain has excellent milling quality but is not as good as most soft white club wheats. Baking tests have shown the flour has good quality for pastry, cookies, and soft white wheat products.

Lewjain was developed by USDA-ARS and Washington State University.

Nugaines

Nugaines is a soft white semidwarf winter wheat with excellent test weight, milling, and baking properties. The variety has a bearded, common-type head with white chaff.

Nugaines is not as winterhardy as Daws or the hard red winter wheat McCall or Wanser but is hardier than Luke and Paha.

Nugaines has good mature plant resistance to stripe rust but is susceptible to stripe rust in the seedling stage. It is also susceptible to leaf rust, dwarf bunt, snow mold, and *Cercosporella* foot rot.

Nugaines is resistant to most races of common bunt and has moderate resistance to flag smut and *Cephalosporium* stripe (fungus stripe). Nugaines was developed by USDA-ARS and Washington State University.

Daws

Daws is a soft white common semidwarf winter wheat. The variety has about a 5-percent yield advantage over Nugaines. It is more winterhardy than Nugaines but is not as hardy as Wanser or McCall.

Daws has good milling property and the flour quality is satisfactory. The variety emerges slower than Nugaines. Daws has good stripe rust resistance but is susceptible to *Cercosporella* foot rot, snow mold, dwarf smut, and *Cephalosporium* stripe (fungus stripe). It is moderately susceptible to leaf rust. Daws was developed by USDA-ARS and Washington State University.

Stephens

Stephens is a soft white common wheat released at Oregon that is resistant to stripe rust and common smut. It is moderately resistant to *Cercosporella* foot rot. Stephens is susceptible to leaf rust, dwarf smut, flag smut, snow mold, and *Cephalosporium* stripe (fungus stripe). It is similar to Nugaines in emergence. The grain yields of Stephens are slightly higher than Nugaines, McDermid, and Hyslop. Stephens has the same winterhardiness as Hyslop. The milling and flour qualities of Stephens are similar to that of Nugaines. Stephens was developed by Oregon State University.

Hill 81

Hill 81 is a soft white common semidwarf winter wheat. It is mid tall with white stiff straw. The spike is awned with white. It is more winter hardy than Stephens but is not as winter hardy as Daws. Hill 81 has seedling resistance to local races of stripe rust and common bunt. It has good adult plant resistance to the current races of stripe rust and leaf rust. It is susceptible to *Cercosporella* foot rot and moderately resistant to *Cephalosporium* stripe.

Hill 81 has maintained high yields, being comparable to Daws but with less yield than Stephens when winter injury is not a factor in yield.

The variety has promising overall white wheat quality characteristics with quality similar to Nugaines.

John

John is a soft white winter wheat with white chaff. The straw height is about the same as Sprague, but is weaker than most other varieties but superior to Sprague. Yields are slightly higher than Sprague.

The emergence appears to be good. The snow mold resistance is comparable to Sprague. John has a slightly higher flour yield than Sprague; otherwise it is similar to Sprague in quality. Yields of John are comparable to Sprague.

It is similar to Sprague in stripe rust resistance, but is slightly less leaf rust-resistant.

John was developed by Washington State University and USDA-ARS.

Sprague

Sprague is a soft white common wheat developed for the snow mold areas. The chaff varies white to gray-brown; the heads are small and awned. It has high tillering capacity from early seedlings but the straw is weak. The test weight of Sprague is below Nugaines but it has been above 60 pounds per bushel.

Sprague has good resistance to snow mold and common bunt but is susceptible to dwarf bunt, stripe and leaf rusts, and *Cercosporella* foot rot.

It has excellent emergence and good winterhardiness. Sprague was developed by USDA-ARS and Washington State University.

Moro

Moro is a soft winter club wheat with brown chaff. Its chief advantages are resistance to stripe rust and excellent emergence. It is susceptible to leaf rust. When stripe rust is severe, Moro produces much better yields than stripe rust susceptible varieties. Moro is resistant to most races of dwarf bunt and common bunt. Moro is moderately resistant to *Cephalosporium* stripe (fungus stripe).

Moro is a good pastry flour; however, it has a higher flour viscosity than other club varieties. Moro is a medium-tall club variety with white kernels. Moro does not have the high yield potential of other club varieties in the higher rainfall areas. In the lower rainfall areas of Washington, where it is difficult to obtain stands with other varieties, Moro will germinate and emerge much better than other varieties from deep seedlings in dry, dusty seedbeds. Moro was developed by Oregon State University.

Batum

Batum is a hard red winter wheat with a white chaff common head. Batum is a semidwarf with shorter straw than Wanser, Hatton or Westin, but the lodging resistance is better than the other hard red winter wheats. The variety emerges equal to Wanser or Hatton. The winterhardiness of the variety is slightly below the other hard red winter wheats. Yield of Batum has been slightly better than Hatton, Wanser or Westin.

It is susceptible to dwarf bunt, but is resistant to stripe rust and moderately resistant to leaf rust. The variety is susceptible to *Cercosporella* foot rot and snow mold. It has acceptable milling and baking quality, but the test weight is 1 lb less than Wanser.

Batum was developed by Washington State University and USDA-ARS.

Wanser and McCall

Wanser and McCall are hard red winter wheats developed for low rainfall areas of Washington. Both varieties yield well in areas that have less than 13 inches of annual rainfall. The two varieties can be distinguished by chaff color. Wanser has a brown-chaffed head and McCall has a white-chaffed head. Both have bearded, lax spikes.

Both varieties are resistant to common smut and most races of dwarf bunt. Wanser shows superiority over McCall in stripe rust tolerance, and winterhardiness is important for maximum production.

McCall is well-adapted to the northern section of the Big Bend area, including Douglas, Grant, and Lincoln Counties. McCall is superior to Wanser in both snow mold tolerance and emergence from deep seedings—two qualities important to production in that area. McCall recovers rapidly in the spring which is another advantage for the northern area.

McCall has good winterhardiness, but less than Wanser. Both Wanser and McCall are more winterhardy than Nugaines, Daws, or the club wheats. Wanser and McCall are shatter resistant.

Wanser mills better than McCall. McCall has slightly better bread-baking qualities than Wanser. Neither is suitable for production of soft white wheat products. Wanser and McCall were developed by USDA-ARS and Washington State University.

Hatton

Hatton is a hard red winter wheat variety with a white-chaffed common type head. The variety is slightly taller and later maturing than Wanser. It has a higher yield record than Wanser. The variety has better stripe rust resistance than Wanser. It is susceptible to dwarf bunt, snow mold and *Cercosporella* foot rot.

Straw strength, shatter resistance and emergence are equal to Wanser. Winterhardiness is slightly better than Wanser. Milling and baking qualities are similar to Wanser and McCall for bread baking.

Hatton was developed by USDA-ARS and Washington State University.

Spring Wheat

Penawawa

Penawawa soft white spring wheat was developed by Washington State University and USDA-ARS and released for Foundation Seed Production in 1985. Penawawa is a long awned semidwarf with white glumes. It is a sister line to Edwall and in many respects is similar in appearance but about 1-2" taller in height. It carries a combination of resistances to stripe, leaf and stem rusts similar to that of Edwall. It differs from Edwall by producing grain of 1-2 lbs/bu test weight higher, a fact which is reflected also in its average 5% + greater average yield. It is moderately susceptible to mildew and susceptible to Russian fly. Penawawa has good lodging resistance and seems more widely adapted than Edwall.

Edwall

Edwall was developed at Washington State University and released for Foundation seed production in 1984. Edwall is derived from the cross of an early Cimmyt wheat, Potam 70, and Fielder. It is an awned semidwarf with white chaff variety. It carries the highest levels of resistance to stripe, leaf and stem rust now available in a soft white spring wheat. Edwall has shown a higher yield potential in many tests than Waverly. It is susceptible to mildew and hessian fly. Edwall is tolerant to acid soil toxicity.

Waverly

Waverly is a semidwarf, white-chaffed, soft white spring wheat developed by Washington State University and USDA-ARS. Waverly has good lodging resistance with desirable straw height for non-irrigated and irrigated spring wheat production.

Waverly matures one to three days later than Fielder and about one to five days earlier than Urquie. Waverly is moderately resistant to stripe rust, leaf rust and stem rust. It is moderately susceptible to mildew. The test weight is slightly below Fielder and Urquie but superior to Twin and Dirkwin. The variety has about the same yield potential as Owens. The yields of Waverly are higher than Fielder when stripe and leaf rusts are present. Waverly carries adult plant resistance to stripe rust which becomes effective at a later growth stage than is the case for Urquie. The variety has good milling and baking quality when grown on non-irrigated or irrigated land.

Dirkwin

Dirkwin is a beardless, white-chaffed, semidwarf wheat released in 1978. It is a very widely-adapted variety, yielding well under both droughty and high-producing conditions. Compared to Twin, Dirkwin is similar in plant height, test weight, and heading date. Dirkwin is resistant to powdery mildew, stem and stripe rust. However, Dirkwin is susceptible to prevalent races of leaf rust. The milling and baking qualities of Dirkwin are satisfactory. Dirkwin was developed by USDA-ARS and the Idaho Experiment Station at Aberdeen, Idaho.

Owens

Owens is a semidwarf, awned, stiff strawed soft white spring wheat developed by USDA-ARS at the Idaho branch experiment station at Aberdeen, Idaho. Owens carries the same resistance to stripe rust present in Dirkwin, but is susceptible to currently prevailing forms of leaf rust and mildew. Owens has high test weight and satisfactory milling and baking properties. Owens yields competitively with other soft white spring wheats when leaf rust is not severe. Seed supplies of Owens are yet somewhat limited. The variety was not released in Washington because of its greater susceptibility to leaf rust than Dirkwin and Waverly.

Urquie

Urquie is a semidwarf, awned, white-chaffed, soft white spring wheat. Urquie is resistant to lodging. The test weight of Urquie is equal to that of Fielder and about two pounds more than Twin and Dirkwin. Urquie yields competitively in the irrigated areas of Washington with other soft white spring wheat varieties. Urquie has moderate high-temperature adult plant resistance to prevalent races of stripe rust but is susceptible to leaf rust, highly susceptible to stem rust and moderately susceptible to mildew. Milling and baking qualities are excellent. Production should now be limited to areas in which these diseases are not a problem.

Urquie was developed by Washington State University and USDA-ARS.

Wampum

Wampum is a new "tall" semidwarf hard red spring wheat developed by Washington State University and with the collaboration of USDA-ARS. The straw is lodging resistant. Yields are higher than Wared and equal to Fielder under irrigation. It is resistant to leaf and stripe rusts. Wampum has excellent milling and bread baking qualities.

McKay

McKay is a semidwarf hard red spring wheat developed by USDA-ARS at the Aberdeen, Idaho station. In Washington, McKay has sometimes shown good overall yield potential, about equal to Wampum. McKay is resistant to stripe, leaf and stem rusts and to mildew.

Borah

Borah is a bearded, white-chaffed, semidwarf wheat released in 1974. Compared to Wampum, maturity is 2 days earlier, and height is about 3 inches shorter. Borah is resistant to leaf rust and stem rusts but moderately resistant to currently prevalent races of stripe rust. Borah has good milling and baking qualities.

Spring Barley

Steptoe

Steptoe is a 6-row, rough-awned, spring non-malting barley with a high yield record. The test weight is high for a 6-row. Steptoe heads later than most 6-row varieties. The variety has stiff straw with good lodging resistance. The straw is medium tall. The heads are erect with rough awns. The variety is not acceptable for malting. Steptoe was developed by Washington State University.

Advance

Advance is a 6-row spring malting variety. The variety has low or no cold tolerance and, therefore, it is susceptible to winterkill which will reduce the problem of volunteer barley in subsequent crop rotations. This is especially important when wheat is grown after barley.

Extreme earliness will permit Advance to mature under more favorable conditions. Advance is a short, stiff-strawed variety. Additionally, tests indicate that advance has a higher feed value for livestock than Steptoe but it yields only 93 percent as much grain as Steptoe. Advance has some susceptibility to mildew but in trials where this disease has been prevalent, yield losses were not detectable and malting quality was not impaired. Advance was developed by Washington State University.

Cougbar

Cougbar is a 6-row spring barley with rough awns, medium height and good lodging resistance. It has high yield and wide adaptation. Its yield has equaled or exceeded Steptoe's at Pullman and is about 96% of Steptoe averaged across eastern Washington. Cougbar has plump kernels, high test weight and less winter hardiness than Steptoe. Cougbar's yield, test weight and percent plump kernals have been greater than those of Advance. Cougbar has relatively good nutritional and malting quality. However, Cougbar is not as yet classified as a malting barley, as industry tests are incomplete. Cougbar was developed by Washington State University.

Andre

Andre is a 2-row, rough awn spring malting barley with good feed quality for the PNW. It has a nodding head with medium-short stiff straw and good tillering capacity. Andre yields exceed Klages and Vanguard and approach those of Steptoe. At Pullman, Andre is one day earlier than Klages, about the same as Vanguard, and six days later than Steptoe. The variety has good lodging and shattering resistance. The kernels are slightly larger than those of Klages or Vanguard but smaller than the kernels of Steptoe. The test weight is higher than Steptoe. Feeding trials indicate that Andre is better than Steptoe in feed value. Malting barley tests indicated Andre has good 2-row malting barley quality. Andre was developed by Washington State University.

Klages

Klages is a 2-row malting barley adapted to production with irrigation. The variety is not well-adapted to low-moisture dryland situations. Klages has stiff straw and the beards are rough. It is mid-season in maturity. The variety has excellent malting quality but does not have as high yield record in Washington tests as other 2-row malting varieties. Klages was developed by the USDA and the University of Idaho.

Belford

Belford is a 6-row, hooded or awnless variety of spring barley developed by Washington State University. It is mid-season in maturity and medium tall. The straw is relatively weak. Belford is recommended only for hay and only in eastern Washington high rainfall areas and in central Washington under irrigation.

Winter Barley

Kamiak

Kamiak is a 6-row winter barley. It has produced high yields in tests. Kamiak has good winterhardiness. Kamiak is mid-tall and lodging can be a problem. The test weight of Kamiak is moderately high. The variety has early maturity. Kamiak does not have small glume hairs which cause "itching" during threshing.

Kamiak performs well in eastern Washington. Kamiak was developed by Washington State University.

Boyer

Boyer is a 6-row, white-kerneled, winter barley variety with rough awns but it does not have the severe "itching" characteristics of other winter varieties.

The variety has a high yield record and relatively short, stiff straw with 15 percent less lodging than most other winter barleys. Boyer is slightly more winterhardy than other varieties except Kamiak. Boyer has shorter straw than most other winter barleys.

The kernels of Boyer are larger and plumper than other winter barleys. Boyer was developed by Washington State University.

Hesk

Hesk is a 6-row winter barley developed by Oregon State University. Hesk has mid season maturity and relatively good yield potential slightly less than Boyer in eastern Washington. It has a plant height, lodging resistance and winterhardiness similar to Boyer. Hesk has a high test weight.

Showin

Showin is a semidwarf 6-row winter feed barley with a better yield record than Kamiak or Boyer. It is 20 percent to 25 percent shorter than Kamiak or Boyer. It is 27 percent more lodging-resistant than Kamiak, being similar to Boyer. Showin is more winterhardy than Boyer, and is similar to Kamiak. Showin has prostrate growth habit until the jointing stage, which would be an advantage in weed control and soil conservation because of the early and more complete ground cover.

Feeding trials indicate Showin is similar to Kamiak and Boyer in nutritional value.

Showin was developed by Washington State University.

Oats

Cayuse

Cayuse is a high-yielding, moderately early spring oat recommended in Washington. Cayuse was developed by Washington State University from a selection made at Cornell University. It is a short, pale green variety with open and spreading heads. The straw is strong and resistant to lodging. The kernels are light yellow. Cayuse has yielded 10 to 20 percent more than Park in test plantings.

The main weakness of Cayuse is its low test weight compared with that of Park. The test weight of Cayuse has averaged about 35 pounds per bushel in all Washington locations, with 37 for Park.

Cayuse has fair tolerance to the most serious oat disease in Washington—barley yellow dwarf virus disease, or "red leaf of oats." The yellow dwarf tolerance of Cayuse can be seen mainly in its high-yielding ability. Discoloration results after severe attack by aphids carrying the virus.

No other disease of consequence has attacked Cayuse at any Washington location since testing began in 1959. Cayuse is susceptible to node blackening and stem break in the eastern part of the United States, but the disease does not affect oat yields in Washington.

Appaloosa

Appaloosa is a new yellow spring oat developed by Washington State University with more yellow dwarf virus tolerance than Cayuse. Appaloosa has up to 10 percent higher yield performance compared with Cayuse, but slightly lower average test weight. Appaloosa is a mid-season spring oat with straw 1 to 2 inches shorter than Cayuse. It has slightly better resistance to lodging than Cayuse.

Monida

Monida is a new white spring oat developed at the USDA-UI Research Station at Aberdeen, Idaho. Monida yields almost as high as Cayuse and Appaloosa, but has the special advantage of a higher grain test weight under most test conditions and the more desired white grain color. It heads a day or so later than Cayuse, and sometimes is a few inches taller. Its lodging resistance is average for its height. It probably would lodge under irrigation and high fertility. It should carry at least the Cayuse level of tolerance to BYDV, but comparative tests have not been made.

SOFT WHITE WINTER WHEAT IMPROVEMENT

C. J. Peterson Jr., S. J. Hayward, and D. F. Moser

Washington wheat growers harvested 127.6 million bushels of wheat in 1985 for an average yield per acre of 47.5 bushels. Production was 24 percent below the previous year. Growing conditions during the crop year were far from ideal. Cold weather during September and October delayed emergence and tillering. This was followed by a prolonged period of snow cover and the wheat seedlings were weakened. The seedlings recovered slowly during the spring and failed to develop the type of plant needed for maximum production. Precipitation during the year was below normal and temperatures during June and July were above normal. Snow mold, fusarium foot rot, and dwarf bunt also reduced grain production in some areas of the Pacific Northwest.

Foundation seed of Dusty (PI486429, WA006912, VH074575), a soft white winter wheat, was available in the fall of 1985. Dusty was selected in the F4 from the cross, Brevor/CI15923//Nugaines. It was a high tillering, late maturing, semidwarf with medium spikes, awns, and white glumes. Dusty is resistant to the local races of stripe rust and common bunt. It has shown some tolerance to flag smut, leaf rust, snow mold, and *Cephalosporium* stripe. Dusty is susceptible to dwarf bunt, stem rust, and *Cercosporella* foot rot. Emergence of Dusty is similar to that of Stephens but the straw is weaker and it may lodge under high production. It flowers 2 to 4 days later than Daws. Dusty produced an average of 69.9 bu/a of grain for 63 site/yrs of tests and it averaged 3.1, 1.6, and 7.3 bu/a more than Daws, Stephens and Nugaines, respectively. Dusty averaged 59.5 pounds per bushel for 69 site/yrs of tests and it averaged 0.8 lbs/bu less than Nugaines and 0.2 lbs/bu more than Daws. The winterhardiness of Dusty is similar to that of Nugaines. The milling and flour characteristics of Dusty are quite similar to that of Daws.

Three new disease resistant, high yielding, semidwarf soft white winter wheat lines were identified. WA007433 has resistance to *Cephalosporium* stripe and *Cercosporella* foot rot, but its winterhardiness and flour quality are questionable. It is also resistant to stripe and leaf rust. WA007432 appears to be resistant to *Cercosporella* foot rot and is resistant to the local races of stripe rust. WA007431 is moderately resistant to snow mold and *Cephalosporium* stripe. It is resistant to the local races of stripe rust and common bunt.

Table 1 contains the yield data for 1984/85. WA007163 produced the most grain at Pullman (early and late). WA007163 is resistant to *Cercosporella* foot rot, stripe rust and stem rust. It will be increased for possible release to the wheat growers in 1988. Malcolm (new variety from Oregon State University) produced the most grain at Pomeroy and Cunningham. Lewjain produced the most grain at Ritzville. Dusty produced the most grain at Walla Walla and it also had the highest yield when the data was averaged over all locations.

Table 2 contains the average grain yield data (bushels per acre) for seven winter wheat varieties grown at five locations in Washington during the past five years. Tres had the highest five year average yield at Pullman. Dusty produced the most grain at Pomeroy and Walla Walla. Lewjain had the highest grain production at Ritzville and Cunningham. When the yields were averaged across all locations over the past five years Lewjain and Dusty produced the most grain. Daws had the heaviest bushel weight of the varieties listed in Table 2 when the data was averaged over years and locations. Tres has a heavier bushel weight than the previous semidwarf club wheats.

Table 3 contains agronomic and disease data on 11 soft white winter wheats. WA007163 (common) and WA007166 (club) have an excellent balance of disease resistance. They represent the first wheats that may be released with *Cercosporella* foot rot resistance. In addition they are resistant to the local races of stem rust. Lewjain has resistance to dwarf bunt and has good tolerance to *Cephalosporium* stripe. Dusty is quite susceptible to *Cercosporella* foot rot. Moro is susceptible to stripe rust.

Table 1. Grain Yield Data (bu/a) for Ten Winter Wheats Grown at Six Locations in Washington During 1984/85.

	PL E	PL L	POM	W W	RITZ	CUNN*	AVG.
Common							
Daws	69	52	40	59	41	100	60
Stephens	51	49	36	58	40	96	55
Lewjain	76	54	41	68	51	116	68
Hill 81	67	56	38	66	45	92	61
Dusty	65	59	45	76	49	120	69
WA007163	78	66	45	65	45	111	68
Malcolm	56	53	46	64	40	121	63
Club							
Crew	76	52	38	59	46	106	63
Tres	70	59	42	64	49	112	66
WA007166	76	57	43	66	43	113	66

*PL E = Pullman early, PL L = Pullman late, POM = Pomeroy, W W = Walla Walla, RITZ = Ritzville and CUNN = Cunningham.

Table 2. Five Year (1981/85) Average Yield (bu/a) and Overall Test Weight (lb/bu) Data on Seven Soft White Winter Wheats Grown at Five Locations in Washington.

	PULL*	POM	W W	RITZ	CUNN	AVG.	TEST WT.
Common Wheats							
Daws	75	66	82	62	110	79	59.3
Stephens	78	62	93	49	107	78	56.2
Lewjain	79	68	84	66	119	83	58.6
Dusty	80	70	100	62	105	83	57.4
Hill 81		66	87	60	102		
Club Wheats							
Crew	77	64	83	63	92	76	56.6
Tres	81	61	87	60	100	78	58.3

*Pullman (late) sown 1st week in October each year.
Pull = Pullman, Pom = Pomeroy, W W = Walla Walla, Ritz = Ritzville, and Cunn = Cunningham.

Table 3. Index and/or Disease Ratings for 11 Winter Wheats. Emergence (EM), Winter Hardiness (WH), Maturity (MAT), Bushel Weight (BW), Common Bunt (CB), Dwarf Bunt (DB), Leaf Rust (LR), Stripe Rust (SR) and *Cephalosporium* Stripe (CS).

Variety	EM	WH	MAT	BW	CB	DB	LR	SR	CS
Nugaines	5*	6	Medium	8	R**	S	S	MS	MR
Daws	4	8	Medium	7	R	S	MS	MR	MS
Stephens	5	2	Early	7	R	S	MS	R	S
Hill 81	5	5	Medium	7	R	S	MS	MR	MR
Lewjain	6	5	Late	7	R	R	MS	R	MR
Dusty	5	5	Med-Late	7	R	S	MS	MR	MS
WA007163	5	5	Medium	7	R	S	R	R	MS
Crew	6	5	Medium	6	MR	S	MR	MR	MS
Tres	6	5	Medium	7	MR	S	R	MR	MS
Moro	8	5	Medium	5	R	MR	S	S	MS
WA007166	6	5	Medium	6	R	S	R	R	MS

* 1 = Poor 10 = Excellent
**R = Resistant, MR = Moderately Resistant
MS = Moderately Susceptible, S = Susceptible

HARD RED WINTER WHEAT BREEDING AND TESTING

E. Donaldson and M. Nagamitsu

The hard red winter wheat breeding and testing program in Washington is partially funded by the Washington Wheat Commission and is conducted from the Dry Land Research Unit at Lind. The primary objective is to provide Washington hard red winter wheat producers with good quality, consistently high yielding, disease resistant varieties through varietal development and testing of advanced selections and varieties developed elsewhere. The great plains yield nurseries, which include selections from Texas to Canada, from public and private breeders are grown at Lind. The Western Regional Hard Red Winter Wheat nursery including advanced selections from the western region, including Oregon, Idaho, Utah, Montana, and Washington is grown at five locations in Washington. In varietal development, emphasis is placed on the agronomic characteristics of emergence, lodging resistance, and yield performance. The most emphasis in disease resistance is currently being placed on strawbreaker foot rot, stripe and leaf rust, dwarf bunt, and snowmold. In breeding for bread baking quality, the challenge is to combine high protein with high flour yield and large loaf volume.

WA6820 (developed by Dr. G. W. Bruehl) is under increase for possible release in 1987. It is a semidwarf and red winter wheat with good snowmold tolerance and fair TCK resistance. WA6820 has an excellent yield record in the Waterville nursery whether snowmold was present or absent. Preliminary tests indicate the overall quality is satisfactory. A tendency toward weak straw and a susceptibility to stripe rust appear to be its major weaknesses.

Two new tall hard red winter wheat selections (WA7429 and WA7430) were entered in the 1986 western regional hard red winter wheat nursery. They have good yield records in three years of testing and have satisfactory quality and stripe rust resistance.

The 1985 performance of 6 hard red winter wheats are given in the following tables. In an average of the dryland nurseries at Lind, Horse Heaven, Finley, and Connell, Hatton had the highest overall yield with 33 bu/a, followed by Neeley with 31 bu/a, and Weston and Winridge with 28 bu/a. In a four year average of these nurseries Batum yielded 39 bu/a. Hatton, Neeley, Weston, Winridge, and Manning yielded 36, 36, 35, 35, and 34 bu/a respectively. Percent whole grain protein was high in the 1985 harvest. The average protein content from the above nurseries was a high of 14.2% for WA6820 and a low of 12.2% for Winridge. The Waterville nursery was a good snowmold trial and a good nursery for identifying superior selections, but a poor yield nursery.

Table 1. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries, 1952-85.

Variety	Avg. Plant ht.	Avg. Test wt.	1985 Yield bu/a	Avg. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	26	61.3	30.1	35.9	128	21
Daws	29	59.2	29.1	34.1	130	12
Dusty	25	60.1	31.8	29.2	166	3
Luke	26	59.8	26.2	32.5	123	17
Lewjain	26	59.3	28.5	32.7	133	9
John	27	60.0	35.6	33.3	127	5
Stephens	28	58.2	29.2	32.0	124	13
Hill 81	27	59.1	32.3	29.8	112	4
Moro	30	58.5	30.2	35.4	123	22
Crew	27	58.1	30.7	35.4	141	8
Tyee	27	58.5	29.3	32.9	116	10
Tres	27	60.1	29.7	37.2	140	6
Wanser	32	61.6	29.2	33.0	115	22
Hatton	31	62.5	31.4	32.5	131	10
Weston	34	61.5	32.2	32.4	129	8
Winridge	31	61.0	29.0	33.8	127	6
Batum	28	60.5	30.5	37.8	145	5
WA6820	28	59.5	25.1	32.8	122	4
Kharkof	33	60.6	26.9	28.6	100	31

Table 2. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row nurseries, 1952-85.

Variety	Av. Test wt.	1985 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	61.5	50.8	42.7	138	20
Daws	60.0	51.2	46.5	143	12
Dusty	58.3	57.7	51.2	153	3
Luke	60.6	50.7	45.7	148	17
Lewjain	60.3	49.7	50.2	157	9
John	59.2	46.8	46.8	149	5
Stephens	59.6	49.2	46.3	142	12
Hill 81	59.5	50.0	52.9	156	4
Moro	58.9	47.9	42.7	138	20
Crew	58.9	45.8	55.1	164	8
Tyee	58.4	53.3	52.9	163	10
Tres	59.6	41.8	54.6	165	6
Batum	59.0	62.6	54.8	161	4
Hatton	62.9	63.7	48.4	150	10
Kharkof	61.0	33.9	33.8	100	32

Table 3. Summary of agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries, 1952-85.

Variety	Avg. Test wt.	1985 Yield bu/a	Avg. Yield bu/a	Yield % Kharkof	No. years grown
Wanser	61.8	9.9	36.4	112	17
Hatton	63.0	14.7	36.3	137	7
Weston	62.2	23.3	35.2	141	6
Winridge	60.9	20.4	36.9	147	5
Batum	60.1	17.1	37.1	148	5
WA6820	60.5	24.1	44.2	183	4
Kharkof	61.1	9.8	32.4	100	26

Table 4. Summary of agronomic characteristics of winter wheat varieties grown at Connell in rod row nurseries, 1975-85.

Variety	Avg. Test wt.	1985 Yield bu/a	Avg. Yield bu/a	Yield % Kharkof	No. years grown
Daws	60.8	33.5	39.6	128	8
Lewjain	61.9	35.9	45.6	132	3
John	61.7	40.1	45.1	131	3
Stephens	60.1	34.0	40.3	130	8
Tres	62.2	37.0	51.8	123	2
Wanser	62.7	30.0	35.7	112	9
Hatton	63.7	38.7	40.4	130	8
Weston	63.5	32.2	40.4	128	6
Winridge	62.1	32.6	43.0	125	3
Batum	61.4	32.9	45.1	131	3
WA6820	61.8	30.5	45.8	136	4
Kharkof	61.9	34.2	32.0	100	9

Table 5. Summary of agronomic characteristics of winter wheat varieties grown at Finley in rod row nurseries, 1984-85.

Variety	1985 Yield bu/a	Yield % Kharkof	Avg. Test wt.	No. years grown
Wanser	26.7	104	63.7	2
Hatton	35.0	136	64.3	2
Batum	27.3	105	62.0	2
Weston	29.3	111	63.7	2
Winridge	28.9	103	62.8	2
WA6820	27.0	91	62.5	2
Kharkof	26.5	100	62.8	2

Table 6. Summary of agronomic characteristics of winter wheat varieties grown at Horse Heaven Hills in rod row nurseries, 1951-85.

Variety	1985 Yield bu/a	Yield % Kharkof	Avg. Test wt.	No. years grown
Wanser	23.2	120	63.3	2
Hatton	28.4	127	64.4	2
Batum	16.9	119	61.0	2
Weston	19.7	115	63.7	2
Winridge	19.5	122	62.0	2
WA6820	23.2	126	62.3	2
Kharkof	21.5	100	63.2	2

DEVELOPING WHEATS FOR REDUCED TILLAGE

R. E. Allan, C. J. Peterson, L. M. Little, J. A. Pritchett, K. K. Hwu

Tests based on 29 trials conducted during 1978 to 1985 indicated that a separate breeding program for reduced tillage culture may not be needed. Yield rankings of the main soft white winter wheat varieties were similar under no-till and till culture. No-till mean yields averaged only 3% lower than till mean yields across all tests. Tillage practice affected yield in about 60% of all analyses and among these no-till significantly reduced yield about 65% of the time. Significant genotype X tillage practice interactions occurred for yield and 15 other traits for 10% of the analyses. This means that the various wheat genotypes usually responded in the same manner for important agronomic traits under no-till and till culture. There seems to be little necessity to test genotypes under no-till culture. Positive correlations occurred between the two tillage practices in 27 of 29 trials with average r values of 0.67 to 0.74. This indicates significant genetic advance could be made for no-till winter wheat yield performance based on till yield performance.

Tests of wheat isolines differing for various morpho-physiological traits indicated that semidwarf growth habit and club spike type favorably affected no-till yield performance whereas awn expression and heading date were neutral. The interaction of semidwarf genes and no-till yield performance was complex. The 1-gene semidwarfs achieved higher mean no-till yields than 2-gene and 0-gene sibs. Genetic background determined whether the Rht_1 or Rht_2 semidwarf gene gave the higher no-till yield potential. As a group, short 2-gene semidwarfs were less affected by tillage practice than the 1- or 0-gene groups. Previous crop altered the no-till yield performance of some semidwarf isolines.

ENHANCEMENT OF RESISTANCE TO RUSTS OF WHEAT

R. E. Allan, J. A. Pritchett, L. M. Little

Tres, released in 1984, has maintained resistance to stripe rust, leaf rust and powdery mildew. Across 48 site-years of tests, the mean yields of Tres, Daws, Stephens, Tyee, Crew, Nugaines, and Faro have been 81, 80, 79, 77, 74, 69, and 68 bu/a, respectively. In 1985, Tres showed field resistance to the stripe rust races that attack Tyee and Fielder.

Rust resistance from alien species and genera of wheat continue to show promise and several agronomically suitable types have been placed in intra-state and regional trials. Regional entries include WA7163, WA7166, and WA7217, each of which express high resistance to all three rusts. These lines also possess tolerance to strawbreaker foot rot. Their resistance to all four diseases is primarily derived from *Aegilops ventricosa,* a weedy relative of wheat. Several other lines derive resistance to stripe rust and stem rust from *Agropyron elongatum.* One of these lines (club sel. 8432) also has high tolerance to both *Cephalosporium* stripe and strawbreaker foot rot. Sel. 8432 yielded comparable to Crew and Tyee in 4 tests in 1985.

The multiline, Crew, apparently has certain yield stability properties not found in most currently grown varieties. Unlike pure-line varieties which are genetically rigid and sometimes limited in their adaptation to fluctuating environmental conditions, multilines are mixtures of pure-lines which theoretically can buffer against changing environmental pressures. We measured stability parameters for Crew and its components and several pure-line varieties. Based on two ways to assess relative stability, Crew proved to be more stable for its yield performance than all of its components except two. Crew demonstrated greater yield stability than Tyee, Faro, Tres, Paha, Nugaines, Daws, and Stephens.

CERCOSPORELLA FOOT ROT RESISTANCE

R. E. Allan, C. J. Peterson, D. Roberts, J. A. Pritchett, and L. M. Little

Progress in variety development. WA7163 and WA7166 are being proposed for possible release in 1987. These two selections derive moderately high resistance to strawbreaker foot rot from two VPM/Moisson selections which are wheat translocation lines obtained from France. The source of foot rot resistance is *Aegilops ventricosa,* a grassy relative of wheat. WA7163 is a common white winter semidwarf wheat which resembles Hill 81, and WA7166 is a semidwarf club wheat similar to Tyee. In addition to high resistance to foot rot, both lines have high levels of resistance to stripe, leaf and stem rust. Table 1 compares the performance of WA7163 and WA7166 to Nugaines, Stephens, and Daws in foot rot inoculated yield trials during 1981 to 1985. WA7163 and WA7166 averaged 113 and 97 bu/a compared to yields of 64 to 73 bu/a for the three varieties. The two selections had foot rot inoculated/benomyl control yield ratios which ranged from 0.85 to 1.24 and averaged 0.94 and 1.00. This means that WA7166 and WA7163 had foot rot-induced yield losses of 0 and 6% compared to average yield losses of 15 to 35% for the three varieties. The milling and baking quality of WA7163 and WA7166 are satisfactory. Their coldhardiness and emergence ability are similar to Tres and Lewjain. Neither line has resistance to *Cephalosporium* stripe, however. A decision on the release of one or both of these selections will be made after 1986 tests are completed.

Table 1. Mean foot rot inoculated yields and inoculated/control yield ratios for WA7163, WA7166 and three cultivars.

Kind	1981		1982		1983		1984		1985		Mean	
	bu/a and inoculated/control yield ratio											
WA7163	94	0.88	129	0.93	124	0.99	96	0.97	111	0.96	113	0.94
WA7166	103	1.24	116	0.94	96	0.86	58	0.85	111	1.03	97	1.00
Nugaines	17	0.37	113	0.84	66	0.61	51	0.57	75	0.68	64	0.65
Daws	34	0.60	116	0.81	61	0.81	75	0.66	81	0.82	73	0.74
Stephens	55	0.56	107	0.87	69	0.97	41	1.28	84	0.87	71	0.85

A quick biochemical test to aid breeding for foot rot resistance. We have known for over 30 years that *Aegilops ventricosa* has high resistance to strawbreaker foot rot. Nevertheless, transferring this resistance to wheat has been difficult because classifying plants for resistance is tedious, labor intensive and not always accurate. Cooperative research with Dr. D. E. McMillin of Georgia State University has identified a biochemical marker which can be used to screen wheat seedlings for foot rot resistance. The marker is an isozyme for endopeptidase enzyme. We were able to show that there is a very close association or linkage between the main gene for resistance to strawbreaker foot rot and the allele for the endopeptidase isozyme among progeny derived from crosses between ordinary wheat and *A. ventricosa* derivatives. The enzyme test can be done rapidly on wheat seedlings that are only 9 days old. Because the endopeptidase gene and the foot rot resistance gene are closely linked, we can use the enzyme test as a quick way to identify individual plants which will most likely be resistant to foot rot. Knowing specifically which seedlings have resistance will greatly speed crossbreeding and selection and shorten the time needed to develop foot rot resistant cultivars. It should also save labor and reduce our field testing program.

GENETICS OF WHEAT GROWTH AND DEVELOPMENT

R. E. Allan, J. A. Pritchett, L. M. Little, L. Bassett

Rht_1 semidwarf gene gives best stand establishment. The Rht_1 semidwarf gene has a less adverse effect on emergence than Rht_2 based on tests with wheat isolines. We evaluated the stand establishment properties of the four genotypes (Rht_1Rht_2, Rht_1rht_2, rht_1Rht_2, and rht_1rht_2) for five near isogenic wheat populations in field tests in 1985. Pooled results across all populations indicated that the genotypes with Rht_1 had higher mean final stands and mean emergence rate indices than those with Rht_2. Among all five populations, the Rht_2 genotypes consistently had lower emergence rate indices than their respective non-semidwarf sibs. For four of the five populations, the Rht_2 genotypes also had significantly lower mean final stand counts than their non-semidwarf counterparts. Mean final stands and emergence rate indices were not significantly different between the Rht_1 genotypes and their non-semidwarf genotypes for four and three of the populations, respectively. Measurements indicated that Rht_1 genotypes had significantly longer coleoptiles than Rht_2 genotypes for two of the five populations and when the data were pooled over all populations. These results are borne out by the fact that cultivars with Rht_1 gene (Stephens, Hill 81, and Lewjain) are generally superior in emergence to cultivars with Rht_2 gene (Nugaines, Tyee and Daws).

Effect of photoperiod response on wheat yields. A replicated preliminary yield test indicated that photoperiod insensitivity genes had negative effects on yield in seven different genetic backgrounds of wheat. Photoperiod insensitivity appeared to reduce yields from 8 to 18% depending on the genetic background. The yield reductions were greater in the genetic backgrounds of Nugaines, Marfed, and Daws than for those of Brevor, Wanser, and Luke. Over 200 5th generation backcrosses were made transferring the photoperiod insensitivity genes of Extra Early Blackhull to Nugaines and Paha. These populations also vary for spike density, awn expression and semidwarfism. During 1986, we will select near isogenic lines which vary for these four different gene systems.

STRAWBREAKER FOOT ROT AND *CEPHALOSPORIUM* STRIPE

T. D. Murray, C. Campbell, and C. Strausbaugh

Mechanisms and genetics of foot rot resistance. Previous work has shown that a wide band of lignified mechanical tissue in the stems of some wheat varieties is associated with resistance to *Pseudocercosporella herpotrichoides,* the fungus responsible for causing foot rot. Work has also shown that lignified structures called papillae that form in the first leaf sheaths are associated with disease resistance. Carl Strausbaugh, a graduate student, is studying the genetics of disease resistance in crosses of very resistant and very susceptible varieties. From this work we hope to develop a quick, seedling test for disease resistance that could be used to speed the development of resistant varieties.

Progeny of crosses between resistant and susceptible varieties are being advanced. When they reach the f_4 generation, single plants will be selected and used to establish pure lines that will in turn be evaluated for disease resistance and width of mechanical tissue in the stem.

Fungicide trials. Trials using both commercial and experimental fungicides are in progress. It is still too early to determine the severity of foot rot this year, but light to moderate disease is expected. New combinations of fungicides being tested are Prochloraz + Benlate and Tilt + Benlate. These combinations may offer early season stripe rust control and at the same time prevent the development of strains of the fungus resistant to Benlate, Mertect, and Topsin.

Variety trials. Experiments to determine the resistance of several commercial varieties and advanced selections of Drs. Allan and Peterson to foot rot and *cephalosporium* stripe are underway. Many of the selections have looked good in previous trials and may have high levels of resistance to these diseases.

Soil pH. Soil pH was adjusted using lime and sulfuric acid to determine if liming may provide control of *cephalosporium* stripe. Work in the greenhouse has shown *cephalosporium* stripe is much worse when soil pH is low (pH 4.5-5.5). Raising soil pH with lime may control this disease.

Work is in progress to develop a method of screening for resistance to *cephalosporium* stripe in the greenhouse using soil pH. Ideally this technique would provide more accurate answers about resistance in a shorter period of time than screening in the field. However, we have had the same problem in the greenhouse as in the field—variable results.

INHIBITION OF WINTER WHEAT GROWTH BY ROOT COLONIZING BACTERIA

H. Bolton, Jr., H. F. Stroo, K. A. Kaufmann, L. F. Elliott, and R. I. Papendick
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Large numbers of bacteria inhibitory to winter wheat growth can be present on the wheat root surface. These bacteria (members of a group called pseudomonads) are aggressive root colonizers which normally appear in large numbers on the root surface after the plants break dormancy in the early spring. We have sampled fields where all of the pseudomonads on the root surfaces were inhibitory. Cold, wet springs seem to encourage the bacteria. They inhibit winter wheat growth by producing a toxin.

Seeding into heavy wheat residue (till or no-till) seems to encourage the presence of these bacteria on the root surface. Inhibitory isolates of the bacteria will colonize various straws and remain on it for long periods of time. In no-till seeding into heavy residue, severe stand loss usually occurs in the chaff row. The inhibitory bacteria grow well on chaff and large numbers have been isolated from chaff in the field.

Crop rotations may be an effective control measure for these inhibitory pseudomonads. Although the bacteria can grow on the root surface and residues of various Palouse crop plants, damage is most severe to winter wheat. Less of an effect is seen on barley and little effect on oats, peas, and lentils. The organisms appear to have no effect on legumes and do not inhibit *Rhizobium* sp. or legume nodulation.

Field studies show that winter wheat inoculated with these pseudomonads in nonsterile soil produce inhibited plants with about a 50% overwinter stand loss. The bacteria were present in high numbers on the root surface. In another field study, the pseudomonads were sprayed onto barley residue, which was either plowed under or left on the soil surface, and planted to winter wheat. The organisms colonized the wheat root surfaces and root-shoot ratios were reduced. This study provides direct evidence that inhibitory pseudomonads on straw from the previous crop can colonize the roots of wheat sown into it.

Work is proceeding in the field on the effect of crop rotations on the presence of these pseudomonads on root surfaces and on residue-microbial relationships. Other areas also being studied are: purification, identification, mode of action of the toxin, and the genetic control of toxin production.

Partial support of this research project by the O. A. Vogel Fund is gratefully acknowledged.

SPRING WHEAT RESEARCH

C. F. Konzak, M. A. Davis, Mark Welter

General

WSU's spring wheat breeding activity is centered at Pullman to gain greater efficiency. Extensive evaluation and screening trials are conducted also in the low rainfall area at the Dry Land Research Unit at Lind and under irrigation at the Royal Slope experimental farm near Othello. Smaller scale, but still substantial, research test plots are conducted via grower cooperation on the Dale Bauermeister farm near Connell (dry land), at the Kramer ranch near Harrington (dry land), near Pullman at the Don Quist Ranch (dryland, recrop), at Foundation Farms, Inc., Walla Walla (sprinkler irrigation) and Waitsburg (dry land, recrop), and at the WSU Wilkie Research Farm at Davenport (recrop and management trial). Extension-related trials further supplement the research tests.

Uniform yield trials of hundreds of new lines are grown at the three main stations each year, in addition to the one trial, WSU's 'Commercial' variety trial, which is used also for demonstrations at many research test locations. The uniform yield trials include Washington State soft white and hard red spring wheat nurseries of about 60 varieties each, which also are grown at many of the off-station sites, and a varying number of advanced and preliminary replicated trials of both wheat types. In 1986 these trials were placed on dry land recrop sites in order to evaluate the entries for drought tolerance and *Fusarium* root rot resistance. Non-replicated seed increase plots, especially of soft white wheats, are usually grown at the Royal Slope farm, as are seed increase lots of advanced materials being prepared for entry into Western Regional trials. A number of special trials are grown only at Pullman. These include the Western Regional Spring Wheat nursery and the Uniform Regional Hard Red Spring Wheat Nursery. This group of nurseries, plus crossing blocks with considerable introduced materials, supplement the base of germplasm available for cross-breeding.

In 1986, crossing blocks employing a chemical hybridizing agent were initiated, both to facilitate crossing, and to evaluate genotype responses to the chemical.

New Varieties

Descriptions of Edwall and Penawawa were presented previously by Dr. K. J. Morrison in this issue.

Proposed Varieties

Currently in preliminary and breeder seed increase channels are 3 new spring wheats:

1. WA7183 – this hessian fly resistant soft white spring wheat was recommended for release in 1986, pending the availability of quality breeder seed stock from production in Arizona or Pullman. WA7183 also carries a combination of resistance to the 3 rusts, although stripe rust resistance (primarily adult plant type) is not as high as that of Edwall and Penawawa (Table 1). Yielding ability of WA7183 is equal to that of Edwall and Penawawa (Tables 2-4), and it shows good lodging resistance. WA7183 has satisfactory quality properties. WA7183 is proposed largely for use in conservation tillage management situations where hessian fly damage can be serious. The proposed name is Wakanz, to reflect its origin through cooperative efforts of Washington, Kansas and New Zealand scientists. WA7183 is a direct result of the accelerated "shuttle" breeding program which has employed 4 off season (winter period) increases in New Zealand.

2. WA7075 – is a high protein semidwarf hard red spring wheat, now in pre-breeder seed production. It is the first development in the WSU program to increase protein production capacity combined with yielding capacity equal to McKay and Wampum (Tables 4-7) of HRS wheats. WA7075 has satisfactory quality properties and the grain averages about 1/2 percentage point higher protein than McKay and Wampum (Table 8), and an outstanding combination of resistances to mildew and to stripe, leaf, and stem rusts. Its stem rust resistance is superior to that of Wampum and its base

Table 1. Maturity, Disease, Pest Reactions SWS Wheats

Variety	Stripe Rust	Leaf Rust	Stem Rust	Mildew	Hessian Fly	Rel.Heading Date
Waverly	MR	RMR	MR	S	S	+1
Edwall	RMR	RMR	R	MS	S	0
Dirkwin	R	R	R	S	S	+1
Owens	R	R	R	S	S	+1
Penawawa	RMR	RMR	R	MS	S	+1
WA7183	RMR	RMR	R	S	R	+1
WA7187	MR	MR	R	SS	S	−1
WA7188	MR	MR	R	SS	S	−1
Treasure(ID)	R					

Table 2.

Location	WA7183		Edwall		Waverly		Penawawa	
	Yld	TW	Yld	TW	Yld	TW	YLD	TW
Pullman	76	(55)	75	(55)	68	(56)	68	(56)
Lind	19	(60)	20	(60)	18	(60)	21	(60)
Royal Slope, Irr.	121	(62)	112	(61)	114	(63)	116	(62)
Walla Walla, Irr.	85	(57)	82	(54)	90	(58)	95	(58)
Harrington, Anl.	37	(55)	39	(52)	36	(52)	35	(53)
Davenport, Anl.	33	(57)	36	(59)	37	(56)	30	(56)
Pullman, Anl.	74	(59)	73	(58)	67	(62)	69	(62)
Pomeroy	30	(50)	35	(51)	35	(52)	34	(57)
Walla Walla	55	(56)	46	(54)	51	(57)	50	(56)
Dayton	39	(56)	32	(53)	29	(55)	46	(58)
Waitsburg, Anl.	43	(51)	45	(49)	41	(50)	47	(54)
Average	56	(56)	54	(55)	53	(56)	56	(57)

Table 3. WA007183 Yield and Test Weight Averages
(Averages by Location Over Years)

Location	L/Y	WA7183		Edwall		Waverly		Penawawa	
		Yld	TW	Yld	TW	Yld	TW	Yld	TW
Pullman	9	77	(58)	78	(57)	71	(57)	77	(59)
Lind	7	36	(60)	37	(59)	35	(60)	36	(61)
Harrington	1	46	(58)	47	(59)	40	(60)	47	(58)
Pomeroy	3	36	(55)	36	(57)	40	(56)	42	(59)
Dayton	3	38	(55)	33	(55)	34	(55)	43	(57)
Walla Walla	3	43	(57)	38	(56)	41	(58)	38	(57)
Pullman Anl.	1	74	(59)	73	(58)	67	(62)	69	(62)
Harrington Anl.	1	37	(55)	39	(52)	36	(52)	35	(53)
Waitsburg Anl.	1	43	(51)	45	(49)	41	(50)	47	(54)
R. Slope Irr.	7	107	(62)	107	(61)	97	(61)	116	(62)
W. Walla Irr.	1	85	(57)	82	(54)	90	(58)	95	(58)
Davenport Anl.	2	45	(59)	50	(59)	50	(58)	45	(59)
Ave:		55	(58)	55	(57)	53	(58)	58	(59)

Table 4. 1985 Commercial Spring Wheat Trial #46

	Yield							Pullman		
Variety:	Pull-man (1)	Harring-ton (2)	Daven-port (3)	Lind (4)	Walla Walla (5)	Royal Slope (6)	Ave. Yield	Test Weight	Plant Height	Holding Date (June)
	Bu/a							Lb/bu	In.	
(Soft White)										
Fielder	64	36	37	19	91	111	60	56	29	22
Urquie	69	34	34	23	85	107	59	58	27	27
Dirkwin	69	36	34	21	98	114	62	53	29	21
Owens	72	33	30	21	91	121	61	57	29	19
Waverly	59	36	37	19	90	114	59	55	28	23
W.S. #1	71	36	28	23	98	120	63	54	28	20
JB000010	62	36	27	20	91	105	57	56	27	20
Edwall	72	39	36	23	82	109	60	55	26	20
PI468960	68	38	34	21	75	106	57	56	29	20
Bliss	67	32	32	22	85	114	59	54	27	24
WA006916	72	40	34	19	99	103	61	57	29	19
Penawawa	61	35	30	23	95	112	59	54	29	22
WA007183	71	37	33	20	85	118	61	54	28	24
WSMP-4120	62	36	26	17	91	100	55	55	28	20
(Hard Red)										
Yecora Rojo	60	40	27	15	95	105	57	56	21	15
Wampum	61	35	32	17	84	113	57	54	31	23
McKay	59	33	27	20	90	113	57	55	27	22
JB000009	64	32	27	14	85	109	55	56	28	23
NK 751	66	36	27	18	89	111	58	54	25	19
WA007075	66	36	31	22	83	113	59	53	29	22
WA007181	65	35	32	17	89	104	57	58	32	23
WA007182	61	32	30	19	91	103	56	56	29	20
WA007185	70	38	24	15	90	99	56	55	26	18
WPB 906R	68	37	22	15	90	95	55	55	26	16
Tammy	71	40	32	20	94	108	61	57	28	20
Success	58	34	30	18	75	76	49	54	30	23
Norseman	66	35	31	16	74	110	55	52	25	20
LSD .05	8	4	6	4	11	9				

*Least Significant Difference: The difference in yield between any two varieties grown in the same nursery are not significant unless the difference exceeds the LSD value.

PREVIOUS GROUP DATA:
1-Pullman, Spillman Farm: Legumes
2-Harrington, Kramer Farm: Winter Wheat
3-Davenport, Wilke Farm: Spring Barley
4-Lind Dry Land Exp. Station: Fallow
5-Walla Walla, Foundation Farms (Irr.): Spring Wheat
6-Royal Slope Exp. Station (Irr.): Fallow

Table 5.

1985		WA7075		Wampum		McKay	
Location:	Tests	Yld	TW	Yld	TW	Yld	TW
Pullman	(3)	67	(54)	67	(54)	74	(56)
Lind	(3)	19	(60)	17	(61)	17	(61)
R.Slope Irr.	(3)	113	(62)	112	(64)	113	(63)
Connell	(1)	24	(61)	22	(61)	24	(62)
Harrington, Anl.	(1)	36	(53)	35	(55)	33	(55)
Davenport, Anl.	(1)	30	(59)	32	(60)	27	(59)
Walla Walla	(1)	83	(58)	84	(57)	90	(58)
Average		53	(58)	53	(59)	54	(59)

Table 6. Yield and Test Weight Averages
(Averages by Location over years)

Location	(Loc/ Yr)	Yld	TW	Yld	TW	Yld	TW
Pullman	(3)	73	(57)	72	(58)	79	(59)
Lind	(3)	31	(60)	28	(60)	29	(61)
Harrington	(2)	41	(56)	38	(58)	38	(57)
Walla Walla	(3)	83	(58)	84	(57)	90	(58)
R. Slope Irr.	(3)	104	(62)	110	(63)	109	(62)
Connell	(3)	26	(61)	30	(61)	30	(62)
Davenport	(2)	44	(60)	47	(60)	47	(61)

Table 7. 1985 Extension Trials, Yield (TW)

Location/entry	McKay		WA7075	
Asotin	27	(45)	27	(45)
Buckleton	11	(44)	12	(42)
Deepcreek	40	(50)	38	(49)
Dusty	29	(51)	32	(52)
Fairfield	61	(48)	64	(50)
Farmington	61	(48)	64	(50)
Lamont	30	(49)	29	(51)
Mayview	46	(52)	60	(51)
St. John	32	(48)	29	(48)
Uniontown	40	(51)	39	(50)
Wilbur	30	(57)	27	(56)
Ave	36.6	(49.7)	37.2	(49.7)

Table 8. Averages

	TWT	F.Y.	FASH	MSCOR	FPRO	MABSC	MTYPE	BABS	MTIME	LVOL	BCRGR	CODI
WA7075	61.1	71.3	.40	85.4	11.8	63.7	3H	66.3	3.4	1025	2.5	8.02
Wampum	62.8	72.2	.41	86.2	10.7	60.4	5H	64.3	3.4	1065	2.3	8.46
McKay	61.3	71.2	.37	87.0	11.1	60.4	5H	62.9	5.1	1041	1.6	7.85

of resistances appears different from that of McKay, Wampum and other wheats currently in production. Its lodging resistance is good, but probably can be lodged under irrigation and high N fertility conditions. Pre breeder seed stock in production may be available in Fall 1986 release. The release date is dependent on production of high quality breeder seed stock now in development. The name proposed is Spillman, in recognition of WSU wheat breeder Geneticist W. J. Spillman who was a rediscoverer of the laws of genetics, and the WSU Centennial.

3. WA7187, WA7188—These semidwarf soft white spring wheats offer a new development in soft wheat processing quality aimed at capturing specialty flour and other new markets, including potential overseas markets. The processing of quality properties of these lines combines the essential features of both pastry and bread type wheats into a single genotype and variety. Laboratory tests have shown these wheats will produce cookies, noodles, sponge cakes and flat breads similar or superior to those of current soft white wheats when using formulae appropriate for these products and when using a bread formula, (Table 10) can produce breads comparable to typical hard red spring wheats. Their water absorption properties are on the low end for hard wheats and in the high range for soft wheats. Their main distinction from typical soft wheats is in their dough mixing properties which are similar to typical bread wheats. Loaf volume is dependent on protein content. These wheats carry moderate resistances to stripe and leaf rusts and high resistance to stem rust, but are susceptible to mildew and the hessian fly much as other SWS wheats. (Table 1)

Yield performance data indicate that these lines yield comparably with current SWS and HRS wheats (Table 11, 12). Because they may have wider than local usage, consideration is being given to plant variety protection (PVP) and licensed release of the one best line via W. S. C. I. A. The name WADU has been proposed. Pre breeder seed stock is in production toward a possible fall 1986 release.

Advances in On-going Research

Spring Wheat research at WSU is adapting to the changes coming about in cropping practices and the problems foreseen as accompanying them. Several new procedures already have been applied in the variety evaluation trials, and as capabilities develop, other actions will be taken.

Results from the 1985 "drought year" indicated that we already had high performing, comparatively drought tolerant wheats in our advanced (state) yield trials, and that differences in resistance to *Fusarium* dry land foot rot were present and important. As a consequence, a shift has been made to grow the WSU State HRS and SWS nurseries at the critical moisture limiting recrop sites near Waitsburg, Harrington, Davenport and Pullman to gain better data on variety and genotype performance under anticipated moisture stress conditions. In addition, we hope to introduce new instrumentation to aid in gauging plant genotype responses to water deficit conditions during their grain fill period.

Shuttle Breeding

Of particular overall significance to growers, is that variety development has been greatly accelerated through the 2-crop/year "shuttle breeding" effort developed with the cooperation of the Crops Research Division of the Department of Scientific and Industrial Research in Lincoln (Christchurch) New Zealand. The New Zealand crop season in the southern hemisphere is essentially the opposite of ours. We grow some of their materials and share germplasm in a reciprocal arrangement now formalized. New stripe rust races have appeared in New Zealand, permitting us to select for broader based resistances complementary to our adult plant resistance of interest also to DSIR.

Soft White Spring Wheats

The initial phases of the "shuttle breeding" program already have been influential on progress toward the release of SWS wheats, Edwall and Penawawa (Tables 1-7), and have been especially effective toward the incorporation of a hessian fly resistance base in the breeding populations of the WSU spring wheat program. This project has benefitted considerably from the cooperation and input of

Table 9.

Variety	Stripe rust	Leaf rust	Stem rust	Mildew	Hessian fly	Rel heading date
Wampum	RMR	R	S	R	S	0
Mckay	RMR	RMR	R	R	S	0
Copper(ID)	RMR	R	R	R	S	–
WA7075	R	R	R	R	S	–1

Drs. J. Hatchett, USDA Manhattan, Kansas and Keith Pike, WSU, Prosser, Washington. A SWS selection (WA7183) from the early phase of this hessian fly resistance breeding program is now in the breeder seed increase and release channels toward its early availability to aid in conservation tillage management. Two sister lines, WA7176 and 7178, have an almost comparable performance record, but have a higher level of stripe rust resistance along with resistances to leaf and stem rust. WA7176 and WA7178 have been advanced into regional testing as a backup and to offer a possible replacement for WA7183. New crosses among soft white wheats involve the introduction of resistances to the hessian fly as a standard, although we are not yet concentrating on use of the H_3 resistance gene. Dr. Keith Pike, WSU entomologist, Prosser, already has begun screening segregating materials for hessian fly resistance, providing for the accelerated development of resistant lines. As this screening program develops, other hessian fly resistance genes will be included in the program.

With the introduction and evident potential of the dual quality wheats, an increasing emphasis will need to be placed on the incorporation of individual quality traits in a new cycle of breeding for disease and pest resistance and improved yield. The advances made in that area are in large measure due to the dedicated and extensive efforts also by Mr. Gordon Rubenthaler, leader, USDA Western Wheat Quality Laboratory, Pullman.

Hard Red Spring Wheats

Considerable progress already has been made also toward the development of hessian fly resistant HRS wheats. Besides building the hessian fly resistance germplasm into breeding populations, we have isolated several high performing, good quality disease resistant lines from a genetics research cooperation program involving Japanese scientists. This cooperative effort also used the New Zealand increase program, and is the means by which the initial phase of the "shuttle breeding" program was achieved. We were fortunate that one of the parent lines selected for the genetics research also carried hessian fly resistance. The most advanced lines from these studies are included in Tri State Regional Spring Wheat Nurseries. Several lines now are in wide testing. Progress also has been made toward enhancing the protein production capacity of our HRS wheats.

Facultative Wheats

The past two seasons have been especially effective in screening for cold hardiness in spring wheats. Most of the lines under test have already proved to have some merit from prior spring planted tests. The high survival of lines selected last year was repeated, although the survival of Urquie is greater this year than last. In addition several other cold hardy lines were identified. These results further confirm the feasibility of developing spring wheats with greater cold hardiness than Walladay, but which head several days before Walladay, and comparable to locally adapted standard spring wheats.

Commercial Variety Trial

The Commercial Variety trial is the spring wheat trial to be shown at the various Field Days. This trial includes most current varieties and several advanced experimentals from the WSU program, some from the University of Idaho, as well as lines nearing registration or sale by private breeders.

Table 10.
Averages (1981, 1983, 1984 Crops)

VARIETY	CLASS	FIELD	FASH	MSCOR	FPROT	MABSC	MTYPE	BABS	BABSC	MTIME	LVOL	VOLVC	BCRGR	CODI	CODIC	CAVOL	SCSOR	WTIN	NOSCO
McKay(2)*	HRS	73.3	.44	85.3	10.7	59.3	6M	62.4	61.7	5.3	990	947	2	8.16	8.21	1130	65.0	364	66
Wampum (2)	HRS	73.0	.46	83.9	11.2	74.8	3H	63.2	62.0	2.7	1018	944	3	8.27	8.37	1195	61.0		
Edwall (2)	SWS	72.6	.44	83.5	9.2	54.3	2M	55.0	55.8	2.1	860	908	7	8.70	8.61	1273	77.0	385	70
WA7186(4)	SWS	74.3	.41	86.3	9.9	57.2	5M	58.8	58.9	3.8	925	930	3	8.76	8.75	1267	74.0	367	67
WA7187(3)	SWS	72.1	.38	85.3	10.7	56.7	5M	59.0	58.1	3.6	1044	992	2	8.73	8.82	1325	78.0	370	69
WA7188(4)	SWS	73.3	.45	83.4	10.1	56.7	4M	57.3	57.2	2.9	937	932	3	8.71	8.72	1235	74.0	359	66

Table 11.
WA007187
Yield and Test Weight Averages
(Averages by variety over location)

Location	Loc/Yr	WA7187 Yld	WA7187 TW	Edwall Yld	Edwall TW	Waverly Yld	Waverly TW	Penawawa Yld	Penawawa TW
Pullman	5	68	(59)	78	(57)	71	(57)	77	(59)
Lind	4	32	(61)	37	(59)	35	(60)	36	(61)
Pomeroy	1	43	(59)	36	(57)	40	(56)	42	(59)
Dayton	1	46	(57)	33	(55)	34	(55)	43	(57)
Walla Walla	1	28	(59)	38	(56)	41	(58)	38	(57)
R. Slope Irr.	4	108	(63)	107	(61)	97	(61)	116	(62)
Ave. Loc/Yr		65	(61)	64	(59)	65	(58)	71	(60)

Table 12.
WA007188
Yield and Test Weight Averages
(Averages by variety over location)

Location	Loc/Yr	WA7187 Yld	WA7187 TW	Edwall Yld	Edwall TW	Waverly Yld	Waverly TW	Penawawa Yld	Penawawa TW
Pullman	4	72	(58)	78	(57)	71	(57)	77	(59)
Lind	4	32	(60)	37	(59)	35	(60)	36	(61)
Pomeroy	1	38	(57)	36	(57)	40	(56)	42	(59)
Dayton	1	44	(54)	33	(55)	34	(55)	43	(57)
Walla Walla	1	45	(58)	38	(56)	41	(58)	38	(57)
R. Slope Irr.	4	106	(62)	107	(61)	97	(61)	116	(62)
Ave. Loc/Yr		67	(60)	64	(59)	65	(58)	71	(60)

Only the WSU entry WA7183 and UI's ID232 which are nearing consideration for release carry hessian fly resistance. Other SWS lines or advanced experimentals also carry hessian fly resistance, but most entries are susceptible to the pest. Hessian fly resistance will be essential when spring wheats are grown extensively under no- or mini-till management systems, or near winter wheats so managed. Of the publicly developed SWS varieties, Waverly will likely be the most commonly grown in 1986, as ample seed supplies are available, and its disease resistance remains adequate. It will gradually be replaced by Edwall, which carries higher resistances to stripe rust, leaf rust and stem rust and has a better yield performance record. All other privately developed entries are hard red spring types; developed largely for the northern Great Plains region. Entries included come from CENEX, NAPB, Interworld Seeds, Firstline Seeds, Northrup King, and Western Plant Breeders.

Among the HRS wheats, McKay (ID) appears to be the current best performer next to Wampum. Wampum maintained its stripe and leaf rust resistance in 1984, but is highly susceptible to stem rust. McKay is resistant to local forms of all rusts. Other entries have not been evaluated sufficiently for comment. (see tables)

Locations and Management of Evaluation Trials

With the development of the new WSU spring wheat cone planter cooperatively with the WSU Dept. of Agricultural Engineering, some major changes in plot technique have become feasible:

1. *Row spacing*—tests at Pullman and Lind cooperative with Dr. A. Ciha, USDA (now at Monsanto) showed an average 10% yield advantage for the 6", 12" row spacing. With the 6" spacing there may have been less within row seedling competition at the same seeding rate (lbs/acre) while the closer spacing may have permitted earlier coverage of the soil to reduce water loss. All spring wheat research program evaluation trials were sown at the close spacing.

2. *Cropping*—In the past, all spring wheat tests were on land fallowed the previous season. This practice continues only where it is necessary to achieve pure seed. Trials at Harrington, Davenport, Waitsburg and Pullman were sown on recrop land after winter wheat, winter or spring barley.

3. *Fertilizer application*—Since 1985 we have tested the application of liquid fertilizer between the seeded rows and starting in 1986 also as a starter with the seed. We hope this practice will simplify the control of weeds and allow better use of fertilizers. However, with hard red spring wheats it may be desirable to shank in the N as NH_4 or urea later in the fall rather than spring to move the fertilizers deeper into the rooting zone in order to improve grain protein production.

BARLEY BREEDING AND TESTING IN WASHINGTON

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Production

Barley production in 1985 in Washington was approximately 1.2 million tons (48 million bushels) from 1.18 million acres. The state average yield was about 1.4 tons/acre (60 bushels/acre). Washington is the third largest barley producing state in the U.S. The planting projection for Washington for 1986 indicates that there will be over 1 million acres of barley.

Objectives

The overall objective of the barley improvement program in the state of Washington is the development of high yielding, stiff-strawed agronomically acceptable varieties that are adapted to the different barley producing areas of Washington and that have superior quality. The winter barley varieties need to be hardy enough to survive most winters with little or no damage. One major objective in both winter and spring varieties, is to develop lines which meet high quality malting standards and also have superior feeding qualities. These multipurpose varieties would meet all market demands for Washington grown barley.

The program involves the development of winter and spring, 2-row and 6-row varieties at Pullman with selection and testing at Lind Dryland Research Unit, the Mielke Farm in Harrington (winterhardiness), and the Royal Slope Research Unit (irrigated). Other major test sites are at Walla Walla, Dayton, Pomeroy, Davenport, and Connell. Dusty, Lamont, Cunningham, Deep Creek, Reardan, Bickleton, Mayview, Anatone, St. John, Uniontown, Fairfield, Farmington, and Wilbur are additional extension test locations. The cooperation of K. J. Morrison, C. F. Konzak and many growers in the testing effort is gratefully acknowledged.

An additional objective is to measure variety response to various cultural practices. This year the effects of tillage methods and nitrogen levels are being investigated at Pullman. Annual cropping system effects are being studied at Davenport (Wilke Res. & Ext. Farm), Harrington, Connell, Walla Walla and Pullman.

Results

The varieties developed at W. S. U. are described in front of the brochure under recommended barley varieties for the state of Washington. Yield results are summarized in the tables below along with newer high yielding selections and other commercial cultivars.

Winter Barley

The winter barley was damaged extensively in the Pullman trials which was in contrast to the Davenport Mielke nursery which survived nearly 100 per cent. Showin continues to have good agronomic performances in most locations (Table 1). Several newer lines are shown in Table 2 with very high yield potential.

The winter sown spring varieties all killed out last winter, including Steptoe. The only Steptoe that survived was in the very late-seeded field day plots.

Table 1. Winter barley yield averages (bu/a)

Variety	Pullman 6 yrs	Pomeroy 6 yrs	Dayton 6 yrs	Walla Walla 6 yrs	24 loc yrs	% of Kamiak
Showin	118	88	94	109	102	109
Boyer	113	82	92	103	98	104
Kamiak	110	75	94	98	94	100

Table 2. Newer winter barley selections

	Pullman 6 yr. ave. (1980-85)					
Variety	Height	Lodging		Test Weight	Yield bu/a	Yield lbs/a
Sel. 3231-77	33	16	93	48.2	123	5911
Sel. 1574-77	38	15	97	48.3	121	5808
Showin	32	4	98	46.9	118	5690
Hesk	39	18	91	49.1	117	5640
Boyer	37	15	84	49.3	113	5430
Kamiak	43	32	100	50.0	110	5302

Spring Barley

2-Row Spring

Andre is the latest 2-row release from W.S.U. and it continues to produce high yields in most locations. These results are shown in Table 3. Selections 8771-78 and 8908-78 are other high yielding 2-rows. Newer selections that show good yield potential are 10789-80 and 9066-82 (Table 4).

Table 3. Spring barley 2-row yield averages (bu/a)

Variety	Pullman 6 yrs	Pomeroy 6 yrs	Dayton 6 yrs	Walla Walla 6 yrs	24 loc yrs	% of Steptoe
Steptoe (yield check)	97	74	72	72	79	100
Sel. 8908-78	96	—	—	—	—	—
Sel. 8771-78	96	74	76	73	80	101
Sel. 8892-78	94	67	77	71	77	97
Andre	92	71	77	76	79	100
Klages (quality check)	84	61	71	71	72	91

Table 4. Newer spring barley 2-row lines

Variety	Plt. ht.	Lodging	Test wt.	Kernel size	Yield bu/a	Yield lbs/a
	Pullman 2 yr. ave. (1984-85)					
Sel. 9066-82	30	13	50.2	77-7	92	4418
Sel. 10789-80	31	15	51.9	77-6	91	4373
Sel. 8908-78	32	12	52.0	91-4	91	4351
Sel. 8771-78	32	9	52.7	88-4	89	4296
Steptoe (yield check)	34	24	47.8	81-7	88	4210
Andre	32	14	52.1	65-10	84	4032
Klages	33	16	50.4	68-8	78	3720

6-Row Spring

Cougbar is the latest W.S.U. 6-row to be released. This new variety has been producing high yields, especially in the Pullman and Walla Walla areas. Cougbar is a multipurpose 6-row with relatively good nutritional quality and it also is a potential malting barley. Comparative yield data are shown in Tables 5 and 6. Spring barley 6-row feed types are compared in Tables 7 and 8.

Table 5. Spring barley 6-row agronomic data

Variety	Plt. ht.	Lodging	Test wt.	Kernel size	Yield bu/a	Yield lbs/a
	Pullman 7 yr. ave. (1979-85)					
Cougbar	36	12	51.4	81-5	102	4880
Steptoe	36	19	49.6	90-4	98	4707
Advance	32	15	49.2	71-10	93	4456
Morex (quality check)	41	21	51.9	87-3	71	3403

Table 6. Spring barley 6-row yields over locations

Variety	Pullman 7 yrs	Dayton 6 yrs	Pomeroy 6 yrs	Walla Walla 6 yrs	25 loc yrs	% of Steptoe
Cougbar	102	68	60	75	76	96
Steptoe	98	74	72	71	79	100
Advance	93	65	67	69	74	94
Morex	71	57	49	59	59	75

Table 7. Spring barley 6-row feed types

Variety	Plt. ht.	Pullman 3 yr. ave (1983-85) Lodging	Test wt.	Kernel size	bu/a	bu/a
Sel. 8359-80	31	15	46.5	80-8	93	4458
Columbia	28	6	45.9	86-4	90	4302
Steptoe	32	16	48.6	86-5	88	4205
Kombar	28	3	44.6	84-4	85	4059
Gus	27	15	46.8	72-9	83	4000

Table 8. Spring barley feed variety performance

Variety	Pullman	1985 data Royal Slope	Lind	Harrington	Ave.	% of Steptoe
Steptoe	93	148	24	46	78	100
Kombar	78	155	17	26	69	88
Columbia	78	152	23	34	72	92
Gus	81	140	25	36	71	91
Lindy	89	133	24	39	71	91
Piston(2-row)	91	135	23	42	73	94

TRITICALE

Clarence Peterson Jr., Kenneth Morrison, Steven Hayward, Duane Moser and Patrick Reisenauer

Triticale is a cereal that was developed by crossing rye and wheat. Plant breeders hope to combine the good traits of both into a superior cereal grain. Early triticale had many poor characteristics such as: low yield, shriveled grain, poor seed set, and the plants were very tall. Early triticales were released to the growers before many of these characteristics were improved which left a bad impression with farmers. Plant breeders have made considerable progress in improving triticale in the last 10 years.

Considerable improvement in triticale grain yield has been attained. Recently developed triticale yields are now quite competitive with the locally adapted winter and spring wheat. When the grain yields were averaged over a four year period (1981 to 1984) triticales (Table 1) produced more grain at Pullman than the winter wheats Daws and Stephens. VT080011 triticale averaged 17 and 26 percent more grain than Stephens and Daws, respectively. Three of the four triticales (Table 2) grown at five locations in Washington during 1984/85 produced more grain than the winter wheats Stephens and Daws. Flora (a winter triticale) produced the most grain at all locations except Uniontown. Flora was developed and released by Oregon State University. In the nurseries grown in Idaho (Table 3) VT080011 produced more grain than Flora. However, Stephens produced more grain than the triticales at all locations. In the spring nurseries grown at Pullman the triticales VT080011 and Juanillo 168 equalled or exceeded the grain production of the spring wheat cultivars (Table 7) Waverly and Edwall for the past three years (1983/1985). There was little difference in the grain production of the

Table 1. Grain Yield data (bu/a) for two winter wheats and six triticales grown for four years in Pullman, Washington.

Cultivar	1981	1982	1983	1984	Avg.
Daws	91.9	74.9	79.0	89.7	83.9
Stephens	116.0	87.9	83.0	74.7	90.4
Grace	101.9	36.9	80.9	67.4	71.8
Whit	61.9	61.9	79.0	64.7	66.9
Beagle	83.9	36.9	72.0	71.6	66.1
VT080011	108.0	101.9	108.0	105.9	106.0
MY766939	91.9	88.9	103.9	93.1	94.5
MY766276	97.0	73.9	101.0	103.9	94.0
Juanillo 168	130.9	59.9	109.9	77.0	94.4

Table 2. Grain yield data (bushels/acre) on 2 winter wheats and four triticales grown at 6 locations in Washington during 1984/85.

Cultivar	Clyde	Lamont	Location Dusty	Goldendale	Uniontown	Avg.
Daws	31	37	49	36	61	43
Stephens	30	38	50	39	60	43
Grace	38	37	50	38	55	44
VT082805	53	44	66	52	63	56
VT080011	52	41	59	44	62	52
Flora	67	52	70	53	52	59

Table 3. Yield data (bu/a) on two winter wheats and two triticales grown in Idaho during 1984/85.

Cultivar	Bonners Ferry	Delco	Norland	Parma	Potlatch	Avg.
Stephens	65	114	117	146	88	106
Lewjain	79	127	122	104	90	104
Flora	58	85	56	84	87	74
VT080011	64	105	74	123	80	89

triticales and spring wheats (Table 8) in the nurseries grown at Pomeroy, Walla Walla and Creston during 1985. VT080011 had the lowest average production because of its low yield at Creston.

Protein content of the triticales (Table 4 and 6) has decreased as the yields have increased, but it is still one to three percent above that of the commercially grown wheat cultivars.

Bushel weight of triticale has improved as better seed types have been developed but further improvement is needed. Bushel weights of triticales averaged approximately 6 to 10 pounds less than the winter and spring wheat cultivars (Table 4, 5, and 9) largely due to shrunken endosperm in the

Table 4. Data on two winter wheats and seven Triticales grown at Pullman, Washington during 1983/84.

Cultivar	Heading Date	Plant Ht.	Test Wt.	Yield	Protein
Daws	6/18	33	56.9	89.7	11.1
Stephens	6/15	34	55.5	74.7	10.9
Grace	6/13	52	50.7	67.4	13.2
Whit	6/11	51	48.4	64.7	13.0
Beagle	6/11	49	50.5	71.6	13.8
VT080011	6/15	45	51.3	105.8	11.6
MY766276	6/14	40	47.0	103.8	11.7
MY769939	6/15	35	47.8	93.1	13.3
Juanillo 168	6/14	48	50.9	77.0	12.4

Table 5. Bushel weight (pounds/bushel) data on two winter wheats and four triticales grown at six locations in Washington during 1984/85.

Cultivar	Clyde	Lamont	Dusty	Goldendale	Uniontown	Pullman	Avg.
Daws	56.9	56.6	63.2	56.9	49.6	57.6	56.8
Stephens	54.8	54.3	59.6	55.7	49.0	54.6	54.6
Grace	49.6	46.0	51.7	48.8	45.2	46.8	48.0
VT082805	46.4	43.1	46.9	46.6	40.2	48.8	45.4
VT080011	50.4	46.5	50.3	50.3	45.3	48.8	48.7
Flora	44.3	41.5	47.2	45.1	34.6	40.8	42.3

Table 6. Protein data (%) on two winter wheats and two triticales grown in Idaho during 1984/85.

Cultivar	Delco	Norland	Parma	Potlatch	Avg.
Stephens	11.3	12.4	12.8	11.7	12.1
Lewjain	10.1	11.7	11.7	11.6	11.3
Flora	12.4	13.2	14.7	12.9	13.3
VT080011	10.5	12.9	12.7	13.2	12.3

Table 7. Yield data (bu/a) on two spring wheats and four triticales grown in Pullman, Washington

Cultivar	1983	1984	1985	Avg.
Owens	40	57	43	47
Waverly	46	56	43	48
Grace	31	51	18	33
Whit	32	37	35	35
VT080011	46	60	39	48
Jaunillo 168	47	69	43	53

Table 8. Grain yield data (Bushels per acre) on 2 spring wheats and four triticales grown at three locations in Washington in 1985.

Cultivar	Pomeroy	Walla Walla	Creston	Average
Waverly	34.9	50.5	29.1	38.2
Edwall	35.1	45.9	33.3	38.1
Grace	36.2	55.0	21.2	37.5
VT082467	40.4	45.0	30.1	38.5
VT080011	32.5	46.5	18.5	32.2
CHUU "S"	37.9	49.4	25.3	37.5

Table 9. Bushel weight data (lbs/bu) on two spring wheats and four triticales grown in Pullman, Washington.

Cultivar	1983	1984	1985	Avg.
Owens	59.0	54.7	54.2	56.0
Waverly	55.9	55.3	52.7	54.6
Grace	49.8	49.5	47.4	48.9
Whit	48.1	46.8	43.2	46.0
VT080011	49.5	50.6	46.3	48.8
Jaunillo 168	50.8	50.4	46.6	49.3

triticales. There was a significant difference in bushel weight among triticales at various winter locations. Flora and VT080011 (Table 5) had the lowest and highest bushel weight of the triticales, respectively. There was little difference in the bushel weight of the spring triticales (Table 9) and all triticales were lower than the spring wheat checks.

Triticale has the same disease problems as wheat. Most of the triticale cultivars and lines tested were resistant to the local races of stripe rust, leaf rust, and stem rust. They are all quite susceptible to *Cephalosporium* stripe. Some of the lines were susceptible to ergot.

Promising Triticale

VT080011 will be increased for possible release in 1987. It is a spring triticale but will survive the winters at Pullman, Washington, if adequate snow cover occurs during the cold weather. VT080011 is resistant to the local races of stripe rust and leaf rust. It is susceptible to *Cephalosporium* stripe. When the grain production of VT080011 was averaged over the last four years in the nurseries grown at Pullman, Washington it has produced 106 bushel/acre. Daws and Stephens produced 94 and 90 bushels of grain respectively in the same nurseries. VT080011 is approximately 15 inches taller than Daws and has a 6 to 10 pound lower bushel weight. It heads earlier than Daws but it matures about the same time. Protein of VT080011 is 1 to 2 percentage points above that of the soft white winter wheat cultivars.

Wheats and triticales used in these tests.

Cultivar	Type	Developed By
Daws	Winter Wheat	USDA–WSU
Stephens	Winter Wheat	USDA–OSU
Lewjain	Winter Wheat	USDA–WSU
Flora	Winter Triticale	USDA–OSU
MY766939	Winter Triticale	USDA–OSU
MY766276	Winter Triticale	USDA–OSU
Waverly	Spring Wheat	WSU
Edwall	Spring Wheat	WSU
Owens	Spring Wheat	USDA–U of I
Grace*	Spring Triticale	Jenkens Foundation
Whit	Spring Triticale	USDA–WSU
Beagle	Spring Triticale	CIMMYT
Juanillo 168	Spring Triticale	CIMMYT
Chuu "S"	Spring Triticale	CIMMYT
VT080011	Spring Triticale	USDA–WSU
VT082805	Spring Triticale	USDA–WSU
VT082467	Spring Triticale	USDA–WSU

*Grace and Palouse are the same triticale.

BREEDING, DISEASES AND CULTURE OF DRY PEAS, LENTILS, AND CHICKPEAS

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Dry pea and lentil research is conducted in the Palouse region of eastern Washington and northern Idaho. New lines, cultivars and breeding populations are tested in these areas to identify plant types with multiple pest resistance, efficient water-use, stress resistance, yielding ability, and quality. The principal areas of research in each of these crops is as follows:

Peas

Root diseases of peas which are caused by a complex of several organisms are a major reason poor pea yields have been common to the area. Most of our efforts have been in identifying resistant lines for use as parents, hybridizing the resistant lines with commercial cultivars, and screening the resulting populations for root rot-resistant segregants with good plant type and adaptability. Because pea enation mosaic virus and pea leaf roll virus have become extremely serious on peas and lentils in recent years, we have started screening for resistance in the field and greenhouse. Good resistance is available in peas, and we have recently identified resistance in lentils to pea enation mosaic virus. The goal is to incorporate resistance to these viruses into new cultivars.

Rates of water uptake in germinating seeds may influence emergence rates and susceptibility to root rots. We have devised new ways to measure stresses in seeds. Lines are being tested for differences in water uptake rates and imbibitional stresses to determine whether these traits can be used in pea and chickpea improvement. Quality tests for resistance to seed bleaching and for adaptability to reconstitution are also conducted. New methods have been developed to accurately measure traits which influence resistance to pea seed bleaching, dark green color, and good color retention. These methods will improve efficiency of breeding efforts.

Variations in leaf morphology in peas are being studied to improve standing ability and reduce foliar disease infection. The semi-leafless type with increased tendrils appears to hold particular promise for reducing foliar disease and maintaining yields that are equal to normal plant types. Future germplasm improvement efforts are being directed toward developing virus resistant semi-leafless types. The afila or "semi-leafless" type has particular promise for a yellow pea type because the reduced foliage allows better light penetration to the pods and results in bright yellow peas. Also, the reduced leaf area hastens maturity.

Varieties of peas developed are as follows:

'Alaska 81'—was released to growers in 1984. The cultivar is early to flower (10th node), early to mature, and has excellent seed quality traits including dark green color and resistance to seed bleaching. Alaska 81 has resistance to *Fusarium* wilt race 1 and is tolerant to pea root rot. Alaska 81 is immune to pea seedborne mosaic virus.

'Garfield'—is resistant to *Fusarium* wilt race 1, is larger seeded, and has a longer vine habit when compared with most Alaska strains. The increased plant height improves harvesting ease, especially on ridges where poor vine growth has been a problem. Garfield does not differ from Alaska in resistance to seed bleaching, powdery mildew, or mechanical damage resistance. Garfield flowers at the 14th node and has tolerance to pea root rot, two factors which delay maturity about one week when compared with most Alaska strains.

'Tracer'—is a small-sieve Alaska type that has yielded nearly 45% more than other small-sieve types. Other major improvements of Tracer over common, small-sieve Alaska strains include more uniform seed size, shape, and color; greater plant height; a lower susceptibility to seed bleaching; and resistance to *Fusarium* wilt race 1. The increased height of Tracer improves harvesting ease on the ridges where poor vine growth has been a problem. Tracer tends to set triple pods at one or more of the reproductive nodes.

Umatilla (WA910431) This line originated as a F_6 selection of a cross (XB75G027) between JI 34, a breeding line from the John Innes Insitute in Norwich, England, and WA110-42, a selection from PI244251. Umatilla was yield tested at several sites in eastern Washington and northern Idaho from 1982 to 1985.

When compared with Latah, Umatilla is about 15 cm shorter (87 cm vs. 102 for Latah) and 13% higher yielding. Umatilla has a double podding habit compared to the single podding habit for Latah. The seeds of Umatilla are larger than Latah and have averaged 18.7 grams per 100 seeds compared to 17.1 for Latah. Seeds of Umatilla are bright yellow and represent a significant improvement in seed quality when compared to Latah in which the seeds have an undesirable green cast.

Lentils—Current objectives in lentil breeding are toward developing an early maturing 'Laird' type and to develop a small red variety from material recently collected in Turkey. Laird is a large-seeded non-mottled variety developed for use in Canada; however, Laird is somewhat late maturing and, on the average, lower yielding than 'Chilean 78' when grown in the Palouse. While Laird's total biomass production is large, its seed production falls behind. Earlier maturing Laird types are now being increased for possible release pending performance in yield and quality tests. Studies are being started to determine whether seed production can be stabilized relative to biomass production in order to ensure efficient use of limited resources.

Varieties of lentils developed are as follows:

'Brewer'—(LC711981) was the highest yielding lentil selection in yield trials over the past three years. The selection averaged about 300 pounds per acre more than Chilean and was larger seeded. Brewer was released and made available to growers in 1985. Brewer is earlier to flower and mature and matures more evenly.

'Redchief,'—a selection released in 1978, has shown a consistent yield advantage over Chilean. Redchief has red cotyledons as opposed to yellow for the commonly grown Chilean.

Chilean '78—is a composite of selections made from common Chilean lentil seed stocks and, therefore, performance is identical to that expected for Chilean. The primary advantage of Chilean 78 is the absence of vetch-type rogues, particularly those rogues that have seeds similar in size, shape and color to lentils.

'Emerald' (selection 504)—A bright green lentil with distinctively green cotyledons, has performed well over the past four years and is being proposed for release. Emerald would be a specialty type lentil because of its distinctive green cotyledon color.

Chickpeas—(Garbanzos) are grown throughout the world in similar environments to those where lentils are grown. The Palouse environment seems well suited to chickpeas and, based on 1980-1984 results, very favorable yields can be obtained. Varieties and breeding lines have been obtained from sources both national and international and have been evaluated for yield potential and seed quality. Cultural practices which include (1) seeding rates-row spacing, (2) seed treatments, and (c)

Rhizobium inoculation have been completed. All indications are that chickpeas can be developed as a successful crop for the Palouse. There are basically two types of chickpeas: the "Kabulis," with large cream-colored seeds and the "Desis," with smaller seeds that are variously pigmented. Kabulis represent less than 20% of the world's production of chickpeas; the remainder are Desi types. The Desis are grown primarily on the Indian subcontinent and parts of Ethiopia; whereas, the Kabulis are grown primarily in the Mediterranean basin and North and South America. Less than 20% of the chickpea production in India, estimated at 22 million acres, are Kabuli types. Promising Kabuli lines being tested include the unifoliate types (CP-8, Surutato 77) and the more common types (U-5 and ILC517). Promising Desi varieties include C235, ICCC 4, and PI273879. Desi types appear to be well adapted to the Palouse environment and they appear to be easier to produce when compared to Kabuli types. Desis are also earlier to mature.

No chickpea trials were conducted in 1985; however, based on data collected from 1981-1984, two lines are being proposed for release as follows:

Tammany (CP8)—This selection has a unifoliate leaf structure which differs from the fern leaf structure that is typical of most chickpea cultivars currently in use. Tammany is earlier to mature and has larger seeds when compared to 'UC-5,' the commonly grown cultivar in the region. Seeds of Tammany average 58 grams per 100 seeds compared to 52 grams from UC-5. The uniformly large light cream-colored seeds of Tammany are highly desired by domestic processors and by exporters.

Garnet (PI273879)—This line originated as a plant introduction from Ethiopia and was mass selected for uniformity. Garnet has produced yields that were equal to or better than other desi lines included in tests from 1982-1984. Garnet matures in about 110 days from planting. The seeds are reddish-tan, uniform in size, and weight 16.4 grams per 100 seeds.

BENEFITS OF LEGUMES IN ROTATION WITH CEREALS

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Recent projections on the future cost of nitrogen fertilizers and the current set-aside programs have reemphasized the need for legumes in rotation with cereals. Our continual battle with soil erosion can only be served through reevaluation of our cropping systems in view of the current options available in tillage management, and through the introduction of alternate legumes. Some specific aspects of our programs are as follows:

N Fixation by Legumes and N Budgets

Only a portion of the total plant legume N is taken from the air fixed in the nodules. The remaining comes from the soil. To do an N budget for a legume crop, the following must be determined.

1. Estimate of N fixed by the plant
2. Total N removed in the seed at harvest

For most seed legumes where the seed is harvested, more N is taken off than what is fixed by the plant which results in a net negative balance. In other words, more N is removed by the legume than what is provided by N fixation. In 1981 and 1982, we found that available soil N reduced the amount of N fixed in chickpeas. Under low soil N, chickpeas fixed over 140 lbs. per acre, whereas less than 10 lbs. per acre was fixed at one high soil-N site. We would expect the same trends for peas. These results point out the need for careful management of N on previous crops in rotation.

The Effect of Rotation

The benefits of rotations have been known throughout history. However, these benefits are now being reevaluated in terms of newer crop varieties, different tillage practices and equipment and higher yield expectations than thirty years ago. We are looking at the cereal yield response following a number of seed legumes (peas, lentils, chickpeas and fababeans) and forage legumes (medics and clovers) managed as seed crops and green manure. The wheat production response to these legumes is being evaluated in terms of fertilizer nitrogen equivalent or the equivalent amount of fertilizer nitrogen saved by using the legume in rotation.

Only part of this response is due to the nitrogen contribution from the legume. Response from legumes in rotation (especially several years of forage) may also be due to breaking up disease and pest cycles, to improved soil structure and tilth and to increased soil organic matter. Separate studies will follow the fate of a non-radioactive ^{15}N isotope that has been incorporated into plant tissue applied as surface and incorporated residues. The results will quantify the actual amount of nitrogen used by the wheat that originated from the residues. The individual nitrogen and rotational inputs to the cereal crop can then be made.

Effect of Tillage and Type of Legume on Response to Cereals in Rotation

Some government programs require that the legume be killed or turned under after a certain date. Previous experience with legume take-out by moldboard plowing was very erosive. We are looking at the beneficial effect of various legumes (peas, hairy vetch, red clover, medic) as potential green manure crops under three management tillage systems:

1. Moldboard plowing. Plant winter wheat with conventional tillage.
2. Chemical kill. Residue left on surface; winter wheat will be no-till planted into this residue.
3. Shallow tillage. Plant winter wheat with conventional tillage.

Three rotational systems will be superimposed on these tillage systems. These include (1) winter wheat-grain legume winter wheat; (2) spring wheat (interplant red clover)-red clover, green manure-winter wheat (3) winter wheat-Austrian winter pea, green manure-winter wheat; winter wheat-hairy vetch, green manure winter wheat. The ultimate response to the winter wheat will be evaluated in 1987.

Our studies will determine how the tillage practice will influence the availability of legume N to the following winter wheat crop and the potential contribution from the various legumes studied. We have also looked at soil water depletion of various legumes planted in rotation with winter wheat.

Nitrogen fixation ranged from 76 to 114 Kg N/ha for the various legumes studied. A total of 98 to 136 Kg N/ha was added to the soil in plant residues. Austrian winter peas and hairy vetch were the highest N_2 fixers and contributors to the soil N pool. Tracer spring peas depleted significantly less water from the six foot profile than the other crops. Other studies conducted with several legumes at Pullman and Dusty, Washington showed no significant influence of crop water depletion on subsequent wheat-grain yields.

Residue Manipulation for Enhanced N Fixation

Because of our results showing a reduction in legume N fixation with high residual soil N, we have explored the possibility of increasing N fixation by reduction of N rates applied to wheat in rotation and by applications of additional wheat residue to plots that will be planted to peas the following year. We are looking at ways to facilitate planting of no-till wheat into previous wheat ground (residue removed) and to “tie-up” the soil N during the pea growing season from the additional wheat residues applied.

N_2 fixation and seed yield of chickpea increased about 30% in 1984 under double wheat residues. The spring peas responded similarly in dry matter, total nitrogen production and seed yield with increases of 20%, 30% and 18% respectively, averaged over three growing seasons. Available soil nitrogen in wheat following legumes grown under 2X residue was 26% higher than under conventional practices. Dry matter yield of wheat in the spring was 12% greater, although increases in grain yields were only 2%. Wheat yields following rotation with peas were 15% higher than continuous wheat.

Long Term Rotation Study

A long-term experiment has been established at the Palouse Conservation Field Station to investigate the nitrogen-fixing capacity and other benefits of legumes in a wheat rotation. Winter wheat and spring wheat are grown in rotation with and without legumes either harvested for grain or returned to the soil as green manure. In one set of plots, winter wheat-spring wheat is being grown continuously under a no-till system with three rates of N fertilizer: zero N, 1/2 optimum rate, and optimum rate, to establish a nitrogen response curve without legume. Yield response of the cereals to nitrogen will be compared with response where Tinga pea, Susami forage pea, and black medic are grown for green manure, and Tracer pea for grain, every third year. Combined with this experiment is another set of plots comparing the zero N continuous no-till winter wheat-spring wheat with these two crops rotated every third year with Tinga pea, biennial sweet clover, red clover, Tinga pea, and black medic grown for green manure. Another treatment in the same experiment will compare winter wheat-spring wheat in a continuous no-till rotation with winter wheat-spring wheat-spring wheat but with annual sweet clover and a new type annual alfalfa intercropped with spring wheat every third year for inclusion as green manure. Tests of the nitrogen status of the soils will be made periodically for the different treatments.

SOIL FERTILITY MANAGEMENT FOR WHEAT AND BARLEY PRODUCTION

Fred Koehler, Marvin Fischer, and Emmett Field

Field experiments concerning soil fertility management for small grain production are widely distributed throughout the wheat producing area of eastern Washington. A number of these involve a no-till management system or a comparison of no-till with a conventional tillage system. The use of spring top dressing with nitrogen for winter wheat has been studied with rates and sources of nitrogen with and without sulfur being used. Other experiments include further studies on nitrogen rates and sources, placement and rate of phosphorus fertilizer, use of sulfur, rates and sources of nitrogen and sulfur with and without phosphorus and zinc for spring grain, and sources and methods of application of various kinds of fertilizers including micronutrients with a no-till system.

In recent years there have been less responses than expected to spring top dressing of winter wheat with nitrogen. Where there have been responses, all sources of nitrogen were equally effective.

In general, where moisture is limiting, no-till gives wheat yields which are as good or better than those obtained with conventional tillage. Exceptions to this are where there are special problems associated with no-till such as severe rodent damage or uncontrollable weed problems. In the higher rainfall areas where moisture is not as limiting for production, management problems other than fertility in the no-till system have sometimes resulted in yields less than those obtained with conventional tillage systems. With a no-till system for spring wheat, placing all fertilizer below the seed normally produces considerably higher yields than does broadcasting the nitrogen and sulfur. However, this was not true in 1980 and 1981, when precipitation was much greater than normal in late spring and early summer. Apparently this precipitation moved the nitrogen and sulfur into the root zone. In 1982 yields of no-till spring wheat were 47% lower where the nitrogen and sulfur were surface applied than where it was placed below the seed; in 1983, 49% lower; and in 1984, only 5% lower.

When fall rains come too late to allow for germination and subsequent killing of weeds prior to seeding winter wheat, it is very difficult to control grassy weeds in a no-till system. In the winter of 1981-82 a new problem was encountered in the Colton area and again in 1982-83 in the Anatone area. An excellent stand of winter wheat was obtained in spring wheat stubble, but nearly all the wheat plants died during the winter for no obvious reason.

At one location near Davenport, no-till has been compared with conventional tillage for 8 years. If the one year of severe rodent damage on the no-till plots is excluded, the average yields of winter wheat were the same for the two systems. For spring wheat, the conventional tillage averaged about 5 bu/a more than the no-till system.

In a series of maximum yield experiments over 4 years, the effect of phosphorus fertilizer on winter wheat yields has been studied. Maximum yields exceeded 100 bu/a at 6 of the 17 sites. At two of these high yielding sites where the soil test values for phosphorus were low, there were increases of 8 and 10 bu/a from the addition of phosphorus fertilizer. At the other sites there was little response to phosphorus. These data indicate that eastern Washington growers are doing a good job of maintaining adequate levels of phosphorus in their soil.

In 1980 spring barley gave a yield response to shanked in phosphorus in one of four locations, as a WSU soil test had predicted. There was no response to zinc at any location. All zinc soil test levels were at 0.5 parts per million or higher, which is considered adequate for small grains.

SOIL ACIDITY AND CROP PRODUCTION

Fred Koehler

Soils of this region are becoming more acid (soil pH is decreasing) for three main reasons:

1. Leaching of bases (calcium, magnesium, and potassium) from the soil.
2. Removal of these bases in crops.
3. The use of ammonium type nitrogen fertilizers.

The first two of these are extremely slow processes so the major cause increasing soil acidity in this region is the use of ammonium type nitrogen fertilizers. In the approximately 30 years of nitrogen fertilizer here, soil pH's have dropped about 1 unit.

Acid soils may cause reduced yields of crops but the pH at which yield reductions begin depends on many factors. Different crops respond differently to soil acidity and there are even large differences among varieties of a single crop in sensitivity to soil acidity. Legumes in general require a higher soil pH than do grass-type crops.

An experiment was established on Spillman Farm about 10 years ago to study the effect of soil acidification on crops. Soil on one third of the plots was acidified, one third was left at the natural pH and one third of the plots received lime. The soil pH's are approximately 5, 6, and 7 respectively. A wheat-pea rotation has been used. There has not been much effect of soil pH on yield. One year, the wheat yields were significantly higher on the limed plots than on the other two treatments.

There are many ways in which soil acidity may affect plant growth. As soils become more acid, the amount of soluble aluminum increases and aluminum is toxic to plants. Molybdenum, a plant micronutrient often deficient for legumes in this area, becomes less available as soil acidity increases. There are many soil pH-plant disease interactions.

The nature of plant reactions and the remedies required to solve soil acidity problems may be different in this area from those in other areas since here subsoils normally have a higher pH than topsoils and the acidification from the use of ammonium type nitrogen fertilizers usually affects only the tilled layer of soil.

In general, natural soil pH's increase with decreasing precipitation. Therefore problems associated with soil acidity should occur first in the highest precipitation areas.

RUNOFF AND EROSION PREDICTION

D. K. McCool, K. E. Saxton, R. I. Papendick, and R. W. Van Klaveren
USDA-Agricultural Research Service

Erosion Prediction

Frozen and thawing soils are an important element in runoff and erosion from non-irrigated cropland of the Pacific Northwest. Knowledge of frost depth and extent is important to verification of erosion models. A network of thermometers and frost depth gages has been installed with cooperators in eastern Washington and northern Idaho. Data from the winter of 1984-85 illustrate the range of soil freezing conditions encountered across eastern Washington and the modifying influence of snow cover. At the time of deepest frost penetration, the first week of January, frost depths ranged from 7 inches at Cheney with 14 inches of snow to 25 inches at Harrington with 5-6 inches of snow. Erosion rates over much of the Palouse were low to moderate because of shallow frost depth and good opportunity for infiltration of the rain and melting snow. Some areas had greater frost depth and higher intensity rains and suffered more severe erosion.

Herbicides in Runoff from Dryfarmed Cropland

Pollution of streams or ground water by herbicides applied to Pacific Northwest dryfarmed cropland is a valid concern. Such pollution could affect fisheries and wildlife as well as public safety. A study addressing the fate of fall-applied herbicides was initiated at the Palouse Conservation Field Station near Pullman, Washington in the fall of 1978. The study included application of a soluble and nonsoluble herbicide to plots with different rotations and managements and determination of concentrations in runoff as well as migration and degradation in the soil. Over the three-year period of the study, on a variety of crop treatments, an average of 1% of the applied soluble and only 0.1% of the applied nonsoluble herbicide were lost in surface runoff. However, in a year with adverse weather conditions (rainfall on thawing soil) and for one particular crop treatment, up to 5% of the applied soluble herbicide was lost. Crop management affected the loss in surface runoff of the nonsoluble herbicide more than the loss of the soluble herbicide. No detectable migration beyond a depth of 8 inches was observed for the soluble, and 3 inches for the nonsoluble, herbicide under conditions of natural rainfall and moderately permeable soil.

CONSERVATION HYDROLOGY

Dr. Keith S. Saxton and Gerald Flerchinger

Frozen Soil Experiments

A concerted effort has been initiated to learn the physics of soil freezing as it is affected by tillage, residue, and snow cover. Much of the severe runoff and erosion in the Palouse region is associated with shallow frozen soil. A very detailed set of instrumentation has been operated at the Palouse Conservation Field Station during the winter of 1985-86 to determine the complete energy and water budget under selected residue-tillage treatments. To analyze these data, an extensive computer model is being written to simulate and predict the simultaneous heat and water budgets of these soil profiles. The definition of the heat and water transfer coefficients is very complex for these systems but vital to the understanding of these mechanisms. These coefficient definitions and predictions are another important component of this study. When complete, this study will provide guidance for benefits and management options to reduce runoff and erosion through tillage and residue management.

Soil Water Conservation

The capture and utilization of precipitation for crop production is extremely important in dry land agriculture. Several on-going studies are investigating these processes. Detailed measurements of soil water conservation under various tillage-residue combinations are being made. Soil water measurements and predictions are being conducted under several cropping systems at several locations in the Palouse and nationally. This knowledge will provide new guidance for water efficiency in dryland farming.

Conservation Tillage

Conservation tillage is continuing to show promise as a significant conservation and farming practice in the Palouse. But like all new farming systems, there are several new problems. We are investigating the action of several drill designs as they interact with the residue and soil conditions for good seed placement emergence. In addition, we are continuing to evaluate slot mulch tillage and the Paraplow as addendum tillages to be used in conjunction with various types of conservation tillage. These several investigations will provide further guidance for improved conservation tillage.

DOWNY BROME AND JOINTED GOATGRASS CONTROL IN WINTER WHEAT

Alex G. Ogg, Jr.
USDA, Agricultural Research Service

Downy brome and jointed goatgrass are annual grasses that germinate in the fall and are particularly troublesome weeds in winter wheat. Downy brome is perhaps the most widespread and troublesome annual weed infesting Washington wheat fields. It has been a problem for many years and is well adapted to many areas. Jointed goatgrass is also an annual grass weed and has been known to occur in Washington since 1917. Only recently it has become a serious weed in winter wheat. The reasons for goatgrass' sudden increase are not known, but may be related to the changes in wheat production practices that have occurred within the past 10 or 15 years. Jointed goatgrass is genetically related to wheat and is resistant to most herbicides registered for use in wheat.

Both downy brome and jointed goatgrass occurred over a wide range of climatic and soil conditions. They are troublesome weeds in conventionally tilled and in no-tilled wheat.

In 1985, we evaluated a new herbicide, ethyl metribuzin (Trade names Tycor-Mobay Co. and Seige-DuPont Co.) for the control of downy brome and jointed goatgrass in conventionally tilled winter wheat. This herbicide applied preemergence at 0.75 to 1.25 lb ai/A selectively controlled downy brome 95 to 100% in Stephens winter wheat. Jointed goatgrass was more tolerant of ethyl metribuzin, but seed heads were reduced 90% by rates of 1.0 lb ai/A.

In 1985, spring applications of ethyl metribuzin did not control downy brome or jointed goatgrass. It was assumed that rainfall after herbicide application was not sufficient to move the herbicide into the root zone of the weeds where it could be adsorbed.

In the fall of 1985, we established an experiment at the Palouse Conservation Field Station to evaluate the effectiveness of ethyl metribuzin for the control of downy brome and jointed goatgrass in no-till winter wheat. Daws winter wheat was planted into barley stubble 5- by 15-inch paired-rows on October 10 with the USDA No. III No-Till drill. Fertilizer was deep banded between the two paired rows at planting time.

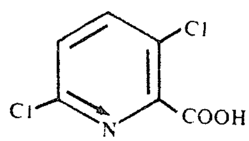
On April 2, 1986, ethyl metribuzin and metribuzin each alone at several rates and as tank mixes at several rates were applied to seedling downy brome and jointed goatgrass growing in the Daws winter wheat.

These research plots will be available for observation during the Palouse Conservation Station Field Day on June 26, 1986. Important results will be pointed out at that time.

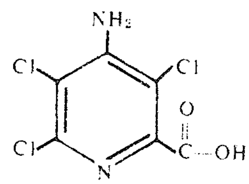
SELECTIVE CONTROL OF CANADA THISTLE

R. E. Whitesides and D. G. Swan, Washington State University

Clopyralid herbicide is a picolinic acid that is closely related to picloram (Tordon).



clopyralid



picloram (Tordon)

Clopyralid is absorbed by the roots and leaves of broadleaf plants and is rapidly translocated throughout the plant. Susceptible plants treated with clopyralid demonstrate an auxin-type response similar to the response produced by other growth regulator herbicides such as 2,4-D. When used alone clopyralid is strongly herbicidal to members of the knotweed family (*Polygonaceae*), pea family (*Leguminosae* or *Fabaceae*), and the sunflower family (*Compositae* or *Asteraceae*)). The grass family (*Gramineae* or *Poaceae*) and the mustard family (*Cruciferae* or *Asteraceae*) show considerable tolerance to clopyralid.

Soil persistence of clopyralid is much shorter than picloram. On a loam soil containing 1% organic matter in California, soybeans (sensitive to clopyralid) could be successfully grown 16 weeks following application of 0.25 lb ai/A of clopyralid. In Corvallis and Pendleton, Oregon sensitive plant species could be grown in soil treated with 0.25 lb ai/A clopyralid 12 months after application.

Clopyralid has been added to formulations containing phenoxy herbicides, such as 2,4-D, to improve the control of several phenoxy-tolerant weeds in small grains. The combination of 2,4-D and clopyralid has given good short-term control of Canada thistles, but there was apparent recovery of the thistles 4 months after application.

In the spring of 1986 Dow Chemical Company announced the approval of an Experimental Use Permit by the Environmental Protection Agency for the use of clopyralid plus 2,4-D amine (trade name Curtail 205) for broadleaf weed control in wheat, barley, and oats. Although many broadleaf weeds are susceptible to clopyralid, the control of Canada thistle looks particularly promising. Canada thistles should be treated after a majority of the rosettes have emerged and are at least 3 to 5 inches in diameter (approximately 5 to 7 leaves).

In the annually-cropped regions of eastern Washington, it would be very desirable to treat Canada thistles in a tolerant crop, such as wheat or barley, and then follow with a normal rotation of peas or lentils. To evaluate this possibility Waverly spring wheat was seeded on May 10, 1985 at the Spillman Agronomy Farm and treated at the 3 to 7 leaf stage (June 13, 1985), the 3 to 5 tiller stage (June 21, 1985), the soft dough stage (Aug. 28, 1985), the hard dough stage (Sept 4, 1985), and in the stubble (Oct. 4, 1985). Wheat yields were not reduced by any herbicide treatment regardless of growth stage. (See Table.) A sensitive pulse crop, seeded in the spring of 1986, will help assess herbicide persistence.

Wheat yields from a clopyralid residue study.

No.	Treatment	Rates lb/a	Timings	Wheat yields* bu/a
1	clopyralid	0.38	Jun 13	66a
2	clopyralid	0.75	|	67a
3	chlorsulfuron (Glean)	0.016	|	68a
4	picloram (Tordon)	0.02	Jun 13	65a
5	clopyralid	0.38	Jun 21	68a
6	clopyralid	0.75	Jun 21	67a
7	clopyralid	0.125		
	+2,4-D amine	0.5	Aug 28	66a
8	clopyralid	0.125		
	+2,4-D amine	0.5	Sep 4	66a
9	clopyralid	0.75	|	67a
10	picloram (Tordon)	0.02	Sep 4	66a
11	clopyralid	0.75	Oct 4	66a
12	clopyralid	1.50	|	67a
13	clopyralid	3.0	Oct 4	68a
14	unweeded check			66a

[a]Means followed by the same letter are not different at the 5% level.

Canada thistle plants on the Spillman Farm in a location separate from the residue study were treated with 2,4-D, MCPA, clopyralid, and clopyralid plus 2,4-D or MCPA on June 11, 1985. Prior to treatment Canada thistle populations (plants/m^2) were estimated in each research plot using a line transect method. The Canada thistle plants were growing in spring barley that was seeded on fall-plowed alfalfa ground. Evaluations of Canada thistle density in a 1986 spring barley crop will identify the most successful herbicide treatment.

WEED CONTROL IN WINTER RAPESEED

Dean G. Swan, R. E. Whitesides, Dave Bragg and T. L. Nagle

A weed control trial was established on February 24, 1986 on the Roger Dye farm in Garfield County.

Results obtained on April 9, 1986 are shown in the following table.

Percentage crop symptoms and weed control from a winter rapeseed trial.

Treatments	Rates lb/A	Crop symptoms[a] S	Crop symptoms[a] C	Weed Control: Wind-grass	Downy brome	Vol. wheat	Henbit	Tumble mustard	Flix-weed
		%							
Pronomide (Kerb)	0.75	3	2	87	20	20	23	2	2
Clopyralid (Lontrel)	0.25	0	0	0	10	10	15	5	5
Fluazifop +crop oil (Fusilade)	0.3 1 qt.	0	2	98	98	98	15	0	0
Sethoxydim +crop oil (Poast)	0.3 1 qt.	0	0	58	85	85	7	0	0
Dalapon (Dowpon M)	3.0	0	32	77	77	77	30	17	8
Diclofop (Hoelon)	1.0	0	0	0	0	0	0	0	0
DPX-A7881 +X-77 (DuPont experimental)	0.032 0.5%	0	0	100	0	0	80	97	68
Cyanazine (Bladex)	1.0	0	20	100	0	0	100	20	22
Ethyl metribuzin (Siege or Tycor)	0.75	22	0	67	13	10	70	52	17
Check		0	0	0	0	0	0	0	0

[a]S = suppressed growth
C = off color

These preliminary results show that the DuPont experimental chemical DPX-A7881 gave best weed control with no visible crop symptoms. However, it did not control the downy brome or volunteer wheat. Fusilade and Poast gave excellent and good grass control respectively. Bladex gave excellent windgrass control. Dowpon M and Siege or Tycor gave the most noticeable crop symptoms. Lontrel and Hoelon were not effective.

This information is preliminary and these products are not registered for weed control in rapeseed.

CONSERVATION AND FORAGE PLANTS FOR DRY FARMLAND AND RANGE SEEDING

James A. Tiedeman
Range Management Specialist

Most of the conservation and forage plants that can be planted on dry farmland and rangeland in eastern Washington may be observed at the Soil Conservation Service, Pullman Plant Material Center. Demonstration plots have been established in Pullman and Lind. Some plant species trials are located at Central Ferry. The local Soil Conservationist or County Extension Agent should be contacted to determine the appropriateness of a particular species for seeding in your local area or situation.

Many of these species are suitable for the Conservation Reserve Program. Seed for some of the species is not available in large supplies, which may be the biggest constraint to selection. Detailed information on various species is available in Extension publication MISC 0058, "The Washington Interagency Guide for Conservation and Forage Plantings" and Agricultural Handbook No. 339. "Grasses and Legumes for Soil Conservation in the Pacific Northwest and Great Basin States," available from the USDA Soil Conservation Service.

Most of the species of grasses and legumes that have been released for conservation and forage use in eastern Washington are listed in the following table. Much of the information was derived from these two publications.

Approximate Effective Precipitation Zone for Planting Most Conservation and Forage Perennial Grasses and Legumes in Eastern Washington

		Precipitation Zone					
Species	Use[1]	<9"	9-12"	12-15"	15-18"	18-25"	>25"
Grasses:							
Siberian wheatgrass	FF,C	X	X	X	X		
Indian ricegrass	C,FO	X	X	X			
Crested wheatgrass	FF,C	X	X	X	X		
Mammoth wildrye	C	X	X	X	X	X	X
Canby bluegrass	C,FO	X	X	X	X	X	X
Thickspike wheatgrass	C,FO	X	X	X	X	X	
Bluebunch wheatgrass	FF,C	X	X	X	X	X	
Idaho fescue	C,FO		X	X	X	X	
Beardless wheatgrass	FF,C		X	X	X	X	X
Sheep fescue	C		X	X	X	X	X
Big bluegrass	FF,C		X	X	X	X	X
Basin wildrye[2]	FO,C			X	X	X	X
Tall wheatgrass[2]	FF,C			X	X	X	X
Slender wheatgrass[3]	FF,C			X	X	X	
Pubescent wheatgrass	FF,C			X	X	X	X
Streambank wheatgrass	C			X	X	X	
Perennial ryegrass[3]	FF,C				X	X	X
Intermediate wheatgrass	FF,C				X	X	X
Western wheatgrass	C,FO				X	X	X
Smooth bromegrass	FF,C				X	X	X
Mountain bromegrass[3]	C,FO				X	X	X

Species	Use[1]	<9"	9-12"	12-15"	15-18"	18-25"	>25"
				Precipitation Zone			
Hard fescue	C				X	X	X
Creeping red fescue	C				X	X	X
Tall fescue	FF,C				X	X	X
Orchardgrass	FF,C				X	X	X
Timothy	FF,C				X	X	X
Canada bluegrass	C				X	X	X
Meadow bromegrass	FF,C				X	X	X
Kentucky bluegrass	FO,C					X	X
Meadow foxtail[4]	FF,C					X	X
Redtop[3,4]	FO,C						X
Reed canarygrass[4]	FF,C					X	X
Creeping foxtail[4]	FF,C					X	X
Legumes:							
Alfalfa[5]	FF,C			X	X	X	X
White clover[5]	FF,C					X	X
Red clover[3,5]	FF,C						X
Alsike clover[3,5,6]	FF,C					X	X
Strawberry clover[2,3,5]	FF,C					X	X
Birdsfoot trefoil	FF,C					X	X
Cicer milkvetch	FF,C					X	X
Bramble vetch[5]	FO,C					X	X
Sainfoin	FO,C					X	X

[1]Use of the plants is listed in order of most common use to least common use as follows: frequently used as forage = FF, occasionally used as forage = FO, used for conservation = C.

[2]Tolerates saline and alkali soils.

[3]Short-lived.

[4]Wet meadow sites.

[5]Caution must be taken to prevent bloat.

[6]Has been reported in a few cases causing photosensitivity in livestock, particularly horses in Washington State.

TREES AND SHRUBS FOR DRY LAND PLANTING

David M. Baumgartner and Rod Clausnitzer
WSU Cooperative Extension

For over 50 years, trees and shrubs have been tested at Lind for farm-home landscaping and windbreaks. Testing was started at Lind in 1928 by the Dry Land Research Unit and the Department of Forestry and Range Management at Washington State University. Plantings have been made periodically since then.

Many of the trees and shrubs currently growing at Lind were planted during the period 1946 through 1948. Concurrently, similar test plantings were made at Prosser and Pullman, Washington, and Morro, Oregon. Station Circular 450, "Adaptation Tests of Trees and Shrubs for the Intermountain Area of the Pacific Northwest," summarizes the results of these adaptation tests.

The planting at the Dry Land Research Unit provides an excellent opportunity to observe the adaptability and growth of non-irrigated dry plantings over a long period of time.

Specific guidelines for windbreaks in the Pacific Northwest are available in the Extension Publication "Trees Against the Wind" PNW Bulletin No. 5. "Windbreak, Forest and Christmas Trees: Where to Get Trees to Plant," Extension Bulletin 0790, provides information on sources of trees.

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Chevron
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American Hoechst Corp.
Arcadian Corp.
BASF
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Chevron
CIBA-Geigy
Diamond Shamrock
Dow
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Rohm & Haas Co.
Spokane Co. Crop Impr. Assoc.
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Tennessee Valley Authority
Union Carbide
Velsicol Chemical Corp.
Washington Barley Commission
Washington Wheat Commission
Wash. Dry Pea & Lentil Commission
Wash. Assoc. of Dry Pea & Lentil Producers
Western Plant Breeders
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Bayne Farms	Horse Heaven
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Tedd Nealy	Endicott
D. E. Phillips Ranch	Lind
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Stanley Owens	Kennewick
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Allen Redman	Palouse
Luther Roecks	Fairfield
Donald Schultheis	Uniontown
Harold Schultheis	Colton
John and Greg Schlomer	Endicott
Tom Schultz	Reardan
Harvey Schumacher	Lewiston, ID
Jim Scott	Pomeroy
Deral Springer/ Larry Shank	Lewiston, ID
Darrell Storment	Endicott
Harold Stueckle	Colfax
Elmo and Larry Tanneberg	Coulee City
Maurice Ulhorn	Ferdinand, ID
Tony Viebrock	Waterville
Don and John Wellsandt	Ritzville
Curt White	Lamont
Les Wigen	Reardan
Paul Williams	Reardan
Joe Wolf	Clarkston

Dry Land Unit, Palouse Conservation Station
Spillman Farm Field Days Contributors

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Agri-Service Inc.
McGregor Company
Palouse Producers, Inc.
Palouse-Rock Lake Conservation District
Pine Creek Conservation District
Ron Wachter
Whitman Conservation District
Whitman County Wheat Growers

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J.L. Ozbun .... Acting Director of Resident Instruction
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G.E. King .... Early Generation Testing

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PUBLICATIONS ON WHEAT, BARLEY, OATS, PEAS AND LENTILS AVAILABLE FROM WASHINGTON STATE UNIVERSITY

Dry Pea Production, EB0582
Growing Lentils In Washington, EB0590
Garfield and Tracer Alaska Type Peas, EB0699
Tekoa Lentil Culture, EC0375
Pea Leaf Weevil: Biology and Control, EM3477
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Blazer Spring Malting Barley, EB0679
Advance Barley, EB0720
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Peas for Western Washington, FG0027
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Economics of Pea Harvest Methods in Eastern Washington and Oregon, XB0684
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N Fertilizer/Irrigated Green Peas, XC0566
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Daws Wheat, EB0676
Barbee Wheat, EB0677
Urquie Spring Wheat, EB0682

Wanser and McCall—Hard Red Winter Wheats, EC0355
Luke Wheat, EC0378
Paha Wheat, EC0379
Sprague Wheat, EC0390
Wared Spring Wheat, EC0396
Frost Damage on Wheat, EC0398
Lewjain Winter Wheat, EB1168
Description and Culture of Chickpeas, EB1112
Lower Granite Dam & Waterway User Charge Impact on PNW Wheat Movement, XB0887
Economics of On-The-Farm Grain Storage, XC0473
Effect Seed Time/Spring Barley, XC0476
Greenbug in Washington, XC0553
Operating Costs for Tillage Implements on Eastern Washington Grain Farms, XC0554
Steptoe Barley, XC0572
Waverly Spring Wheat EB 1256
Andre Spring Barley EB 1249
Crew Winter Wheat EB 1212
Irrigated Spring Wheat Production in Washington EB 1111
Irrigated Winter Wheat Production in Washington EB 0916
Wheat Seed Quality EB 1256
Spring Barley EB 1260

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