WSU FIELD DAYS

June 16, 1983
Dry Land Research Unit, Lind

June 30, 1983
Palouse Conservation Station
Field Day, Pullman

July 7, 1983
Spillman Farm, Pullman

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DEDICATION

The 1983 Field Day brochure is dedicated to Mr. Alvin G. Law. Al, as he is known throughout the university, the agriculture industry and by farmers, came to WSU in 1941. Al has taught all but one of the undergraduate Agronomy courses including weeds and turf. He has influenced Agronomy and Soils students at both the graduate and undergraduate level.

In 1946 he was the driving force in the organization and development of the Washington State Crop Improvement Association. He served as secretary until 1969. The Washington State Crop Improvement Association honored Al by naming their building the Al Law Seed Storage Facility. He also helped organize the Pacific Northwest Turf Association in 1947. He helped develop and release grass and legume varieties for rotation with wheat that reduced erosion in Washington and adjacent states.

His research in grass seed production has enabled the PNW to become one of the important turf grass seed producing areas in the U.S.

Al's graduate students hold prominent and important positions in universities, government agencies and industry.

Al's work with pure seed, and particularly Gaines, made the variety available to growers.

Al spent two years in India, helping develop pure seed programs, and a three-year stay in Lesotho, helping develop a farming system program for that country located in South Africa.

Al plans to remain in Pullman where he and his charming wife Roberta (Bobbie) will continue to have close contacts with the turf, seed and agriculture industries in the state.

We wish Bobbi and Al many happy retirement years, and thank him for his contributions to Washington agriculture.

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 certain problems, which, because of special conditions such as climate, soil, etc., cannot be studied at a central station." For over fifty 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 has 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 machine storage built shortly after the station was established. The old barn was dismantled in April 1973 and the residence in 1979. A small elevator 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's 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. With the addition of a 12' x 60' trailer house, residence 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. 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 66th 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. One experiment on the station is concerned with annual cropping winter wheat under supplemental irrigation. The irrigated winter and spring 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 wheats for higher rainfall and irrigated agriculture, but to speed up and aid in the development of better varieties for the dryland wheat summerfallow 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.	1982	1983	62 yrs. av. (in)
January	34	22	.88	1.09	1.02
February	42	24	.77	1.81	.88
March	53	32	.77	1.84	.74
April	63	35	1.35	.46	.66
May	72	42	.33		.78
June	83	45	.71		.86
July	90	52	.18		.24
August	90	50	.04		.34
September	79	45	1.34		.55
October	65	38	1.65		.87
November	47	29	1.28		1.19
December	37	26	1.62		1.29
			10.92		9.42

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 1. Temperature and precipitation at Palouse Conservation Field Station, Pullman, 1982 and 1983

Month	Monthly Avg. Temperature (F)		Precipitation				
	Max.	Min.	30-Yr. Avg.*	Monthly	Total Accum.	Deviation from Avg. Monthly	Deviation from Avg. Accum.
1982							
January	33.2	21.8	2.79	3.99	3.99	+1.20	+1.20
February	36.6	23.9	2.06	3.36	7.35	+1.30	+2.50
March	47.0	32.3	1.84	2.35	9.70	+0.51	+3.01
April	51.1	32.9	1.55	2.20	11.90	+0.65	+3.66
May	62.8	40.0	1.53	1.11	13.01	−0.42	+3.24
June	73.0	49.1	1.65	0.79	13.80	−0.86	+2.38
July	77.1	48.3	0.45	1.50	15.30	+1.05	+3.43
August	79.6	50.8	0.64	0.42	15.72	−0.22	+3.21
September	70.9	45.3	1.14	1.58	17.30	+0.44	+3.65
October	56.4	36.5	1.83	2.47	19.77	+0.64	+4.29
November	38.2	26.8	2.66	2.56	22.33	−0.10	+4.19
December	35.7	24.2	2.67	2.66	24.99	−0.01	+4.18
TOTAL	51.1	36.0	20.81	24.99	24.99		+4.18
1983							
January	42.5	30.5	2.79	2.82	2.82	+0.03	+0.03
February	45.3	33.1	2.06	3.05	5.87	+0.99	+1.02
March	50.7	35.2	1.84	3.49	9.36	+1.65	+2.67
April 28			1.55	0.85	10.21	−0.70	+1.97
TOTAL			8.24	10.21	10.21		+1.97
1983 CROP YEAR Sept. 1982 thru April 28, 1983			16.54		19.48		+2.94

*Thirty-year average for precipitation, 1941-1970

RECOMMENDED VARIETIES—WHEAT, OATS, BARLEY

AREA	WINTER WHEAT	SPRING WHEAT	OATS	SPRING BARLEY	WINTER BARLEY
EASTERN WASHINGTON 14 Inches or More Rainfall	Nugaines Daws Barbee Stephens Faro Tyee Hill 81 Lewjain Crew	Urquie Dirkwin Waverly	Cayuse Park Appaloosa	Steptoe Advance Larker—malting barley Belford—for hay only Vanguard—malting barley Kimberly Andre	Kamiak Boyer
EASTERN WASHINGTON Less Than 14 Inches Rainfall	Wanser McCall Hatton Nugaines Sprague Lewjain Moro Barbee Faro Hatton Tyee Crew	Sawtell Wampum Wared Twin Urquie Waverly Dirkwin		Steptoe	
CENTRAL WASHINGTON Under Irrigation	Nugaines Daws Stephens Hill 81 Lewjain	Urquie Sawtell Wared Wampum Waverly Dirkwin	Cayuse Park Appaloosa	Andre Kimberly Klages Steptoe Belford—for hay only	Boyer
Snow Mold Areas	Sprague				

WHEAT, BARLEY, AND OATS

Kenneth J. Morrison
Washington State University

Winter Wheat

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.

Hyslop

Hyslop is a soft white semidwarf winter wheat that yields well in high rainfall areas or with irrigation. Hyslop has a slightly better yield record than Nugaines where winter injury is not a factor. Insufficient winterhardiness limits the use of Hyslop in eastern Washington. Coldhardiness tests have shown Hyslop to lack the winterhardiness of such varieties as Paha, Luke, McDermid, Nugaines, and Daws.

Hyslop is resistant to common bunt, stripe rust, and susceptible to dwarf smut, flag smut, leaf rust, and *Cephalosporium* stripe (fungus stripe).

Milling and baking qualities of Hyslop are similar to Nugaines. Hyslop was developed by Oregon State University.

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.

Barbee

Barbee is a semidwarf soft white club winter wheat with a bearded head. The variety has a slightly higher yield record than other club wheats. Barbee is not as good as other club wheats in emergence.

The variety has good stripe rust resistance and is resistant to flag smut and most races of dwarf smut, and moderately resistant to *Cephalosporium* stripe (fungus stripe). It produces an excellent flour but it mills more like a soft white common wheat variety than a club wheat variety.

Barbee is expected to replace Paha because of the higher yield record and better stripe rust resistance. Barbee was developed by USDA-ARS and Washington State University.

Tyee

Tyee is a soft white club winter wheat with compact heads and awnless white chaff. It is a semidwarf wheat that is medium in maturity. The variety has high resistance to stripe rust that is different from the resistance in Moro, Barbee, and Faro.

The emergence is about the same as Paha. Emergence would be slower than Moro. The variety is moderately susceptible to flag smut. It has about the same common bunt or common smut resistance as Nugaines. It is susceptible to dwarf bunt. Tyee has the same susceptibility to leaf rust as Barbee, Faro, and Moro. The variety is highly susceptible to mildew. Tyee has about the same tolerance to strawbreaker foot rot as Barbee. It is more tolerant than Paha or Nugaines. Data is not available on *Cephalosporium* stripe (fungus stripe).

Tyee has high yielding ability, exceeding Paha, Moro, and Barbee and often better than Faro. It has test weight comparable to Moro and Barbee. It is 1 to 2 inches taller than Faro, 1 to 5 inches taller than Nugaines, and 5 inches shorter than Moro. Tyee has more lodging resistance than Paha and considerably more resistance than Moro.

The variety has about the same winterhardiness as Nugaines and, under some conditions, may prove to be better than Nugaines.

The quality of Tyee is similar to Moro but somewhat lower in quality than Paha. It may be superior to Faro for low ash content and increased cookie diameter. The variety was developed by wheat breeding and production of USDA-ARS and released jointly by the Washington, Oregon, and Idaho Agriculture Experiment Stations.

Paha

Paha is a short, standard height, white club wheat. It is susceptible to some races of stripe and leaf rusts, powdery mildew, and flag smut. It has moderate resistance to *Cercosporella* foot rot and *Cephalosporium* stripe (fungus stripe). The variety is resistant to lodging and shattering. Good germination and emergence characteristics of the selection are similar to other club wheats but not as good as Moro.

The variety is adapted to areas that produce the quality of club wheats desired by domestic and foreign markets. Paha was developed by USDA-ARS and Washington State University.

Faro

Faro is a semidwarf soft white club. It has a good yield record in the southern part of the wheat-producing area but does not have as good emergence as Moro. Faro is resistant to stripe rust and common bunt but is susceptible to flag smut, snow mold, and dwarf bunt. It is moderately resistant to dwarf bunt, foot rot, and *Cephalosporium* stripe (fungus stripe). Faro has equaled or exceeded the grain yields of Paha and it is similar to Paha in emergence and winterhardiness. Faro was developed by Oregon 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 seedings in dry, dusty seedbeds. Moro was developed by Oregon State University.

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

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. Urquie has moderate high-temperature adult plant resistance to prevalent races of stripe rust but is susceptible to leaf rust and moderately susceptible to mildew. Milling and baking qualities are excellent.

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

Fielder

Fielder is a soft white spring wheat developed by USDA-ARS and the Idaho Branch Experiment Station at Aberdeen, Idaho. Fielder is a semidwarf, stiff-strawed, white-chaffed, awned variety with moderate resistance to common races of leaf rust but is susceptible to a new race present in the area. Fielder has moderate resistance to earlier races but is highly susceptible to a recently prevalent race of stripe rust, and is moderately susceptible to mildew. Fielder has established a higher yield record than Twin or Marfed in the higher rainfall areas of eastern Washington. Fielder yields about the same as Marfed in lower rainfall areas. Test weight of Fielder averages about 2 pounds per bushel more than Twin and about the same as Urquie.

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 and moderately resistant to leaf rust and stripe rust. The milling and baking qualities of Dirkwin are satisfactory. Dirkwin was also developed by USDA-ARS and the Idaho Experiment Station at Aberdeen, Idaho.

Wared

Wared is a hard red spring wheat evaluated and released by Washington State University and USDA-ARS. The original crosses and selections were made by Minnesota as part of the United States Department of Agriculture, Agricultural Research Service, and University of Minnesota wheat research programs. Wared has an awned, white-chaffed head with semidwarf plant-type growth. The variety is slightly earlier maturing than Marfed. Wared has a higher yield record than Peak 72 and has excellent milling and baking qualities when grown on dryland or with irrigation.

Wampum

Wampum is a new "tall" semidwarf hard red spring wheat developed by Washington State University and 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.

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 and leaf rust. It is 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 rust is present.

The variety has good milling and baking quality when grown on non-irrigated or irrigated land.

Sawtell

Sawtell is a semidwarf hard red spring wheat developed by USDA-ARS at the Aberdeen, Idaho, station. In Washington, Sawtell has sometimes shown higher yield potential under low rainfall conditions than other hard red spring wheats; however, it was inferior to Wampum in 1978. Under irrigation, its performance has not been exceptional but appears similar to other hard red spring wheats. Under some conditions, it has tended to produce grain of about 1 percent lower protein than other hard red spring varieties. Sawtell is moderately susceptible to stripe and leaf rusts and is moderately susceptible to mildew. In 1978, Sawtell was highly susceptible to both leaf and stripe rusts at Pullman.

Borah

Borah is a bearded, white-chaffed, semidwarf wheat released in 1974. Compared to Twin, grain test weight is about 3 pounds per bushel greater, maturity is five days earlier, and height is about 1 inch shorter. Borah is resistant to leaf and stripe rusts and has good milling and baking qualities.

Spring Barley

Steptoe

Steptoe is a 6-row, rough-awned, spring nonmalting barley with a high yield record. The test weight is high. 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 variety with good potential as a malting variety. The variety has low or no cold tolerance and, therefore, it is very likely to winterkill which will reduce the problem of volunteer barley in subsequent crop rotations. This is especially important when wheat is grown after barley.

This extreme earliness will permit Advance to mature under more favorable conditions. Advance is a short, stiff-strawed variety. Additional 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.

Karl

Karl is a mid-season, white-kerneled, midwest malting-type barley with rough awns. It averages about 8 percent higher than midwest types. Karl is usually 3 to 4 inches shorter and heads earlier than Traill. It has good test weight and kernel weight. It is slightly superior in shattering resistance.

Although Karl is generally equal to or superior to Traill in agronomic performance under irrigation, it is more susceptible to lodging and shattering than varieties such as Steptoe. It is not well-adapted to production on nonirrigated land in very low rainfall areas. The variety was developed by USDA-ARS and the University of Idaho.

Larker

Larker is a white-kerneled, semismooth-awned, 6-row malting barley. It has moderate resistance to lodging and is high in test weight. Larker yields have been low. It heads earlier than Traill. It is moderately susceptible to the smuts and powdery mildew and resistant to stem rust. It may have some tolerance to barley yellow dwarf virus.

Andre

Andre is a two-row, rough awn spring barley with potential malting and 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 but are below 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 Klages or Vanguard but smaller than Steptoe. The test weight is higher than Steptoe. Chick feeding trials indicate that Andre is slightly better than Steptoe in feed value. Malting barley tests indicated Andre has good two-row malting barley quality.

Vanguard

Vanguard is a 2-row malting barley recommended for nonirrigated areas. It has good lodging resistance. Vanguard matures about the same and is the same height as other 2-row varieties. It is a 2-row, spring barley with rough awns. The seed size is slightly smaller than Piroline. The malting quality is slightly below Klages and Kimberly but the yield has been higher on nonirrigated tests.

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 been classified as acceptable for malting and brewing by the Malting Barley Improvement Association.

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 University of Idaho.

Kimberly

Kimberly is a 2-row spring malting barley variety released by USDA-ARS and the Idaho and Oregon Agricultural Experiment Stations. Kimberly has averaged higher yields than Klages and has been similar to Klages in test weight, plump kernel percent, height, and lodging in irrigated trials. It has performed similar to Klages in nonirrigated trials in yield. The variety is mid-season in maturity with long heads that have rough awns. The variety is similar to Klages in malting trials.

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 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 winter-hardiness with large kernels. It is more lodging resistant with short straw. The test weight of Kamiak is high. The variety matures in mid-season. 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 beards but it does not have the severe "itching" characteristics of other winter varieties.

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

The kernels of Boyer are larger and plumper than other winter barleys. Boyer 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 diseases 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.

SOFT WHITE WINTER WHEAT IMPROVEMENT

Clarence J. Peterson, Jr., Steven Hayward, and Duane Moser

General Results

Washington produced 130.7 million bushels of wheat in 1981-82 for a 46 bushels per acre average yield. Stands and fall growth were poor in many areas of the state. Cold weather during the winter with no snow cover on parts of the fields resulted in decreased stands. This was followed by a cold dry spring and resulted in below normal yields. Disease and insect problems were considerably less than the previous year. Cheat grass was a major problem.

Objective

The objective of the soft white winter wheat program is to develop wheats with the disease resistance and agronomic characteristics needed for production in the Pacific Northwest. The wheats must also have the quality characteristics that are needed for the domestic and export markets.

Promising New Lines

WA006910 (VH080590, Maris Huntsman/VH074521) is a soft white winter wheat that is resistant to the local races of stripe rust and leaf rust. It is moderately resistant to *Cercosporella* foot rot and is susceptible to common and dwarf bunt. WA006910 is equal to or slightly less winterhardy than Stephens.

WA006912 (VH074575, Brevor/CI015932//Nugaines) is a late maturing soft white winter wheat. It is resistant to the local races of stripe rust and common bunt. It is moderately resistant to leaf rust and susceptible to dwarf bunt and *Cercosporella* foot rot. It has had a very good yield record.

WA007047 (Norco/3/VHO72297, Nugaines/101//PI172582) is a soft white winter semidwarf wheat that is resistant to the local races of stripe rust and common bunt. It is moderately resistant to leaf rust, and is susceptible to *Cercosporella* foot rot and dwarf bunt. WA007047 has had an excellent yield record the past two years.

Production

Lewjain, Daws, and Hill 81 (Table 1) had the highest yield performance record in 1981/82 based on the average of the five nurseries. The grain yield of Stephens was reduced at Ritzville and Pullman because the cold weather reduced the stands of Stephens. The club wheats performed very good in 1981/82 and this may have been due to the lack of disease problems. Lewjain and WA006912 had the best overall grain yield record based on the average of the five locations for the past four years. Stephens is still the highest yielding variety if it escapes being damaged during the winter by cold weather.

Table 1. Grain yield data for 17 winter wheat varieties grown at five locations in Washington. Data reported for 1981-82 and the four year average.

	PULLMAN		POMEROY		WALLA WALLA		RITZVILLE		CUNNINGHAM		AVERAGE	
	1982	4 yr. AVG.	1982	4 yr. AVG.	1982	4 yr. AVG.	1982	4 yr. AVG.	1982	4 yr. AVG.	1982	4 yr. AVG.
Nugaines	82	67	65	61	95	58	33	56	127	97	80	68
Luke	71	73	63	56	86	65	43	62	116	99	76	71
Lewjain	79	78	73	64	100	71	47	67	137	109	87	78
Daws	74	74	71	63	111	67	43	64	136	107	87	75
Stephens	68	73	67	64	116	70	30	52	136	106	83	73
Hill 81	83		70		106		46		130		87	
ID745318	69	73	78	60	95	61	44	63	105	97	78	71
WA006912	68	78	67	68	107	74	48	65	137	102	85	77
WA006696	75	79	70	60	112	64	48	68	121		85	
WA006910	67		74		103		54		129		85	
Barbee	89	68	79	59	96	60	45	60	117	95	85	68
Faro	72	66	72	54	93	66	43	56	116	90	79	66
Tyee	91	75	74	58	94	67	47	64	113		84	
Crew	87	74	71	58	102	68	43	60	106	93	82	71
Jacmar	83	68	63	61	90	63	49	64	121		81	
Moro	74	60	66	46	62	46	39	49	86	81	65	56
WA006698	83		68		95		43		121		82	

HARD RED WINTER WHEAT BREEDING AND TESTING

E. Donaldson, M. Nagamitsu, and M. Dalos

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, high yielding, disease resistant varieties through varietal development and testing of advanced selections and varieties developed elsewhere. In varietal development, emphasis is placed on combining the higher yield potential of soft white and other winter wheats with better adapted varieties and selections of good quality hard red winter wheats. Crosses are made to include a wide genetic background in the breeding program. Different types and sources of disease resistance are used to help prevent having only one source of resistance to any given disease. Many of the sources for disease resistance, winterhardiness, quality, or yield are not well adapted to the area and require one or two series of crosses (parent building) to get the desirable features of high quality and disease resistance into adapted varieties for the low rainfall area.

Promising Selection

WA 6816 is a tall semidwarf hard red winter wheat that has shown high yield potential in three years of testing. Adequate stripe rust resistance to prevalent races has been incorporated in this selection. It has some resistance to leaf rust. Emergence is not as good as desired. Milling and baking quality is marginal. Low protein content may be a problem.

WA 6820 (developed by Dr. Bruehl) is a semidwarf hard red winter wheat with good snowmold resistance and fair resistance to TCK. Preliminary tests indicate that WA 6820 has adequate quality. Its yield record, thus far, is excellent. A tendency toward weak straw is one of its deficiencies.

Results

Nineteen eighty-two was a poor year for testing for disease resistance. Barley yellow dwarf was prevalent in early seedings masking the expression of *Fusarium* and *Cercosporella* foot rot. *Cephalosporium* stripe was prevalent in some areas. Levels of infection in the innoculated common bunt nursery were adequate to provide a good indication of resistance. Stripe rust, leaf rust, and snow mold were not present.

In the 1982/83 dryland nurseries at Lind, emergence was a serious problem. Due to lack of land and seed, these nurseries were not reseeded. The nurseries were seeded late and deep (September 28). Plots received 0.34 inch of rain and cool temperatures between seeding and emergence. Table 6 shows the percent spring ground cover for some released varieties. Considerable plot to plot variation existed, making the results less than absolute.

Table 1. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row nurseries, 1952-82.

Variety	Av. Test wt.	1982 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	61.7	37.6	41.7	137	17
Luke	60.8	47.6	44.9	148	14
Sprague	61.1	43.5	46.5	146	12
Daws	60.4	34.2	44.7	139	9
Stephens	60.3	47.0	45.5	141	9
Lewjain	60.6	39.6	48.8	157	6
Hill 81	59.3	40.6	40.6	166	1
Moro	59.0	43.4	41.2	135	17
Faro	59.0	42.5	46.7	145	9
Crew	59.1	45.2	55.4	164	5
Tyee	58.6	54.8	51.9	162	7
Barbee	59.3	45.3	48.0	145	10
Hatton	63.2	45.9	45.4	142	7
Kharkof	61.1	35.7	33.9	100	29

Table 2. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries, 1952-82.

Variety	Av. Plant ht.	Av. Test wt.	1982 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	26	61.3	25.6	36.8	130	18
Luke	26	59.6	27.1	33.5	128	14
Sprague	27	60.2	26.1	33.5	131	12
Daws	30	59.0	29.8	35.4	136	9
Stephens	29	58.0	25.9	33.0	131	10
Hill 81	25	57.6	27.4	27.4	119	1
Lewjain	27	58.7	27.9	34.1	148	6
Moro	32	58.3	25.5	35.8	124	19
Faro	28	57.5	21.6	37.1	127	9
Crew	28	57.5	26.0	37.7	160	5
Tyee	27	58.0	24.5	35.2	122	7
Barbee	26	58.3	25.8	36.2	140	10
Wanser	32	61.6	26.3	33.4	115	19
Hatton	31	62.3	23.5	32.5	138	7
Weston	35	61.2	23.3	31.7	134	5
Kharkof	33	60.5	23.0	28.8	100	28

Table 3. Summary of agronomic characteristics of winter wheat varieties grown at Horse Heaven Hills in rod row nurseries, 1951-82.

Variety	Av. Test wt.	1982 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Wanser	60.3	27.6	39.9	116	14
Hatton	62.5	25.0	42.7	143	6
Weston	62.0	24.7	37.3	132	3
Kharkof	60.1	24.0	33.6	100	21

Table 4. Summary of agronomic characteristics of winter wheat varieties grown near Connell in rod row nurseries, 1975-81.

Variety	Av. Test wt.	*1981 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	62.4	48.9	35.9	117	6
Daws	60.8	52.7	37.7	130	5
Stephens	59.8	58.7	38.4	132	5
Moro	59.6	36.9	38.8	126	6
Faro	59.2	51.4	38.2	131	5
Barbee	60.3	50.1	34.6	130	4
Wanser	62.3	42.3	35.7	116	6
Hatton	63.2	51.7	37.6	130	5
Weston	63.1	51.3	40.6	140	3
Kharkof	61.4	31.8	30.7	100	6

*Not harvested in 1982.

Some agronomic characteristics of recommended varieties and the older varieties they replace are given for five locations in Eastern Washington. Table 1, Harrington (Robert Kramer); Table 2, Lind; Table 3, Horse Heaven (Bayne Farms); Table 4, Connell, (Dale Bauermeister); Table 5, Waterville, (Tony Viebrock). The nurseries at Finley and Connell were not harvested.

Table 5. Summary of agronomic characteristics of winter wheat varieties grown at Waterville in rod row nurseries, 1952-82.

Variety	Av. Test wt.	1982 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	62.0	42.5	45.7	130	13
Luke	61.0	52.5	49.3	149	10
Sprague	60.8	50.9	45.3	143	8
Daws	60.1	41.1	46.1	147	4
Stevens	59.2	46.7	50.6	162	4
Lewjain	62.0	53.5	57.1	176	2
Moro	59.1	46.3	44.8	128	13
Faro	58.9	46.8	47.3	151	4
Crew	60.6	50.0	51.6	159	2
Tyee	59.0	55.0	52.6	178	3
Barbee	59.2	53.4	48.8	156	4
Wanser	62.0	41.1	40.8	116	14
Hatton	63.5	48.4	47.2	151	4
Weston	62.4	46.1	41.5	140	3
Kharkof	61.1	29.3	34.0	100	23

Table 6. Percent spring ground cover of 10 hard red winter wheats and 12 soft white winter wheats following late, deep fall seeding with area receiving cool temperatures and 0.34 inches of rain between seeding and emergence.

Soft white variety	% spring ground cover	Hard red variety	% spring ground cover
Moro	68	Manning	53
Sprague	50	Weston	50
Lewjain	47	Windridge	38
Luke	44	Wanser	37
Barbee	43	Hatton	36
Crew	40	Neeley	28
Nugaines	39		
Stephens	39	WA 6816	35
Hill 81	38	WA 6820	38
Faro	32	WA 7048	49
Jacmar	32	WA 7049	47
Daws	32		

SPRING WHEAT

C.F. Konzak, Project Leader
M.A. Davis, Agricultural Research Technician
M.R. Wilson, Agricultural Research Technician

General

WSU's spring wheat breeding activity is centered at Pullman to gain greater efficiency. However, 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), and on the Phillips ranch near Cunningham (circle sprinkler irrigation). 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 all 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. 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 several nurseries distributed by CIMMYT, such as the International Spring Wheat Yield and Bread Wheat Screening Nurseries, and the Uniform Regional Hard Red Spring Wheat Nursery. This group of nurseries plus crossing blocks supplement the base of resource material available for cross-breeding and rarely for direct utilization.

New Varieties and Their Characteristics

Waverly—released in 1981 by the states of Washington and Idaho after an over-winter increase in Arizona. Waverly carries adult plant resistances to both stripe and leaf rust diseases. Adult plant resistance to stripe rust may be more stable against new races. Waverly is susceptible in the seedling stage to stripe and leaf rust, and seems to be more severely injured in the seedling stage by stripe rust than Urquie, which has similar, but even less effective adult plant resistance. Fortunately, there is promise for the near future registration of a seed treatment to control rust diseases in the seedling stage. Waverly is susceptible to powdery mildew, but mildew has not proved a very important disease. It has satisfactory pastry processing quality properties. Seed should be in good supply in 1983.

Owens—released in 1981 by the states of Idaho and Oregon. Owens carries the Twin and Dirkwin type of race specific resistance to stripe rust, which provides protection at all plant growth stages, but is vulnerable to the occurrence of a new race, not yet present in the area, but already known to exist. Owens carries some resistance to leaf rust, but was fully susceptible to the races present in Washington in 1981. Seed may still be in short supply in 1983.

1982 Research

SWS lines WA 6826, WA 6830, WA 6831 were advanced for possible release consideration in 1983. These lines all have better adult plant resistance to stripe and leaf rusts than Waverly, better quality and better yielding capacity. Backup SWS lines in the program show evidence of further improvements in apparent yield potential and adaptation.

Major emphasis in breeding SWS wheats has been to more fully exploit yield potential advances made by combining the best new lines in crosses to improve resistance to the Hessian fly, and to broaden their base of resistance to leaf and stripe rusts. Considerable progress has been made toward converting the whole of the SWS and facultative SWS breeding populations to H. fly resistance, through the close cooperation of Drs. K. Pike, WSU, Prosser, and J. Hatchett, USDA Manhattan, Kansas, and through the opportunity to increase materials in New Zealand. The New Zealand increases have been made possible through a related U.S.-N.S.F.-Japan Cooperative project and the STEEP program. Selections from crosses for H. fly resistance will be placed in replicated yield tests in 1983. Male sterile facilitated recurrent selections (MSFRS) breeding population was initiated. Results from field trials in 1982 showed several SWS lines to have wide adaptation and high yields. Results at Royal Slope were generally good and a test at Cunningham was likewise excellent.

The fall-sown screening trial of facultative wheats allowed the identification of several new lines carrying even better cold tolerance and disease resistance. New crosses were made with these lines to bring in H. fly resistance and to further improve stripe and leaf rust resistance. Efforts also are aimed at combining both specific and non-specific types of resistance to the two rusts. New, extremely early Japanese winter wheats were obtained and used in breeding for earliness and hardiness.

In 1982 more than one half of all new HRS crosses involved H. fly resistance in 1 parent. Major emphasis has been on increasing the protein production capacity of these wheats, utilizing a wide range of exotic germ plasm sources which can also be expected to contribute favorably toward yield advancement in these wheats. New MSFRS populations were developed, with the second cycle initiated in 1982. Reselections of high protein WA 6823, WA 6824 and WA 6825 were grown in New Zealand and increased further at Royal Slope. Lodging in Wampum and NK 751 was found to limit the achievement of high protein levels under sprinkler irrigation, after supplemental N application, but yields up to 130 bu/acre were achieved. This indicates that for irrigated production it will be desirable to further reduce plant height. Progress toward facultative HRS wheats was achieved in 1982 by the identification of a new HRF line with better winter survival than Walladay.

1983 Objectives

(1) Initiate a head progeny reselection program under relative isolation to purify lines currently in Western Regional nurseries, aiming at more uniform seed stocks from which pre-breeder plants can be selected. (2) Evaluate advanced lines of SWS and HRS wheats in replicated trials at Pullman, Lind and Royal Slope, and at Cunningham and Harrington; select materials for regional trials; begin yield tests on H. fly resistant SWS wheats. (3) Conduct facultative wheat screening trial at Pullman. (4) Consolidate advances in data management, improve efficiency of operations, accuracy of data, and access to analyses. (5) Continue MSFRS breeding populations in SWS and HRS wheats, begin screening subpopulations for H. fly resistance and for winter survival. Begin sampling populations for evaluation. (6) Continue modified pedigree breeding via crosses to improve the base of breeding materials with resistances to H. fly, stripe rust, leaf rust and mildew; evaluate 1982 crosses and select F_2, F_3 and F_4 materials for generation advancement and F_5 line increases for preliminary yield trials.

GENETIC AND ADAPTATION STUDIES IN DEVELOPING WHEATS FOR REDUCED TILLAGE

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

After six years of testing a diverse group of wheat varieties, lines and populations under both conventional tillage and reduced tillage, we have been able to identify several of the traits most often affected by reduced tillage. These traits included grain yield, seed weight, test weight, stand, maturity date, tillering and severity of diseases favored by reduced tillage. Some of the most important plant traits that should be considered in developing wheat varieties for reduced tillage include: improved stand establishment, rapid juvenile plant growth, early maturity, high tillering ability, weed competitiveness and resistance to diseases favored by reduced tillage.

When grown under reduced tillage at different locations and in different years, the performance of wheat varieties and lines as a rule has been very inconsistent. Limitations such as poor stands, low tillering, delayed plant growth, and late heading may be serious one year or at one location, but not during others. Wheat varieties with general or broad adaptation are best able to buffer against the occurrence of such unexpected events. Interestingly, multiline varieties, such as Crew, have also performed well in reduced tillage situations. Multilines and variety mixtures often show fitness and stability properties because unlike pureline varieties they are genetically heterogeneous and can better adapt to variable environmental conditions.

For the most part, screening genetically fixed wheat germplasm under reduced tillage has been unrewarding. We are now growing early generation, genetically plastic populations in reduced tillage tests. From the first segregating generation on, these plants and populations know no other life but reduced tillage management. We hope reduced tillage culture over time will select out the most fit offspring. This approach was first tested in 1982 but already we have detected genetic shifts in certain agronomic traits. For instance, populations derived under reduced tillage had lower grain yields, higher biological yields, earlier heading dates, taller plant heights and more tillers than when these same populations were grown under conventional tillage. This test was continued in 1983 and after harvest we should definitely know whether reduced tillage management can be used as an effective selection tool to screen out wheats with special adaptation to conservation tillage systems.

GENETIC STUDIES SUPPORTING WHEAT IMPROVEMENT

R.E. Allan, C.A. Griffey, J.M. Poulos,
J.A. Pritchett, and L.M. Little

Stripe Rust Resistance

The relative effectiveness of resistance to stripe rust was compared among several different sources of resistance using isogenic lines in the variety Lemhi 53. The European varieties Soissonais and Ministre imparted the most effective resistance based on yield loss comparisons. Reductions in test weight, kernel weight, and plant height did not consistently reflect yield losses. No close relationship was found with ratings assigned for stripe rust and the ability of a line to withstand yield loss. In fact, some lines that rated moderately susceptible yielded equal to or better than other lines that rated highly resistant. Incorporation of some resistant genes actually appeared to have deleterious effects on yield. Our results showed that subjective ratings for rust reaction of these lines did not consistently predict their effectiveness in prevention of yield loss and suggested the best way to measure stripe rust resistance is to test for yielding ability under severe rust attack.

Breeding for Resistance to Sprout Damage

Timely early fall rains in 1982 subjected 296 F_3 lines of three populations to potential sprout damage. These populations derive possible sprout resistance from Brevor, Peck, Vakka and two white grained spring wheats. Results indicate Brevor and Vakka have distinctly different genetic systems that impart sprouting resistance as measured by low alpha-amylase activity after being subjected to rain damage. Peck was less effective in limiting alpha-amylase activity than either Vakka or Brevor, but in crosses to the two spring wheats several offspring with very low alpha-amylase activity were recovered. These populations have been sown again in 1983 and will be allowed to receive natural rain damage. If rain does not occur, we will sprinkle irrigate them. By comparing the results from the two seasons we can learn to what degree alpha-amylase activity is heritable and get an idea as to the gain we can expect to make by selecting for this trait.

Breeding for Improved Stand Establishment

WA 6914 continues to show superior stand establishment capabilities to all commercially grown semidwarf white wheat varieties except Sprague. WA 6914 derives its seedling vigor from PI 178383 and the spring variety, Spinkcota. Two reselections of WA 6914 had yields equal to or above Daws and Lewjain in 1982 state tests. Both selections are moderately resistant to leaf rust and stripe rust and have the Bt_9 and Bt_{10} gene for common and dwarf bunt resistance.

Inheritance of Crown Depth

We know that deep crown formation is related to coldhardiness. Daws and Cheyenne form deep crowns and are coldhardy, whereas Stephens, Luke, and Brevor form shallow crowns and lack coldhardiness. Very little is known about the inheritance of crown depth, or how the environment influences its expression. We have begun a study on crown depth—the objectives of which include:

1) Devise a suitable greenhouse test for measuring crown depth of early generation breeding material. Determine the influence of light, water, temperature, planting medium, and planting depth on crown formation. Demonstrate the predictability of greenhouse vs. field evaluations.

2) Study the heritability of crown depth and length of subcrown internode in several crosses involving Daws (deep crown), Nugaines (mid-deep crown), Stephens, Sel. 7952 and Cappelle Desprez (shallow crowns).

3) Measure the relationship of crown depth to seedling vigor, coleoptile length, plant height, heading date (photoperiod response).

4) Determine if environmental factors such as light, soil temperature, soil water, planting depth, planting density, and planting medium interact with genotypic differences.

If a quick and easy test can be perfected, we may be able to screen for coldhardiness almost any time of the year without subjecting the plants to freezing and in this way speed up the breeding process.

PROGRESS ON BREEDING WHEATS RESISTANT TO FOOT ROT

R.E. Allan, C.J. Peterson, Jr., J.A. Pritchett, L.M. Little, and M.A. Baldridge

We continue to be optimistic about several of our advanced lines that derive resistance to strawbreaker foot rot from *Aegilops ventricosa,* a weedy relative of wheat. Our source of *A. ventricosa* resistance was obtained from a wheat selection developed by French breeders in which they transferred a portion of the *A. ventricosa* chromosome with foot rot resistance to a wheat chromosome.

Of 65 lines tested in 1982, we identified 13 that yielded 121 to 147 Bu/A under moderate foot rot attack. In the same test, Stephens, Nugaines, and Daws yielded 107, 113 and 116 Bu/A, respectively. These 13 lines had foot rot induced grain yield losses that ranged from 0 to 8% and averaged 3%. In comparison, the losses for Stephens, Nugaines and Daws were 13, 15 and 18%. In 1981, these same 13 lines had grain yields that ranged from 73 to 112 Bu/A under much more severe foot rot. In the same 1981 tests, Stephens, Nugaines and Daws yielded 55, 17 and 34 Bu/A, respectively.

Nine of these lines appear to have very high resistance to foot rot and have suffered average grain yield losses of less than 5% during the two years of tests. In contrast, Stephens, Nugaines and Daws suffered average losses of 30, 39 and 39%, respectively, during the same two years.

Our 1983 tests should help to confirm the level of progress we have achieved in breeding for strawbreaker foot rot resistance. It appears foot rot damage will be moderately severe in this year's yield trial. We have planted 260 early generation lines in a preliminary test where foot rot is very severe. Most of these early generation lines are reselections of lines that looked promising in our 1981 tests. Some of these *A. ventricosa* lines also have excellent resistance to *Cephalosporium* stripe, leaf rust and stripe rust. The main faults of this germplasm are inadequate coldhardiness, shatter susceptibility and marginal milling and baking quality.

SMALL GRAIN MANAGEMENT AND PRODUCTION

A.J. Ciha
USDA-ARS

Annual Cropping of Spring Wheat

Continuous spring seeding of wheat has been examined at Lind and Harrington the past several years. Spring wheat cultivars were examined using the following tillage systems: fall-chisel, spring tillage only, and no tillage. The seeding rates were approximately 75 lbs/acre and were seeded at a 14-inch row spacing using hoe-type openers and John Deere HZ split packer wheels. Glyphosate was applied prior to seeding to control grassy weeds and volunteer grain.

Over the years, fall chiseling has usually resulted in the greatest grain yields since available soil moisture at seeding has been generally greater with the fall chisel treatment than the other tillages. At Harrington in 1982, Dirkwin and Wampum were the highest yielding soft white and hard red cultivars examined, with yields of 30 and 34 bushels per acre, respectively. At Lind, moisture was so limiting that grain yields were usually in the 12-18 bushels per acre range.

Computer estimates of production costs comparing winter wheat-summer fallow and spring wheat grown under continuous cropping have shown that at Lind the winter wheat rotation was more profitable than annual cropping unless winter annual grassy weeds were a problem. However, at Harrington, annual cropping of spring grains was as profitable and sometimes more profitable than a winter wheat-summer fallow system.

Row Spacing and Seeding Rate

In 1982, experiments to determine the influence of rate of seeding (30, 60, 90 and 120 lbs/acre) and row spacing (6 and 14 inch) were grown at Lind and Pullman, Washington using 8 spring wheat cultivars. Average grain yield was significantly reduced with the wider row spacing. The narrower rows produced an average of 4 and 1.3 bushels per acre more at Pullman and Lind, respectively, than the wide rows. However, grain yield for several cultivars was not influenced by row width. Grain yield was not significantly increased with seeding rates above 60 bushels per acre under dryland conditions at either Lind or Pullman in 1982.

MORE DOMESTIC UTILIZATION: AN ALTERNATIVE FOR PROMOTION OF A BETTER MARKET FOR PNW SOFT WHITE WHEAT

Hamed A. Faridi and Gordon L. Rubenthaler

Wheat is one of the most important staple crops, furnishing a major portion of the caloric intake as well as protein intake of peoples of the world. The survival of the human race was made possible when man discovered the many advantages of cultivating cereal crops. Unfortunately, the recent image of baked products as "starchy" and "fattening" is quite contrary to the role grain products have played in the history of human utilization.

Recently, several studies dealing with the health advantages of a high cereal diet were published. According to these studies, such a diet may ameliorate or delay development of problems such as osteoporosis, diabetes, obesity, and colon disorders and also lower the blood urea level. Although more research is needed to clarify these observations, they provide rather convincing evidence that higher consumption of bread is of significant benefit to consumers.

The per capita daily consumption of grain products in the U.S. has decreased from 39% of food energy in 1909 to 19% of food energy in 1977. Various consumer studies indicate that cereal grains and white bread in particular, are perceived to have a relatively low nutritional value. A nationwide FDA consumer survey in 1975 indicated that only 27% of food shoppers mentioned cereal/bread foods in the definition of a well balanced diet. In other words, the consumer has a pretty clear understanding of vitamin C foods (fruits), fiber (vegetables) and protein (meat/eggs/beans), but a very unclear picture of the nutritional contribution of cereal grain products. Specific education and marketing programs are needed to give identity to wheat and other cereal nutrients, many of which are cheaper when derived from cereal foods than from other recognized sources (e.g., thiamine, derived from meat vs thiamine derived from breads).

One way to promote domestic utilization of cereals in the United States is to introduce new cereal-based products and variety breads.

The North American continent has traditionally been predominantly a white pan bread market, but variety bread consumption has increased dramatically during the last decade and represents an exciting opportunity for the baking industry in the years ahead.

Variety breads have shown the most rapid growth among baked products and now represent almost one-third of the total bread market.

The steady increase in the popularity of variety breads clearly indicates that consumers want variety in the bread they eat, just as they want variety in other types of foods.

On the other hand, because of increased economic pressures and the widespread concern for nutrition, variety breads will continue to enjoy popularity in the years to come. Few other products have as much value to offer for the food dollar as the cereal-based products. With increasing economic pressure, consumers will continue to seek ways of decreasing their food costs. Increasing the percentage of bread and cereal products in the diet is one way to meet this goal because cereal products are generally more reasonably priced than meat, fruit, vegetables and dairy products. As the cereal-based portion of the diet increases, people will seek more variety and increase consumption of variety breads.

One of the characteristics of some variety breads is that they require less gluten strength, and quality variety breads can be made from soft white wheat grown in the Pacific Northwest. When soft white wheat is employed, the bread becomes less chewy, softer and lighter (especially with higher extraction flour), characteristics that are generally assumed to be desirable.

The soft white wheat grown in the Pacific Northwest is largely exported (80 to 85% of total production). Many of the importing countries use this wheat for the production of various kinds of breads. These breads are usually produced from a lean formula and have a good flavor. With the increased interest and production of pocket breads (pita) as well as other flat breads, it is appropriate to develop methods of producing some of these traditional Middle-Eastern, North European and South American breads that would be best suited for home and industry production in the United States.

Some of the breads best made from soft white wheat include Barbari, lavash, Tunisian, pocket, marraqueta, chapatti, puri, naan, Nepalese, Jewish tea, taftoon, sandwich, rye, Chinese steam, Swedish, lefse white and lefse whole wheat. Recipes can be obtained from either the Office of Washington Wheat Commission, 409 Great Western Building, Spokane, WA 99201 or the Oregon Wheat Commission, P.O. Box 400, Pendleton, OR 97801.

Finally, to better understand and to promote soft white wheat consumption we are developing baking technology and documenting bread's nutritional significance. In the last four years we have accomplished some, but certainly our work is only beginning. The PNW is on the threshold of a new era of scientific achievement. To enhance this work we need the support and cooperation of all segments of the wheat industry. Together we can do a lot to increase wheat consumption, improve the nutritional status of all Americans, and in the process develop a strong domestic market for our favorite white wheats.

INHIBITORY BACTERIA ON WINTER WHEAT ROOTS

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Studies are showing that large numbers of bacteria inhibitory to winter wheat growth can be present on winter wheat roots. Seeding into heavy wheat residues (till or no till) seems to encourage the presence of these bacteria; however, we do not know why. At this point we have been unable to isolate the organisms from the straw. The organisms cannot be found on the wheat seedling roots until after periods of cold-wet weather in the winter. In laboratory tests the organisms grow very well at low temperatures and some have the ability to reduce wheat seedling root growth by as much as 50%. Also, they are aggressive root colonizers in the presence of other microorganisms. When several wheat cultivars were tested, resistance to the effects of the organisms varied greatly.

Current studies are focusing on stabilizing the organisms, determining how they affect the plant, and whether the organisms are entering the roots. Preliminary data indicates the organisms are entering the roots.

Financial assistance from the O.A. Vogel fund is gratefully acknowledged.

BARLEY BREEDING AND TESTING IN WASHINGTON

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Production

Barley production in 1982 in Washington was approximately 1.25 million tons from just over 800,000 acres. The state average yield was about 1.5 tons/acre. Washington is the 5th largest barley producing state in the U.S. Planting projections for Washington for 1983 indicate that this will be the third year in a row of 800,000 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. When winter grown, they must have winterhardiness superior to the current winter barley varieties. This objective includes the development of "multipurpose" varieties that will be the highest yielding varieties available. Spring varieties, whether 2-row or 6-row will have quality that will meet malting industry standards when grown under suitable conditions and they should be superior in feed quality. Thus they will meet all market demands for barley grown in the state.

The program involves the development of winter and spring, 2-row and 6-row varieties at Pullman with selection and testing at Lind (dryland), Harrington (winterhardiness), and Royal Slope (irrigated). Other major test sites are at Walla Walla, Dayton and Pomeroy. Vancouver, Puyallup, Mount Vernon, Dusty, Lamont, Cunningham, Deep Creek, Reardan, Bickleton, Mayview, Anatone, St. John, Uniontown, Fairfield, Farmington, and Wilbur are additional test locations.

Results

The new varieties developed within WSU's barley breeding program are described in the front of the brochure under recommended barley varieties for the state of Washington. Representative results of the performance of these varieties in tests are summarized in Table 1. This table also includes some advanced selections which will be discussed below.

6-row Spring

Advance, WSU's most recent 6-row release was planted on 20% of Washington's barley acreage in 1982. Its agronomic characteristics are described in the front of this brochure under recommended barley varieties for Washington. Advance is a designated malting barley and can be marketed as such if industry standards of quality are met by the grower. Advance has been proven to be superior to Steptoe and equal to the best 2-rows in nutritional quality especially due to its protein characteristics. Steptoe is still the leading variety in Washington. It was planted on 64% of Washington's barley acreage in 1982. Each of the other varieties grown in 1982 was planted on 4% or less of the barley acreage. Several newer 6-row selections are showing promise in advanced testing, especially 14583-77 and 8543-78. New 6-rows should have high yield and good quality and have plumper kernels than those of Advance. A major drawback of Advance is small kernel size.

2-row Spring

Andre is a new 2-row spring barley released this year. It was known formally as 9691-75 and WA006442. Andre was released without designation, but it is expected to be recommended for malting and brewing. Final industry tests are underway. Long-term averages establish Andre as having higher yields than Vanguard, Klages, Kimberly and Lud and slightly higher than Advance and approaching Steptoe. Andre has a high test weight, is plump and is equivalent to Klages in malting quality. Registered seed is being produced in 1983.

Other 2-rows showing promise in advanced testing include the lines 11296-76, 10698-76, 8892-78 and 8771-78.

Winter Barley

The 1982-83 winter was very mild throughout the state, which allowed for very good winter barley survival. Although good for winter barley producers, this kind of winter does not allow for the identification of barley lines with improved winterhardiness. There was good differential winter survival in 1982 and growing conditions were good for survivors. Several winter barley lines, particularly 6-row types, have yielded well over the past 3 years including the semi-dwarf 2905-75. This line is quite short and lodging resistant, and has good yield potential, but the test weight tends to be low. Other 6-row and 2-row types of good potential are listed in Table 1. The yield potential for winter barley is very good, but winterhardiness is a major limiting factor.

Table 1. Yields of barley varieties and lines at several Washington locations, 3 year averages, 1980-82 (lb/a).

Variety	Type	Pullman	Pomeroy	Dayton	Walla Walla	Average	% Survival Pullman
			Spring Barley				
Steptoe	6-row WSU	5400	3700	4000	4300	4350	
Advance	6-row WSU	5300	3500	3600	4000	4100	
Morex	6-row Minn	3700	2400	3700	3600	3350	
14583-76	6-row WSU	6100	3200	3100	4800	4300	
8543-78	6-row WSU	5900	3400	3000	4100	4100	
Andre	2-row WSU	5400	4500	3900	4800	4650	
11296-76	2-row WSU	5600	4100	3900	4200	4450	
10698-76	2-row WSU	5100	3800	3700	4800	4350	
8892-78	2-row WSU	5800	4500	3800	4300	4600	
8771-78	2-row WSU	5600	4500	4300	4000	4600	
Klages	2-row Idaho	3700	4100	3200	4000	3750	
Vanguard	2-row WSU	4800	4100	3500	3700	4000	
			Winter Barley				
Kamiak	6-row WSU	5600	2900	4600	5200	4550	100
Boyer	6-row WSU	5600	3400	3600	5000	4400	70
Hesk	6-row Oregon	5200	--	--	--	--	80
2905-75	6-row WSU	6200	4000	3700	5200	4800	95
2378-75	6-row WSU	5600	3800	4000	5000	4600	70
3231-77	6-row WSU	6800	--	--	--	--	70
1430-77	6-row WSU	6400	--	--	--	--	95
1623-75	2-row WSU	4700	3700	3900	4700	4250	95

LUPINE PRODUCTION FOR THE PALOUSE

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White lupines *(Lupinus albus* L.) are being examined as a possible alternate crop for the Palouse Region. Lupines are a grain legume which have the potential of producing their own nitrogen through nitrogen fixation. Lupine seed is harvested and after processing can be used as a protein source in livestock feed. In 1982, over 30 accessions of low and high alkaloid content lupines from the Mediterranean, Europe, Australia, and the USA, were seeded on April 29, at a rate of 5 plants per square foot.

The lupines were classified into three growth types based on seedling growth habit and vernalization requirement. The spring growth type had the highest seed yield with a range of 1850 to 3668 lbs./acre. The highest yielding cultivars were 'Kali,' 'Kiev Mutant,' and 'Nyirsegi' with seed yields of 3668, 3597 and 3399 lbs./acre, respectively. Optimal planting dates were from mid-April to mid-May for the spring types. The accessions showed a wide range in their date of maturity with lines being harvested from the end of August to the middle of September. Additional research to identify lupine cultivars best adapted to the Palouse Region and the optimum seeding rate and planting date are being examined in 1983.

A preliminary greenhouse study was conducted to evaluate the tolerance of lupines (cv. 'Astra') to several herbicides commonly used on other grain legumes. Pre-plant incorporated (PPI) and post emergence (PoE) herbicides were applied at two rates, the recommended rate and three times the recommended rate for peas *(Pisum sativa* L.) and soybeans *(Glycine max* L.). For the PoE treatments, plants were sprayed at three different growth stages (1-2, 4-5 and 7-8 leaf stage).

In the PPI treatment, Fargo reduced the number of emerged seedlings, while EPTC slowed emergence and caused seedling injury. Lupines were not injured by PPI treatments of Treflan, Sonalan, Prowl or Lasso. Lupine injury due to PoE treatments was not influenced by stage of development at the time of application. There was little or no injury with Hoelon, Avenge, Barban, Poast, or Fusilade at either rate. Lupines were severely injured by all broadleaf herbicides examined. MCPA Na salt, 2, 4-DB ester, Basagran, Premerge 3, and Metribuzin exhibited seedling injury ranging from 50-100% at the low rate.

Additional research is needed to examine the influence of these herbicides in field environmental conditions.

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

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Dry pea, lentil, and chickpea research is conducted in the Palouse area of eastern Washington and northern Idaho, the nearby irrigated areas, and on the Camas Prairie. New lines, cultivars and breeding populations are tested in these areas to identify plant types with multiple pest resistance, stress resistance, yielding ability, and quality. The principal areas of research in each of these crops is as follows:

Peas: Root diseases of peas caused by a complex of several organisms are the major reason poor pea yields have been common to the area. Most of our efforts the past few years 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. Two green pea varieties, 'Garfield' and 'Tracer,' were released in 1976. Yield tests showed that Garfield, a large-seeded selection, out-yields common 'Alaska' by over 15%.

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.

Pea seedborne mosaic virus has caused problems in our breeding program and is a serious threat to both dry peas and lentils. Because of the obvious threat this virus poses to the industry, we incorporated resistance to the virus into eight pea varieties commonly grown in the region. These varieties include five dry peas and three freezer and canner peas and were released as germplasm. Four dry pea breeding lines, Alaska 81, Latah 81, Garfield 81, and Tracer 81, carry immunity to pea seedborne mosaic virus and are similar to their recurrent parents. These four lines are now being increased and should be available to growers in 1984. Alaska 81 also has good resistance to seed bleaching.

Lines with pea seed weevil-resistant parentage that showed resistance to *Fusarium* wilt race 1 are being evaluated in cooperation with the University of Idaho in 1983 for resistance to the insect. Hopefully, agronomically acceptable lines can be identified and used as a control measure for the insect or to effectively reduce the percentage of infestation. One line (WA813768) has been identified as being highly resistant to pea weevil and is very close to a dry edible type. The line will be released as germplasm and used in the crossing program.

Variations in leaf morphology in peas is 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.

Lentils: Current objectives in lentil breeding are toward developing an early maturing 'Laird' type. Laird is a large-seeded non-mottled variety developed for use in Canada; however, Laird is somewhat late maturing and lower yielding than 'Chilean 78' when grown in the Palouse. Earlier maturing Laird types are now being increased for possible release pending performance in yield and quality tests.

'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. The line was recently approved for release and is now under seed increase. Small quantities of this new variety should be available to growers in the spring of 1984.

'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.

Chickpeas: (Garbanzos) are grown throughout the world in similar environments to those where lentils are grown. The Palouse environment seems ideally suited to chickpeas and, based on 1980-1982 results, very favorable yields and quality can be obtained. Research needs to determine suitable varieties and cultural practices for this crop. Varieties and breeding lines have been obtained from sources both national and international and are being evaluated for yield potential and seed quality. Cultural practices which include (1) seeding rates-row spacing, (2) seed treatments, and (3) *Rhizobium* inoculation are being studied. 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 represents 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.

NITROGEN FIXATION POTENTIAL OF DRY PEAS, LENTILS, CHICKPEAS AND OTHER LEGUMES AND THEIR ROLE IN CROPPING SYSTEMS IN THE PALOUSE

D.F. Bezdicek, C. Root, R. Turco, T. Moorman, E. Kirby and F.J. Muehlbauer

Recent projections on the future cost of nitrogen fertilizers and the current set-aside and PIK 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:

Inoculation of N-fixing organisms (Rhizobium)

The bacteria that produce the nodules on peas and lentils are called *Rhizobium* which are found in our soils from previous inoculation. Although we seldom get a response to inoculation of peas and lentils, we are looking for more effective strains that increase nitrogen fixation and reduce the need for N fertilizer. *Rhizobium* are specialized with regard to the type of plant they infect. Faba-bean are infected by the pea and lentil rhizobia in the soil, but do better with some specialized strains we've tested.

Chickpeas require a specialized strain of rhizobia which are not found in our soils. We obtained excellent seed yield response to inoculation in 1981 and 1982. Results from 1981 are shown below.

Response to inoculation of chickpeas in 1981

Variety	Yield*		Increased yield due to inoculation
	Inoculated	Non-inoculate	
	kg/ha^{-1}		%
UC-5	1632	1098	48.6
Mission	1300	999	30.1
Weyon	1311	1080	21.3
Mean	1414	1059	33.5

*Means of five locations

N Fixation By Legumes and N Budgets

Only a portion of the total plant legume N is taken from the air and 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. was fixed under high soil N. When N in the seed was removed at harvest, chickpeas provided a net input of about 50 lbs. per acre after harvest at the low soil N sites, but removed a net 100 lbs. per acre at one high soil-N site. We would expect the same trends to occur for peas. These results point out the need for careful management of N on previous crops in rotation.

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

The current PIK program requires that the legume be killed or turned under after a certain date. Previous experience of take out of legumes by moldboard plowing has shown to be very erosive. We are looking at the beneficial effect of various legumes (peas, fababeans, chickpeas, sweetclover, medic) as potential green manure crops under three management tillage systems:

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

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 will also look at soil water depletion of various legumes planted in rotation with winter wheat.

Evaluation of Methods to Estimate N Fixation in Legumes

We have very few options as to what methods to use in estimating the amount of N fixed by a legume. If we measure the N in the legume plant, we have no way of knowing what proportion came from the air or from the soil. Some techniques we are looking at are:

1. Difference method—measure total N difference between nodulated and non-nodulated plants. Useful only for legumes that are not nodulated by rhizobia in the soil. Not useful for peas and lentils.

2. ^{15}N methods, using an isotope of regular N. Useful for all legumes, but expensive. Cost of fertilizer ^{15}N is about $25,000 per pound. We use it very carefully.

3. The acetylene technique—Based on an enzyme assay using regular welding gas. This technique will be demonstrated.

Residue Manipulation for Enhanced N Fixation

Because of our results showing a reduction in legume N fixation with high residual soil N, we are exploring the possibility of increasing N fixation by reduction of N rates applied to wheat in rotation and by fall addition of 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 for this purpose) and to "tie-up" the soil N during the pea growing season from the wheat residue removed.

SLOT-MULCH TILLAGE

Keith E. Saxton
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We continue to develop the theory, data, and machinery to test the concept of slot-mulch tillage. All indications to date have shown that this concept has merit as a runoff and erosion control method and for residue management with reduced tillage systems.

This past year we have spent considerable effort to test machine concepts which would cut a smooth, narrow soil slot, pick up straw and chaff from a windrow, and compact this material into the soil slot leaving the field ready for seeding or overwintering.

In preparation for slot-mulch tillage, we tried several ways of manipulating the straw and chaff coming from the combine. We alternately used a straw chopper, chaff blower, and chaff saver. The chaff saver places the chaff on top of the unchopped straw row which makes it easier for later pickup by the slot-mulch machine. This seems better than the chaff blower because it does not spread weeds and volunteer seeds.

We established several sets of slot-mulch test plots on the research farm this year. All were no-till drilled to winter wheat after the slot-mulching was done. A hoe drill was used on some plots; we found that the hoe drill significantly disturbed the mulched slots so they were not very effective for runoff infiltration. The straw also caused drill plugging. A disc drill seems to cause minimal disturbance of the mulched slots.

We had one week of frozen soil in early January, 1983, with some rain and runoff. On our runoff-erosion plots, most tillage treatments had 0.25 to 1.0 inch of water runoff and some erosion. The slot-mulch plots had no measurable runoff. These data again substantiate the ability of the slot-mulch tillage to control runoff and erosion even with frozen ground conditions.

RUNOFF AND EROSION PREDICTION AND CONTROL

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Erodibility of Thawing Soils

Frozen soil is a dominant factor in erosion in much of the dry farmed area of the Pacific Northwest. Our weather pattern is such that, as the soil thaws, rainfall or snowmelt, or a combination, generally occurs. Farmers and others have observed that during the thaw the soil seems to be extremely susceptible to erosion, more so than during periods with extremely wet but unfrozen soil. Understanding the mechanisms and relationships can improve erosion predictions as well as lead to improved erosion control.

A laboratory study on the factors affecting erodibility of a thawing silt loam soil was undertaken. Undisturbed samples of a silt loam soil were obtained from tilled, fallow plots at the Palouse Conservation Field Station. The samples were frozen three times in the laboratory at different values of matric potential (moisture tension). During cooling of the samples, water migrated to the freezing front from a water supply attached to the base of the sample.

The soil was thawed and surface strength was measured at or near saturation with a Swedish fall-cone. Three freeze-thaw cycles resulted in a sheer strength less than half the initial strength of the unfrozen, unconsolidated topsoil. As the soil thawed, cohesion was regained after the soil began to drain.

The results highlight the role of even weak tillage pans in creating zones where soil moisture is high during the winter and concrete or impermeable frost can form during cold periods. Concrete frost results in nearly saturated soil during thawing from the surface, and hence periods of extreme erosion susceptibility. Other research has indicated that occurrence of concrete frost can be lessened by rotations that fully utilize soil moisture, proper and timely tillage, and leaving residues on or near the surface.

FERTILIZING FOR TOP FORAGE PRODUCTION

A.R. Halvorson
Extension Soil Scientist

Some wheat land in the Palouse is so susceptible to erosion that it might best be converted to forage production, preferably alfalfa, alfalfa grass or grass clover. Erosion could be reduced to acceptable levels while still maintaining acceptable monetary returns. Forage marketing could be done either by direct sale of hay or through an "on-farm" livestock operation. To achieve this, the same care and attention given a wheat fertilizer program would have to be given to alfalfa fertilization needs. In the Palouse area this means: (1) soil testing for: pH, levels of phosphorus, potassium and boron; (2) regular use of sulfur fertilizer; (3) making sure there is adequate rhizobia inoculum in the soil or adding it at the time of seeding; (4) checking very closely the need for molybdenum fertilizer (mainly in the area from Pullman and east and to the north); and (5) checking for lime needs—mainly in the Fairfield/Rockford area and to the north. The areas that are most subject to erosion are the areas that would benefit from transition of wheat production to forage production. Being eroded, these areas are the ones most in need of proper fertilization. When this is done, these areas have a good chance of being as profitable as is wheat production.

HERBICIDE EVALUATION FOR CHEMICAL FALLOW

L.A. Morrow, F.L. Young, D.R. Gealy, J.R. Pust, and W.A. Shull
USDA, Agricultural Research Service

Herbicides are being evaluated for the control of annual grass weeds (primarily downy brome and volunteer wheat). Herbicides are applied in the fall and/or the following spring to determine how long adequate weed control can be achieved without tillage. Plots are late-seeded to winter wheat in the fall to determine herbicide residue in the soil. Several herbicides show promise for adequately controlling weeds in a chemical fallow program.

CONTROL OF RUSSIAN THISTLE WITH POSTEMERGENCE APPLICATIONS OF CHLORSULFURON (GLEAN)

F.L. Young, D.R. Gealy, and L.A. Murrow
USDA, Agricultural Research Service

A study is being conducted to evaluate the efficacy of chlorsulfuron for the control of Russian thistle. Several rates and times of chlorsulfuron application are being evaluated. Chlorsulfuron was applied at ¼, ½, 1, and 2 oz ai/a, with and without a surfactant (X-77 at .25%) after harvest on September 2, 1981. During the summer-fallow year, chlorsulfuron was applied on June 8, 1982 at ¼, ½, and 1 oz ai/a plus surfactant. 'Wampum' spring wheat was planted on March 18, 1983, and early post-emergence applications of chlorsulfuron at ¼, ½, and 1 oz ai/a plus surfactant was applied April 27. To determine residual control of Russian thistle, applications were made only once to each respective plot. One year following after-harvest applications (September 1982), all treatments gave excellent residual control of Russian thistle.

WINTER WHEAT VARIETY TOLERANCE TO SELECTED HERBICIDES AT DIFFERENT STAGES OF WHEAT GROWTH

R.E. Whitesides, Washington State University

New wheat varieties are developed to overcome problems associated with crop production including such things as disease resistance and straw height. Only a limited amount of work is completed with herbicides to determine the tolerance of wheat varieties at different growth stages to herbicides.

The question of varietal response to herbicide treatments is under evaluation at the Spillman Agronomy farm where four wheat varieties will be tested with eight different herbicides. Herbicide treatments will be made at three growth stages in the development of the wheat. Using 2,4-D as a standard, treatments will be made at the 2-3 leaf stage of growth (considered too early for use of 2,4-D), and the boot stage (too late for 2,4-D). Other herbicides will be compared to 2,4-D and an untreated check on all varieties at all growth stages. The varieties and herbicides under evaluation are listed below.

Wheat Varieties

1. Daws
2. Lewjain
3. Hill
4. Stephens

Herbicides

1. 2,4-D LVE
2. MCPA LVE
3. Bromoxynil (Brominal or Buctril)
4. Chlorsulfuron (Glean)
5. Bromozynil + MCPA LVE (Bronate or Brominal 3 + 3)
6. Bromoxynil + Chlorsulfuron
7. Dicamba + Chlorsulfuron (Banvel + Glean)
8. Metribuzin (Lexone or Sencor)

CONTROL OF STRIPE RUST AND LEAF RUST OF WHEAT

Roland F. Line
Assistant Professor, USDA, Plant Pathology

Three rusts (stripe rust, leaf rust, and stem rust) occur on wheat in the Pacific Northwest. Stripe rust appears as golden-yellow, long, narrow stripes on the leaf surface and glumes; leaf rust appears as small, red pustules on the leaf surface and leaf sheath; and stem rust appears as larger, red-brown, diamond-shaped pustules on the leaf surface and stems. Stripe rust and leaf rust overwinter on wheat and rapidly increase during the spring. Stripe rust develops during the cool temperatures of early spring. Leaf rust develops at warmer temperatures later in the spring. In the late 1950's and early 1960's stripe rust caused losses in excess of 50%. Since 1963, destructive epidemics have occurred in fields of susceptible varieties in 15 of the last 20 years. As recent as 1981, stripe rust reduced yields by 20%. However, without development of resistant varieties and emergency registration of a new fungicide, Bayleton, for rust control, losses would have exceeded 50% in 1981. Leaf rust has become increasingly more important since 1962. In 1974, losses in Twin spring wheat exceeded 50%. Since then, leaf rust caused severe losses in 1975, 1976, 1978, 1980, and 1981. As we develop varieties with better stripe rust resistance, leaf rust becomes more important because tissue not damaged by stripe rust is damaged by the later developing leaf rust. Stem rust usually appears very late in the season and seldom causes damage. However, in 1981 and 1982, it reduced test weight of late maturing wheat in the Palouse region. Because of the greater importance of stripe rust and leaf rust, most of my research is on control of those diseases. The major emphasis of research is on: (1) monitoring the diseases to determine where they are, what wheats are vulnerable, and the potential importance of new races; (2) identifying and utilizing various types of resistance; (3) evaluating fungicides at various rates and schedules for control of rusts; (4) studying the factors that contribute to rust epidemics; and (5) determining the amount of damage caused by the rusts so that priorities can be determined. The research is conducted at several field sites throughout the region and under controlled conditions in the greenhouse.

Monitoring rust. We must monitor the rusts and identify races to forewarn growers and wheat breeders of its appearance, distribution, and severity; determine vulnerability of varieties to new races; and determine how races evolve. The monitoring program involves: (1) planting trap plots, consisting of varieties that differentiate races and varieties with various types of resistance at sites throughout the region, and (2) collecting rust specimens and testing them on selected wheats under controlled conditions. Races of rust are identified by their ability to attack certain varieties. New races can arise by mutation and thus, are able to attack varieties that were previously resistant.

Twenty-five races of stripe rust have been identified. Most stripe rust races identified in 1982 were virulent on Fielder, Fieldwin, Sterling, and seedlings of Walladay, World Seed 1, Nugaines, Daws, Hyslop, McDermid, and Luke. A few were virulent on Paha and Yamhill and seedlings of Stephens. None were virulent on Tyee, Moro, Barbee, Faro, Jacmar, and Raeder. Predominant races of leaf rust in the region are virulent on all winter varieties, except a component of the multiline, Crew, and all spring wheats, except World Seed 1, Wampum, and Wared.

Resistance to rust. Research on resistance involves identifying new types and sources of resistance, understanding how resistance works, incorporating resistance into adapted wheats, and developing methods of using resistance. Research on resistance to stripe rust and leaf rust is being conducted at several field sites where the rusts occur and under controlled environmental conditions. Several types of resistance to stripe rust and leaf rust have been identified. Some varieties have a type of stripe rust resistance that is effective against all races at high temperatures late in the growing season but not at low temperatures early in the season. Gaines, Nugaines, Wanser, McCall, Hyslop, McDermid, Luke, Daws, Stephens, Lewjain, and Hill 81 all have various degrees of the high-temperature adult plant resistance. This type of resistance is considered to be durable because it does not "break down" to new races. Some types of leaf rust resistance are "slow rusting" and do not allow the rust to increase as rapidly. The various types of leaf rust and stripe rust resistance are being incorporated into new varieties. Studies on the genetics of stripe rust resistance and leaf rust resistance are presently being conducted in the field and greenhouse.

Fungicides. In the past, fungicides were not considered economically practical for control of rust. However, we have identified new systemics that can even stop the rust from increasing once it is present on the plant. In 1981, emergency registration of Bayleton was obtained, which resulted in increasing wheat production in Washington by more than 1,000,000 bushels. Bayleton is now fully registered for use on wheat for control of rust, and guidelines for its use have been developed. Studies are presently being conducted to determine the best time and amount of fungicide to apply and to determine how fungicides may be used in an emergency or in combination with resistance. New fungicides that have potential are also being evaluated, and a new seed treatment, Baytan, that has potential as part of a rust control program, is expected to be registered for use this fall.

Relationship of rust to weather. A model based on the relationship of stripe rust to winter and spring temperatures, used to predict a severe epidemic in 1981, accurately predicted that stripe rust would not be severe in 1982. The model, based on data from Pullman, WA, was tested and modified using data from other sites in the Pacific Northwest. A site correction factor improved the predictive accuracy using negative degree days in the winter, and a method of identifying the beginning of spring growth using positive degree days provided additional accuracy. Based on the model, we expect relatively severe epidemics of stripe rust and leaf rust in 1983.

Losses caused by rust. Selective fungicides and resistant varieties are being used to control rust in field plots at several sites. When rust severity and yields from the control plots are compared with rust and yield in noncontrolled plots, we are able to determine losses caused by the rusts. Studies on the relationship of yield to percent of the surface covered by rust show that less than 20% stripe rust or 30% leaf rust at dough stage reduces yield less than 10%, 20-60% stripe rust, or 30-55% leaf rust reduces yield 10-25% and more than 60% stripe rust or 55% leaf rust reduces yield more than 25%.

CONTROL OF WILD OAT IN WINTER AND SPRING WHEAT

L.A. Morrow, F.L. Young, J.R. Pust, and W.A. Shull
USDA, Agricultural Research Service

Fall applications of triallate granules followed by spring application of reduced rates of post-emergence herbicides are being evaluated for the control of wild oat in winter wheat. Reduced rates and combinations of post-emergence herbicides are being evaluated for wild oat control in spring wheat.

Triallate granules applied in the fall to the soil surface will control fall and early spring germinating wild oats, but probably will not be effective on those that germinate late in the spring. Post-emergence applications of wild oat herbicides at reduced rates, or in combination, may be effective for the control of these later-germinating wild oats.

Reduced rates and combinations of spring applications of wild oat herbicides are evaluated for wild oat control in spring wheat.

TAKE-ALL AND *PYTHIUM* ROOT ROT

R.J. Cook
Professor, USDA, Plant Pathology

Take-all and *Pythium* root rot are becoming more important on wheat in eastern Washington with the shift in cultural practices toward more recropping (wheat after wheat or barley) and less tillage.

Take-all is a problem mainly for irrigated wheat, although the disease has caused significant loss in the Palouse in recent years in annual-cropped, no-till wheat. Symptoms include blackened roots, and the lower 1-2 inches of the stems of severely diseased mature plants may be blackened by the fungus. Plants usually die in patches after heading and show "white heads." The fungus lives in the crop residue and is especially successful when crowns of infected plants from one season are left undisturbed (as with no-till); the fungus can then grow from a large food base directly into the plants of the succeeding crop.

Pythium root rot is a problem mainly on late-seeded winter wheat. The fungus lives as spores in the soil, and may thin a stand of wheat by causing seed decay or seedling blight before or shortly after emergence. *Pythium* also damages the feeder roots of the plant, resulting in uneven height, less tillering, and smaller heads; the plants appear poorly nourished. *Pythium* is thought to obtain some of its nutrients and energy for infection from the fresh straw and chaff left on the soil surface (as with no-till), or blended with the top few inches of soil (as with minimum till). Both fungi, being parasites of wheat and barley roots, thrive with recropping of wheat and barley.

The best control for take-all is crop rotation, i.e., do not grow wheat or barley in the same field more than every other year. Potatoes, alfalfa, corn, and beans are all nonhost crops. Irrigation water supplied in large but infrequent applications, e.g., 3-4 inches every 7-10 days (as is possible with rill or solid-set systems) will also help keep take-all in check. Pivot irrigation is more favorable to the fungus. Thorough tillage helps control the disease by accelerating the death rate of the fungus. A major objective of our research is to control take-all without crop rotation, under pivots, and with less tillage. Good phosphorus fertility can give some control. The disease eventually declines with recropping; a plot at Lind in its 15th consecutive year of irrigated wheat averaged 107 bu/A in 1982 (95% of the yield in fumigated plots at the site), achieved by water and fertility management, tillage, and take-all decline. Unfortunately, rotation crops break this cycle so that, when wheat is again grown, severe take-all will occur again, and eventually decline again. We are attempting to develop a biological control involving antagonistic root-colonizing bacteria applied as a living seed treatment. Some significant field results have been obtained with this treatment in small plots, and a pilot test is underway in a five-acre trial near Ephrata. The results are encouraging but commercial application is still a few years away.

Work on *Pythium* control involved a search for a chemical or biological seed treatment. Several compounds have been found to protect against the seed rot and seedling blight phases of this disease. However, the compound must be systemic or must somehow move or be placed into the root zone beneath the seed to be effective against the root damage caused by *Pythium*. Unfortunately, at least four *Pythium* spp. are involved in this root-rot complex and a compound may be effective against some but not all species. Thus, Apron (metalaxyl) controls three but not a fourth species, which makes up 25-30% of the total *Pythium* population in some fields of the Palouse. As for take-all, a biological seed treatment is showing promise in preliminary field trials.

The overall thrust of our program is to improve the health of roots of wheat and barley grown in the intensive management systems. Soil fumigation as a research tool demonstrated that poor root health reduced the yield of Daws by 30 bu/A, (the yield averaged 100 bu/A in fumigated plots, but only 70 bu/A in nonfumigated plots) in the Pullman area in 1982 in a wheat-pea rotation. Good root health can increase yields, and possibly also reduce the rates of fertilizer since healthy roots are more efficient than diseased roots in uptake of plant nutrients. With the exception of trials at Lind, all of our work is off station. Special arrangments can be made if desired to see these trials.

STRAWBREAKER FOOT ROT

G.W. Bruehl, R. Machtmes, T. Murray, and R.E. Allan

The study of the relation of anatomy and gross chemical content of wheat stems to resistance to foot rot has been completed. Within the stem is a circle of thick-walled cells called the hypodermis. The thicker this layer and the richer it is in lignin the more resistant the wheat is. This layer is not easily digested by the enzymes of the fungus, so it adds strength under attack and protects the conducting tissues of the wheat, enabling grain filling and reducing lodging. This structural type of resistance should not be subject to loss from new races of the fungus.

A study of the hypodermis width and resistance in 18 lines from a very susceptible (Sel 101) x resistant (VPM-1) cross gave evidence that this type of resistance is inherited in a complex manner. It will not be easy to develop highly resistant wheats, but once resistance is achieved, it should be dependable.

Years ago skew-treading and harrowing wheat in the spring was a common practice in the dryland area to reduce cheat grass infestations. The mellow dryland soil spilled into the deep-furrow drill about the base of the wheat plants. This increased the severity of foot rot. Skew treading was usually done in March.

When ash from Mt. St. Helens fell over much of the dryland area in mid-May, we felt it could increase foot rot. Experiments have shown that ash in mid-May was too late to increase the disease and that it was beneficial as a mulch. Ash in mid-April would have increased disease and reduced yield. Ash in March would have been worse.

Ash and soil have the same effect.

CEPHALOSPORIUM STRIPE

G.W. Bruehl and R. Machtmes

Work under this project, sponsored by the Vogel Fund, is in progress. The most disturbing find so far was a strong season-to-season variation in varietial resistance. A breeding line, 80-112, was very resistant in the 1980-81 season and just moderately resistant in the 1981-82 season. Seasonal variations of this magnitude can greatly hinder a breeding project. Varieties, to be valuable, should be resistant or relatively so every season and not sporadically so. We do not know the reason for this variation.

We have a nursery with three levels of inoculum, very heavy, natural (following a diseased crop), and light. We hope to determine whether wheats respond differently to different levels of inoculum. It is possible that too severe a test will eliminate what resistance there is.

We are determining the populations of spores in the soil and we hope to determine the correlation between inoculum in the soil and disease severity.

SNOW MOLD

G.W. Bruehl, R. Machtmes, C. Peterson, E. Donaldson, D. Jacobs and G. Rubenthaller

Snow fell on our selection nursery on unfrozen ground November 19 and lasted four months. The natural inoculum level was too low at this site for a good test, but the inoculated rows were severely diseased. Good survival and recovery vigor data were obtained.

Resistance ratings at the David Peterson Ranch, Mansfield, 1983.

Selection	**Score**
79-177 (soft white)	83
WA 6819 (soft white)	73
Sprague	71
WA 7050 (77-261) club	56
WA 6915 (77-136) soft white	54
WA 6820 (77-99) hard red	49
Lewjain	42
Jacmar	25
Daws	24
Hattan	10

Sel 79-177 will not be acceptable as a variety because of inadequate baking quality. It should be valuable as a parent.

WA 6819, 6820, 6915, and 7050 all have quality, and all selections have slightly stronger straw than Sprague. They are all in the regional nurseries and are being evaluated for possible release.

Under very severe conditions the resistance level of Sprague is essential, but under moderate disease severity a wheat of 50 or above should be useful.

Darrel Jacobs, a graduate student, is studying the populations of snow mold fungi in the soils of Washington and Idaho.

With Dr. Alan Ciha's help we will use a growth regulator to attempt to strengthen straw.

SOIL FERTILITY MANAGEMENT FIELD TRIALS FOR WHEAT PRODUCTION

Fred Koehler, Marvin Fischer, and Emmett Field

There are 19 field experiments concerning soil fertility management for wheat production in 1983. These are widely distributed throughout the wheat producing area of eastern Washington from Asotin to Waterville. 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 is being 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.

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. An excellent stand of winter wheat was obtained in spring wheat stubble, but nearly all the wheat plants died during the winter for no explainable reason.

At one location near Davenport, no-till has been compared with conventional tillage for 5 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 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.

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 Experiment Station 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.

AUSTRIAN PINE TRIALS FOR EASTERN WASHINGTON WINDBREAKS

David M. Baumgartner and Rod Clausnitzer
WSU Cooperative Extension

The objective of the Austrian pine, *Pinus nigra* Arnold, planting at Lind is to evaluate sources from across the range of this species for adaptability and suitability for planting in low rainfall areas of eastern Washington. Austrian pine is a commonly planted windbreak and ornamental species in eastern Washington; however, survival and growth are often limited due to low moisture and high winds.

On May 4, 1976, 329 Austrian pine 1-2 (3 years old) were planted at the Lind Dry Land Experiment Station. These seedlings represented 40 different sources from the countries of Austria, France, Spain, Yugoslavia, Turkey, Greece and the USSR. Approximately ten seedlings were planted from each source, although individual sources ranged from two seedlings to fifteen seedlings.

At the end of the 1980 growing season when the seedlings were eight years old, the following results were observed:

Survival and Growth of Austrian Pine at Lind, Washington by Country of Origin, March 1981

Country of Origin	Number of Sources	Number Planted	% Survival	Average Height in Inches
Austria	3	29	90	45
France	3	21	43	36
Spain	3	28	50	29
Yugoslavia	2	17	76	48
Turkey	5	34	71	41
USSR	9	80	71	34
Greece	15	120	71	35
	40	329	69	37

There is considerable variation between and within sources. Trees now range from 74 inches in height to 9 inches. All seedlings from some sources died, while other sources showed 100% survival. It appears that the trees from Austria and Yugoslavia have shown the best overall survival and average height growth.

While it is difficult to draw conclusions with the relatively few number of trees planted and the few years of growth, it appears that further investigation into the genetic traits exhibited by different sources of Austrian pine could lead to improved adaptability and suitability for planting in eastern Washington.

The planting at Lind will be monitored as it continues to develop. It is possible that some sources will exhibit significantly better survival and growth. This may well be true when the trees reach and exceed ten to twelve years of age.

CONTRIBUTORS IN SUPPORT OF RESEARCH
1982-83
ACKNOWLEDGMENT

The cereal research programs in Washington funded by state and federal appropriations are substantial, but would be significantly lower if it were not for the excellent support of the wheat, pea and lentil growers, as contributed through the assessment program. In addition, we are most grateful for the support of individual growers who furnish plot land and service, and the firms, who contribute through grants and products:

Fertilizer, Seed and Amendments

BNP Lentil Company
Cenex
Chevron
Cominco American Inc.
Great Salt Lake Minerals
Green Acres Gypsum & Lime Co.
Monsanto Co.
Palouse Producers
Simplot
Tennessee Valley Authority
Union Chemical Co.

Herbicides

American Cyanamid Co.
American Hoechst Corp.
BASF Corp.
Chevron Chemical Co.
CIBA–Geigy Corp.
Dow Chemical Co.
E.I. DuPont de Nemours & Co.
Elanco Producers Co.
Mobay Chemical Corp.
Monsanto Co.
PPG Industries, Inc.
Rhone Poulenc, Inc.
Rohm and Haas Co.
Stauffer Chemical Co.
Union Carbide Corp.
Uniroyal Chemical Co.
Velsicol Chemical Corp.
Vertac Chemical Co.

Cash Contributions

American Cyanamid Co.
American Hoechst Corp.
BASF Corp.
CIBA-Geigy Co.
E.I. DuPont de Nemours & Co.
Grant County Crop Improvement Assoc. Inc.
Norm Heitstuman
International Mineral & Chemical
Mobay Chemical Corp.
Monsanto Co.
Northwest Plant Food Assn.
Potash-Phosphate Institute
Rhone-Poulenc, Inc.
Rohm and Haas Co.
Stauffer Chemical Co.
Tennessee Valley Authority
Union Carbide Corp.
U.S. Borax Co.
Velsicol Chemical Corp.
Washington Wheat Commission

Farmer Cooperators

Variety and Disease Plots

James Anderson	Potlatch
Orin Anderson	Clyde
Dale Bauermeister	Connell
Bayne Farms	Horse Heaven
Bud Benedict	Asotin
George Brocke	Kendrick
Elwood Brown	Bickleton
Doug & Dan Bruce	Farmington
Louis Crosner	Goldendale
Richard Deffenbaugh	Kennewick
Diamond Spear Angus Ranch	Lamont
Don and Jim Druffel	Colton
Elmer Easton	Harrington
Sanford Evans	Genesee, ID
Jim and Don Ferrel	Walla Walla
Foundation Farm, Inc.— Jack DeWitt	Walla Walla
Peter Goldmark	Okanogan
Fred Hair	Clyde
Jim Hand	Prescott
Greg Hart	Connell
Joe Havlina	Connell
Heitstuman Farms	Uniontown
Ed and Henry Hiller	Pomeroy
Bob Hinrichs	Pullman
Lowel Hoffman	Cavendish
Albert Jacobson	Waterville
Marcus Jacobson	Pullman
Dick Jones	Dayton
Dewelly Jones	Walla Walla
Wayne Klindworth	Connell
Koller Farms	Pomeroy
Robert Kramer	Harrington
Phil Krause	Creston
Quentin Landreth	Espanola
Lehn Brothers	Farmington
Lee Maguire	Rosalia
Kenneth McIntoch	Lewiston, ID
Don McKenzie	Deary
Carl and Mac Mielke	Harrington
Woodrow and Mac Mills	St. John
Don Moore	Dusty
Stephen Naught	Bickleton
Bruce Nelson	Farmington
John Oaks	Dusty
David Peterson	Mansfield
Bill & Dick Pierson	Prosser
O.E. Phillips Ranch	Lind
Luther Roecks	Fairfield
Wayne Rock	Waterville
Jack Rodrigues	Wilbur
Harold Schultheis	Colton
Read Smith	Endicott
Harvey Steuckle	Steptoe
Al Strohmaier	Lind
Warren Talbot	Pomeroy
Elmo and Larry Tanneberg	Coulee City
Wilford & Eric Thorn	Dayton
Mauris Ulhorn	Ferdinand, ID
Tony Viebrock	Waterville
Keny Wahl	Lind
Dale Walker	Moses Lake
Don and John Wellsandt	Ritzville
Earl and Paul Williams	Reardan

Fertility, Seed Tillage and Management

Lynn Ausman	Asotin
Dry Land Research Unit	Lind
Roger Dye	Pomeroy
Elmer Easton	Harrington
Curtis Gering	Lind
Gayle Gering	Ritzville
Gale Gfeller	Lind
Charles Goetz	Palouse
Tom Hyslop	Espanola
Inland Empire Pea & Lentil Growers	
William Jacky	Reardan
Hal Johnson	Reardan
Keith Mader	Palouse
Don Moore	Dusty
Don Ogle	Waterville
Don Quist	Palouse
Glen and Chris Ramsey	Freeman
Marvon and Rick Repp	St. John
Scheele Brothers	Waverly
Harold Schultheis	Colton
Tom Schultz	Reardan
Whitman County Grain Growers	
Leonard Zehm	Waverly

Weed Control Experiments

Edison Appleford	Anatone
Bruce Beeson	Palouse
Vern Bidle	Pullman
Doug Bruce	Farmington
Jim Cochran	Palouse
Earl Crowe	Farmington
Francis Fitzgerald	Clarkston
Bob Frazier	Walla Walla
Garfield County Road Dept.	Pomeroy
Howard Hill	Palouse
Gary Housen	Pomeroy
Bob Hutchins	Dayton
Dewelly Jones	Walla Walla
Greg & Mark Mader	Pullman
Fred Mader	Colfax
McGregor Farms	Hooper
Ted Nealy	Endicott
Peter Price	Walla Walla
Gene Rambo	Farmington
Ted & Gary Schecle	Waverly
Bill Schwerin	Walla Walla
Lee Shulthies	Uniontown
Don Sodorff	Pullman
Spillman Farm	Pullman
State Highway Dept.	Washtucna
USDA Conservation Farm	Pullman
USDA Plant Materials Center	Pullman
Lyle West	Palouse

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

Adams Co. Wheat Growers
Agri-Service Inc.
Lind Grange Supply
McGregor Co.
Palouse Conservation District
Palouse Producers
Palouse Rock Lake Conservation District
Whitman Co. Wheat Growers
WilFac Inc.

Equipment

James Dahmen, Colton—John Deere 4-bottom plow

LISTING OF COOPERATIVE PERSONNEL AND AREA OF ACTIVITY

Glenn Terrell .... President, Washington State University
J.L. Ozbun .... Dean, College of Agriculture
C.A. Pettibone .... Director of Resident Instruction
L.L. Boyd .... Director of Research, College of Agriculture
J.O. Young .... Director of Cooperative Extension
J.C. Engibous .... Chairman, Department of Agronomy and Soils
N.I. James .... Area Director OR-WA-ID Area AR-SEA

Cereal Breeding, Genetics, and Physiology

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E. Donaldson, M. Nagamitsu, Dry Land Research Unit, Lind .... Wheat Breeding
C.F. Konzak, M.A. Davis, M.R. Wilson, Pullman .... Wheat Breeding & Genetics
S.E. Ullrich, C.E. Muir, D.A. Deerkop, Pullman .... Barley Breeding & Genetics
C.J. Peterson, S. Hayward, D.F. Moser, USDA, Pullman .... Wheat Breeding
R.L. Warner, A. Kleinhofs .... Cereal Evaluation Laboratory
A.J. Ciha, USDA, Pullman .... Wheat Mgmt. and Production
S.E. Brauen, Puyallup .... Varietal Testing
K.J. Morrison, P.E. Reisenauer, Pullman .... Varietal Testing

USDA Western Wheat Quality Laboratory

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S.J. Kitterman .... Research Chemist
P.L. Finney, H.C. Jeffers .... Research Technologists
P.D. Anderson, A.D. Bettge .... Physical Science Technicians
M. Baldridge, G.E. King .... Early Generation Testing

Cereal Diseases

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R.J. Cook, Cooperative USDA, Pullman .... Root Rot Diseases
J.W. Hendrix, Pullman .... Leaf Rust Wheat Septoria
R.F. Line, Cooperative USDA, Pullman .... Flag Smut Control

Seed Testing

J.D. Maguire, Pullman

Breeding and Culture of Dry Peas and Lentils

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Ray Nelson

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
Peas Lentils for Eastern Washington, FG0025
Insects of Peas, PNW0150
Seed Rates and Phosphorus Placement for Alaska Peas in the Palouse, XB0794
Seed Rates Tekoa Lentils, XC0565
Diseases of Cereal Crops, EB0559
Insect Cont. in Stored Grain and Peas and Seed Treatment for Small Grains, EM3314
Winter Wheat and Barley for Western Washington, FG0017
Spring Wheat, Barley and Oats for Western Washington, FG0048
Wheat and Barley Output Under Alternative Prices in Washington and North Idaho, XT0061
Boyer Winter Barley, EB0678
Blazer Spring Malting Barley, EB0679
Advance Barley, EB0720
Vanguard Barley, EC0385
Steptoe Barley, EC0392
Barley for Eastern Washington, FG0029
Effect Seed Time/Spring Barley, WC0476
Steptoe Barley, XC0572
Morphology/Himalaya Barley, XT0055
Cayuse Oats, EC0358
Western Washington Weed Control Guides Green Peas, EM3342
Biology and Control of the Pea Weevil, EM4004
Peas for Western Washington, FG0027
Irrigated Peas for Central Washington, FG0033
Economics of Pea Harvest Methods in Eastern Washington and Oregon, XB0684
Fertilizer Placement/Peas, XB0721
Acidity and Phosphorus/Peas, XB0722
Pea Varieties/Freeze Can, XC0483
Pea Varieties/Freeze Can, SC0503
Fertilizer Experiments/Irrigated Peas, XC0547
N Fertilizer/Irrigated Green Peas, XC0566
Forecasting Crop Yield and Income in the Palouse Wheat Pea Area, XB0712
Financial Structure of Large Farms in the Washington Wheat-Pea Area, XB0738
Irrigated Small Grains Central Washington, FG0009
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Wheat and Barley Output Under Alternative Prices in Washington and Northern Idaho, XT0061
Annual Weed Control in Winter Wheat, EB0599
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

Developed by Wheat Industry Resource Committee in cooperation with the National Association of Wheat Growers.