



# WSU FIELD DAYS

June 17, 1982

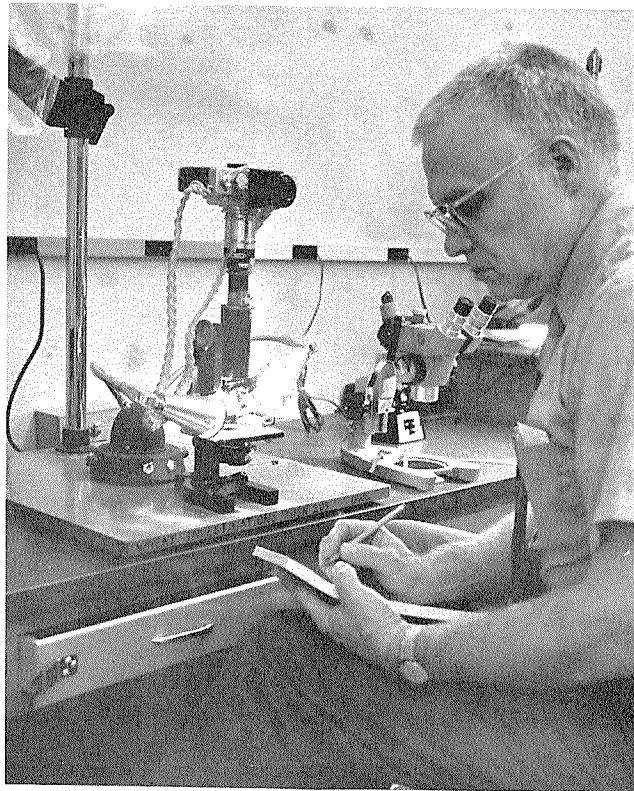
Dry Land Research Unit, Lind

July 1, 1982

Palouse Conservation Station  
Field Day, Pullman

July 8, 1982

Spillman Farm, Pullman



### DEDICATION

It is a great pleasure to dedicate the 1981 Field Day Brochure to honor Mr. Don George, an agronomist with the U.S. Department of Agriculture Research Service. Don is known best for his cold hardiness research in the Pacific Northwest. Don graduated from Kansas State University after which he worked on sorghum at Texas A & M University and the University of Arizona. He was recruited by Dr. O. A. Vogel to work at the USDA Pendleton Field Station near Pendleton, Oregon, where he began studying winterhardiness problems and testing breeding lines of wheat for cold hardiness.

Don also worked on post-harvest dormancy problems in wheat. Don learned that wheat taken from the combine was still dormant and would germinate slowly or not at all even when adequate moisture was available when seeded early. He found the hot, midsummer seedbed aggravated dormancy problems. Don found the solution was to plant year old seed which had lost its dormancy.

Don transferred from the Pendleton Station to Pullman in 1965.

Don developed a crown freezing technique that enabled scientists to evaluate wheat for winterhardiness. His crown technique enabled the wheat breeders to select more winterhardy varieties such as Daws, for farmers in the Pacific Northwest.

Don plans to remain in Pullman where he will pursue fish, fowl and game. In between trips to the field, he plans to give his garden the kind of attention it should have. He will keep his shooting sharp by taking part in small bore rifle competition. He has served as a hunter safety instructor for 15 years.

We take this opportunity to recognize Don George and wish him and Mrs. George many happy retirement years. His research has been a great help to Washington wheat farmers.

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## 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. Dr. 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 Commissions 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 around 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 65th 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.

Month	Temperature °F.		Precipitation		Precipitation
	Max.	Min.	1981	1982	61 yrs. av. (in)
January	34	22	.23	.88	1.03
February	42	24	.79	.77	.88
March	53	32	1.23	.77	.74
April	63	35	.21	1.35	.65
May	72	42	1.10		.79
June	83	45	.67		.86
July	90	52	.11		.24
August	90	50	.06		.34
September	79	45	.48		.55
October	65	38	.85		.87
November	47	29	.79		1.20
December	37	26	1.55		1.29
			8.07		9.44

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, 1981 and 1982

Month	Average		Precipitation				
	Temperature °F		30-Yr. Avg.*	Monthly	Total Accum.	Deviation from Avg.	
	Max.	Min.				Monthly	Accum.
1981							
January	40.4	31.2	2.79	1.04	1.04	− 1.75	− 1.75
February	41.5	28.8	2.06	3.31	4.35	+ 1.25	− 0.50
March	51.7	31.7	1.84	2.30	6.65	+ 0.46	− 0.04
April	54.2	36.2	1.55	2.22	8.87	+ 0.67	+ 0.63
May	61.1	41.3	1.53	1.72	10.59	+ 0.19	+ 0.82
June	64.6	44.9	1.65	2.78	13.37	+ 1.13	+ 1.95
July	79.0	46.3	0.45	0.71	14.08	+ 0.26	+ 2.21
August	86.2	49.7	0.64	0.16	14.24	− 0.48	+ 1.73
September	73.9	42.9	1.14	0.64	14.88	− 0.50	+ 1.23
October	55.4	35.6	1.83	2.34	17.22	+ 0.51	+ 1.74
November	49.7	35.2	2.66	2.30	19.52	− 0.36	+ 1.38
December	37.7	27.2	2.67	4.31	23.83	+ 1.64	+ 3.02
TOTAL	58.0	37.6	20.81	23.83	23.83		+ 3.02
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 26			1.55	2.51	12.21	+ 0.96	+ 3.97
TOTAL			8.24	12.21	12.21		+ 3.97
1982 CROP YEAR							
Sept. 1981 thru							
April 26, 1982			16.54		21.79		+ 5.26

\*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 Luke Daws Barbee Stephens Faro Tyee	Urquie Dirkwin Waverly	Cayuse Park Appaloosa	Steptoe Advance Larker—malting barley Belford—for hay only Vanguard—malting barley Kimberly	Kamiak Boyer
EASTERN WASHINGTON					
Less Than 14 Inches Rainfall	Wanser McCall Hatton Nugaines Sprague	Sawtell Wampum Wared Twin Urquie Waverly Dirkwin		Steptoe	
	Moro Barbee Faro Hatton Tyee Crew				
CENTRAL WASHINGTON					
Under Irrigation	Nugaines Daws Stephens Walladay Wandell (Durum)	Urquie Sawtell Wared Wampum Waverly Dirkwin	Cayuse Park Appaloosa	Kimberly Klages Steptoe Belford—for hay only	Boyer
Snow Mold Areas	Sprague				

## WHEAT, OATS, AND BARLEY

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 *Cercospora* 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* strip.

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 mild, and *Cercospora* 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.

## Luke

Luke is a late maturing soft white semidwarf winter wheat. Luke is resistant to most races of common and dwarf bunt and is well-adapted to areas where dwarf bunt is a problem. This variety is slightly better than most commercial varieties in resistance to *Cercospora* foot rot, snow mold, and stripe rust. Luke is moderately susceptible to leaf rust, flag smut, and *Cephalosporium* stripe (fungus stripe). It emerges well for a semidwarf.

Luke is less winterhardy than Nugaines. The milling quality is unusually good for soft white wheat and the baking quality is similar to Nugaines. Its resistance to lodging and shattering are slightly less than that of Nugaines. Luke 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 *Cercospora* 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 *Cercospora* 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.

## McDermid

McDermid is a semidwarf soft white common winter wheat. It has weaker straw than Hyslop. McDermid has more winterhardiness than Hyslop but is not as hardy as Nugaines.

McDermid is similar to Nugaines in common smut reaction but is susceptible to most races of dwarf smut and *Cephalosporium* stripe (fungus stripe). The variety is moderately resistant to stripe rust and leaf rust. McDermid has shown a slightly lower yield than Nugaines in yield trials in Washington. The variety has performed in the best in the northcentral areas of Oregon and southern areas of Washington. The milling and flour characteristics of McDermid are similar to Nugaines. McDermid was developed by Oregon State University.

### 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 *Cercospora* 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 moderate resistance 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 *Cercospora* 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 white club winter 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 *Cerco-sporella* foot rot.

Straw strength, shatter resistance and emergence are equal to Wanser. Winter hardiness 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 Dirkin. 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 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.

## **Facultative Wheats**

### **Walladay**

Walladay is a soft white, semidwarf, facultative wheat developed by Washington State University and USDA-ARS. The variety has an awned common white-chaffed head. Kernels are white and mid-size. The variety is adapted to fall seedings in southeast Washington wheat-producing areas. The winterhardiness is not adequate to recommend growing Walladay in the other wheat-producing areas as a winter wheat.

From fall seedings in southeast Washington, yields of Walladay are competitive with Nugaines. From spring seedings, the variety is competitive with Fielder and Urquie.

Walladay is very susceptible to *Cercospora* foot rot. The variety is moderately resistant to stripe rust, resistant to previous leaf rust, but susceptible to a new leaf race recently in the area. Walladay is slightly earlier than Luke but is a later maturing variety than Urquie or Fielder when spring seeded.

## **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.

### **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 Pirolina. 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 winterhardiness 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, Steven Hayward,  
Mary Baldrige and Duane Moser

### General Results

Washington produced 168 million bushels of wheat in 1980-81 for a 53.8 bushel per acre average yield. Stands and plant growth in the fall of 1980 were exceptional and due to the mild winter plant vigor was very good in the spring. The mild winter also provided an excellent environment for the growth of plant diseases and insects. Yields were reduced in many areas by the cereal diseases, *Cercospora* foot rot, stripe rust, leaf rust, take-all and barley yellow dwarf. Stem rust was quite prevalent along the Washington-Idaho border. Many fields of Nugaines and Daws were hurt by stripe rust, especially when the heads were infected. All of the commercial soft white winter wheats are susceptible to leaf rust.

Aphids were a major problem in some areas of Washington and therefore many fields were sprayed. Spring wheat and barley were damaged by barley yellow dwarf which is transmitted by aphids.

### 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.

### New Varieties

*Hill 81* is a soft white common semidwarf winter wheat developed for the Pacific Northwest by Oregon State University. It equals or possibly exceeds Luke, Lewjain and McDermid in winter hardiness. Hill 81 is resistant to local races of stripe rust and common bunt. It is susceptible to *Cercospora* foot rot and *Cephalosporium* stripe. Hill 81, although high yielding, has generally produced less grain than Stephens.

### Promising Lines

Two new lines were entered in the 1982/83 Western Regional Winter Wheat Nurseries for further evaluation. They were WA006910 (VH080590, Maris Huntsman/VH74521) and WA006912 (VH074575, Brevor/CI15932//Nugaines).

WA6910 is a soft white winter wheat that is resistant to the local races of stripe and leaf rust. It is moderately resistant to *Cercospora* foot rot (Table 1), but is susceptible to common and dwarf bunt. WA006910 is equal to or slightly less winter hardy than Stephens.

WA6912 had an excellent yield record in 1980-81. WA6912 is a late maturing soft white winter wheat. It is resistant to the local races of stripe rust and common bunt. WA6912 is susceptible to leaf rust, dwarf bunt and *Cercospora* foot rot. It has a good yield record for the past three years (Table 2).

Table 1. Grain yield data (bu/A) on 9 winter wheats grown in the Cercospora Foot Rot Nursery at Pullman, Washington for 5 years

	1980-81		% Reduction	5 Yr. Avg.		% Reduction
	Foot Rot	Control		Foot Rot	Control	
Nugaines	17	44	61	46	69	33
Daws	27	50	46	54	69	22
Stephens	42	74	43	60	72	17
Luke	33	57	42	53	72	26
Lewjain	31	48	35	58	82	29
Barbee	36	54	33	53	64	17
Faro	25	37	32	43	60	28
WA009612	30	56	46	58	74	22
VH080490	64	92	30			

Table 2. Grain yield data for 16 winter wheat varieties grown at five locations in Washington. Data reported for 1980/81 and the average for the past three years except at Cunningham which covers only two years.

	PULLMAN		POMEROY		WALLA WALLA		RITZVILLE		CUNNINGHAM		AVERAGE	
	1981	3 YR. AVG.	1981	3 YR. AVG.	1981	3 YR. AVG.	1981	3 YR. AVG.	1981	2 YR. AVG.	1981	3 YR. AVG.
Nugaines	59	62	68	61	43	52	63	60	81	86	63	64
Daws	77	74	73	63	51	52	70	60	91	92	72	68
Stephens	89	75	81	64	67	62	75	56	107	83	84	68
Lewjain	77	78	70	62	53	66	73	71	101	93	75	74
Luke	71	73	64	56	56	55	67	65	97	90	71	68
Barbee	63	62	58	56	46	54	62	62	77	87	61	64
Faro	67	64	55	51	61	62	63	59	68	72	53	62
Tyee	70	73	60	55	59	62	66	67	79	87	67	69
Crew	69	69	55	56	60	64	68	63	83	81	67	67
Jacmar	56	63	60	61	53	59	64	67	75	84	62	67
ID745318	71	75	60	57	50	55	61	67	86	90	66	69
WA006813	74	81	66	64	45	62	73	72	98	103	71	76
WA006696	78	80	64	61	39	56	70	72	93	94	69	72
WA006912	84	82	85	68	80	68	71	68	101	93	84	76
WA006698	87		55		80		70		104		79	
WA006910	78		71		68		76		93		77	

**Cercospora Foot Rot**

Infection was very severe in the Cercospora foot rot nursery and grain production was reduced an average of 36 percent. The grain yield of Nugaines, Daws, Stephens, Luke, Lewjain, Barbee, and Faro was reduced 61, 46, 43, 42, 35, 33 and 32 percent, respectively, in 1980/81, when compared with the benlate treated check. The highest yielding line in the inoculated portion of the nursery was VH080490 which produced 64 bushels per acre. This was 22 bushels above the highest yielding commercial variety (Stephens; 42 bu/A) and 37 bushels more than that of Daws. When the foot rot was controlled VH080490 produced 93 bushels per acre and Stephens 74 bushels per acre.

**Production**

Stephens was the highest yielding variety at all locations in 1980/81 (Table 2). The three year average of Stephens is lower than some of the varieties because it was damaged during the winter of 1978/79 by low temperatures. Lewjain produced more grain than Luke at all locations in 1980/81 except at Walla Walla and it has a higher three year average than the other varieties. Two new selections (WA006813 and WA006912) have the highest overall average grain production for the past three years and WA006912 equalled the grain production of Stephens in 1980/81.

## HARD RED WINTER WHEAT BREEDING AND TESTING

E. Donaldson, M. Nagamitsu and M. Dalos

The Hard Red Winter Wheat Breeding and Testing programs in Washington are partially funded by the Washington Wheat Commission and are conducted from the Dry Land Research Unit at Lind. Primary emphasis is placed on combining the higher yield potential of soft white and other winter wheats with better adapted varieties and selections. Crosses are also 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 into adapted varieties of high quality and disease resistance for the low rainfall area.

### Promising Selection

WA6816 is a tall semidwarf hard red winter wheat that has shown the highest yield potential of the advanced lines tested in 1981. Adequate stripe rust resistance to prevalent races has been incorporated in this selection, and it has some resistance to leaf rust. Emergence is not as good as desired. From preliminary tests, WA6816 is slightly low in protein content, and milling or baking quality.

### Results

The unusually mild winter and cool wet spring of 1980-81 brought on the most severe incidence of stripe rust and leaf rust observed at Lind in recent years. Some selections which had shown adequate resistance to stripe rust in past years were severely infected. If leaf rust continues to be a problem, much more breeding effort will have to be directed toward incorporating resistance. Data was obtained on common bunt, but not on snowmold.

Seventy-five lines were tested for yield and resistance to *Cercospora* foot rot. Sixteen of these were selected for further testing. Due to a lack of drought stress and heavy incidence of barley yellow dwarf, during 1981, *Fusarium* foot rot was extremely difficult to identify. About seventy-five hard red winter wheats from the World Wheat Collection were identified as possibly having some resistance to *Fusarium*.

In the 1981 harvest year, rain during planting caused emergence problems and a mild winter contributed to widespread damage from rust. An abnormally mild winter followed by a cool wet spring precluded selecting for winterhardiness and resistance to drought stress. In several older varieties including Wanser and McCall, yields were not as high as anticipated by the number of tillers and length of heads. New varieties, like Hatton, appeared to have more kernels per rachis joint than were observed in the older varieties. The yield nurseries at Lind, Harrington, and Connell had good stands, and were fairly uniform, but the Horse Heaven and Waterville nurseries showed considerable variation in yield between plots within varieties due to uneven soil conditions.

Some agronomic characteristics of recommended varieties and the older varieties they replace are given for four locations in Eastern Washington. In 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 nursery at Finley was not harvested.

Table 1. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row nurseries, 1952-81.

Variety	Av. Test wt.	1981 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	61.8	51.3	42.0	139	16
Luke	60.9	60.5	44.7	150	13
Sprague	61.2	50.6	46.7	148	11
Daws	60.6	57.2	46.1	145	8
Stephens	60.5	58.4	45.4	142	8
Lewjain	60.5	64.3	50.6	167	5
Moro	59.2	42.3	41.1	136	16
Faro	59.2	59.2	47.2	148	8
Crew	59.2	57.5	58.0	175	4
Tyee	58.7	56.7	51.4	164	6
Barbee	59.3	59.3	48.4	147	9
Wanser	62.3	*	39.9	131	14
Hatton	63.3	50.9	45.4	145	6
Kharkof	61.1	21.4	33.9	100	28

\*Not grown in 1981.

Table 2. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries, 1952-81.

Variety	Av. Plant ht.	Av. Test wt.	1981 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	26	61.3	38.0	37.5	131	17
Luke	26	59.8	39.4	34.0	129	13
Sprague	27	60.4	41.7	34.2	133	11
Daws	31	59.2	41.2	36.1	137	8
Stephens	29	58.1	53.8	33.8	133	9
Lewjain	27	59.0	48.2	35.4	153	5
Moro	31	58.5	36.3	36.4	124	18
Faro	29	57.7	50.2	39.1	131	8
Crew	29	57.5	51.6	40.6	171	4
Tyee	28	58.3	51.0	36.9	124	6
Barbee	27	58.4	47.5	37.4	143	9
Wanser	32	61.7	34.1	33.8	115	18
McCall	31	61.8	31.9	36.0	121	17
Hatton	32	62.4	43.0	34.1	144	6
Weston	37	61.4	39.5	33.8	142	4
Kharkof	33	60.6	24.9	29.0	100	27

Table 3. Summary of agronomic characteristics of winter wheat varieties grown at Horse Heaven Hills in rod row nurseries, 1951-81.

Variety	Av. Test wt.	1981 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	60.4	38.4	20.4	117	10
Daws	59.3	39.6	17.1	106	5
Stephens	58.1	44.8	19.3	120	5
Moro	63.1	42.8	19.6	118	12
Faro	57.8	44.7	17.9	112	5
Barbee	57.8	40.7	16.9	106	4
Wanser	60.4	36.8	19.5	116	13
Hatton	62.6	38.9	17.3	108	5
Weston	62.5	40.3	28.4	124	2
Kharkof	60.1	32.1	17.9	100	20

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

Table 5. Summary of agronomic characteristics of winter wheat varieties grown at Waterville in rod row nurseries, 1952-81.

Variety	Av. Test wt.	1981 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	61.9	61.0	46.0	129	12
Luke	60.7	60.6	48.9	146	9
Sprague	60.6	63.0	44.5	139	7
Daws	59.3	59.8	47.8	150	3
Stephens	58.4	65.6	51.8	162	3
Lewjain	60.6	64.4	60.6	170	1
Moro	59.0	45.2	44.7	125	12
Faro	57.9	56.4	47.4	148	3
Crew	59.1	53.1	53.1	149	1
Tyee	57.7	60.2	51.4	172	2
Barbee	58.4	48.8	47.3	148	3
Wanser	61.9	44.4	40.7	115	13
Hatton	62.9	51.9	46.7	146	3
Weston	61.7	45.4	39.3	132	2
Kharkof	61.0	35.6	34.2	100	22

## SPRING WHEAT

C. F. Konzak, Project Leader  
M. A. Davis, Experimental Aide III  
M. R. Wilson, Experimental Aide II

### 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 Bauermesiter 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, the Tri State spring wheat nursery grown also at Idaho and Oregon 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, the OSU-CIMMYT Winter/Spring Wheat Nursery 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.

Real and significant advances have been made in improving the yield potential and disease resistance of spring and facultative wheats. This has come about because of the increased effort spring wheat breeding and evaluation initiated several years ago via Washington Wheat Commission supplementary support and because of equipment acquisitions gained largely through small supplementary gift grants and a small share of support from the STEEP erosion control program. The opportunity, via small gift grants, the STEEP program and a federal basic research grant, to produce three off-season increases in New Zealand over the past 4 years has demonstrated that spring wheat selection and variety development can be greatly accelerated. This program is yet exploratory, and inadequately funded. However, the results of this winter increase program have been to provide a major assist to the rapid incorporation of resistance to both stripe and leaf rust resistances in essentially all new soft white wheat lines now in yield tests. More recently the program has accelerated the incorporation also of Hessian fly resistance in a significant proportion of new materials, some of which are already included in preliminary replicated yield trials. The most recent New Zealand increase permitted the selection of plants for possible preliminary Breeder Seed production of three high yielding, more disease candidate soft white spring wheat lines to be considered for a possible emergency release in fall 1982. This will be done hopefully in time to permit a winter seed increase in southern Arizona should that course be elected. If one or two of these lines is released, two full years time will have been saved in their development as a result of the New Zealand increase program. The reason for using New Zealand rather than southern Arizona or California, is to be able to have the seed back in time for planting in mid to late March vs. mid May for Arizona. The earlier return permits increase and

tests under irrigation at our Royal Slope farm and may sometimes permit direct entry of lines into Western Regional trials.

### **'Commercial' Variety Nursery**

This trial is used for demonstration and comparative evaluation purposes. It includes all available new lines nearing release by public and private breeders as well as representatives of varieties currently in production in the PNW. Included are all of WSU's Western Regional entries, materials under increase from Idaho, and new lines from North American Plant Breeders, Northup King and Company, Pioneer HiBred Company, Western Plant Breeders and World Seeds, Inc. Some obsolete cultivars are not included, but the trial does include essentially all commercial cultivars likely to be grown in the area.

### **Facultative Spring Wheat Screening Nursery**

Shown at Spillman Farm Field Day only in Pullman, the WSU facultative wheat screening nursery demonstrates the marked differences in the ability of spring wheats to survive winter conditions. Many of the lines are being tested for the first time, and as a result, most proved to be winter-tender and did not survive. Some others show a low to moderate survival while very few show good survival. A higher proportion of lines with Walladay parentage tend to show good survival. However, to improve disease and pest resistances it has been necessary to cross Walladay with less hardy Mexican spring wheats or southern soft red winter wheats. Unfortunately, crosses with European soft red winter wheats tend to introduce more lateness. Progress in facultative wheat breeding has been slowed by the urgency to concentrate effort on improving standard SWS wheats. No satisfactory selections were available for a 1981-82 Western Facultative Wheat regional trial.

### **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.

### **Promising New Materials Currently Under Increase: WA6826, WA6830, WA6831**

Three sister lines carrying increased levels of adult plant resistance to stripe and leaf rusts. Two season tests have shown their yield performance to be significantly superior to other soft white spring wheats. WA6826 was high yielder among the 36 Western Regional entries at 16 western test locations. WA6826 has slightly weaker straw than WA6830 or WA6831. All are susceptible to powdery mildew and to Hessian fly injury. All three have satisfactory pastry making properties.

*ID232*—This new line, currently under preliminary increase in Idaho, will be the first soft white spring wheat with resistance to Hessian fly. ID232 also carries high resistance to stripe and leaf rust and to powdery mildew. Unfortunately, the superiority of ID232 does not extend to yield and agronomic features. The yield capacity appears to be below that of Waverly and Owens, and the straw strength appears the weakest of wheats considered for release. ID232 has good pastry processing quality properties and will prove to be an outstanding parent for breeding.

*Obsolete Varieties*—Because of their high susceptibility to stripe rust, the most damaging and frequent plant disease in the PNW, the following soft white spring wheat varieties should no longer be grown in the area: Fielder, Fieldwin and Sterling. Of these, only Fielder was released by Washington State in cooperation with Idaho and USDA. Losses (due largely to rust) in these varieties exceeded 50% in trials; the yield loss was as high as 60%. The prevalent races of the stripe rust fungus in the area are highly specific for these varieties. Spraying rust-infected plants with fungicide could reduce losses, but the cost of the spray would far exceed any possible advantage of these varieties compared with alternatives.

*Walladay*—While this variety has shown promise as a facultative wheat, it has two weaknesses which mitigate against its further production from fall plantings: (1) high susceptibility to *Cercospora* foot rot, (2) inadequate stripe and leaf rust resistance. In 1981 from spring plantings, Walladay was more injured by stripe and leaf rust than was Urquie although both fared better than Fielder. However, with the risk of loss in the range of 30% or higher, this variety should be considered obsolete.

Some comments about other varieties of SWS and HRS wheats.

1. All SWS and HRS wheats currently available for production in Washington are susceptible to Hessian fly injury.

2. Varieties and types of disease resistance SWS wheats.

<i>Variety</i>	<i>Stripe Rust</i>	<i>Leaf Rust</i>	<i>Mildew</i>
Twin	High, specific	Susceptible	Very susceptible
Dirkwin	High, specific	Some, susceptible	Resistant
Urquie	Moderate, adult	Susceptible	Moderate susceptible
World Seeds 1	Moderate, adult	Moderate, adult	Resistant

Grain of World Seed 1 tends to have unsatisfactory processing quality properties, especially when produced in the low rainfall area.

3. Disease resistance of major HRS wheats is currently adequate. The overall best performing, most disease resistant varieties are NK751, Wampum, and McKay based on 1980-1981 test results. N-fertility and cultural practices are important to economic production of these HRS wheats.

## DEVELOPING MULTI-DISEASE RESISTANT WHEAT GERMPLASM

R. E. Allan, R. F. Line, G. W. Bruehl, J. A. Pritchett,  
M. L. Baldrige, and L. M. Little

A major task of wheat breeding is placing together stable-effective resistances to the numerous diseases that attack wheat in this region. Four very serious diseases of early sown wheat are strawbreaker foot rot, *Cephalosporium* or fungus stripe, and leaf and stripe rust. During the 1981 test season we succeeded in making a significant breakthrough by combining the resistances to these four diseases into single wheat prototypes or parental lines. Hopefully some of these lines may even hold potential as future cultivars.

A distant relative of wheat (*Aegilops ventricosa*) related to the weed, goatgrass, apparently contributed most of the genes for resistance for foot rot, fungus stripe and leaf rust resistance. Several years ago, French plant geneticists were successful in transferring foot rot resistance of *A. ventricosa* first into a durum type wheat and then into a common bread wheat. We have made hundreds of crosses to this germplasm but until 1981 we had never recovered foot rot resistant types among the most agronomically desirable segregates of these crosses. In 1981 several lines yielded 93 to 145 bu/ac under severe foot rot when Stephens produced only 55 bu/ac. Some of the lines suffered no yield reduction due to strawbreaker foot rot whereas yields of Stephens, Daws and Nugaines were reduced 45, 60 and 64%, respectively.

In a separate test inoculated with the *Cephalosporium* stripe pathogen we learned that a few of these same *A. ventricosa* derived lines also had resistance to fungus stripe disease. Leaf and stripe rust were severe in 1981 as well. The *A. ventricosa* wheat derivative was found to possess moderately high resistance to leaf rust. Greenhouse tests showed the leaf rust resistance was of the adult plant type. Nearly all of these lines also have adult plant type resistance to stripe rust. After cross comparing the reactions to all four diseases, we identified a few lines that apparently carry combined resistance to all four diseases. These lines are in our 1982 tests and will be used extensively as parents of future crosses.

We have repeated our foot rot and *Cephalosporium* screening tests again in 1982 and hopefully will get useful readings on leaf and stripe rust. It is already certain that we will get excellent readings among this germplasm for strawbreaker foot rot. Early symptoms indicate we should obtain readings on fungus stripe as well. Not all is encouraging. The past winter damaged several of the lines that gave high resistance to strawbreaker foot rot in 1981. We will have to wait until harvest to see whether any of the survivors will rate as promising as the 1981 tests indicated.

## TRITICALE

Clarence Peterson, Steven Hayward  
Mary Baldrige, and Duane Moser

Fifty-seven triticales were included in both a winter and spring nursery at Pullman in 1980-81. Two nurseries from Alabama (winter and spring) and one from CIMMYT were also grown. Most of the lines are spring triticales but they generally survive the winter at Pullman. A few true winter types were also included in the tests.

Six triticale lines in the 1980-81 winter triticale nursery produced more grain than the winter wheat check, Stephens (116 bu/A), and 26 lines produced more than 100 bushels of grain per acre.

Table 1 contains the data obtained on a few of the triticale and wheat varieties that were grown at Pullman in 1980/81. A476 (Palouse) and Beagle are available for production in the Pacific Northwest. A476 is a line developed by Charles Jenkins and Beagle was developed by CIMMYT.

The test weight of the triticale lines (Table 1) was below that of the wheat checks even though the test weights of the wheat were quite low in this test. Plant height (Table 1) of some of the new triticale lines has been reduced. In spite of their height, the triticales have good straw strength and little lodging occurs except under irrigation. Brittle rachis, fertility, and shattering are still problems with many of the new lines.

Two cereal diseases, Ergot and Cephalosporium stripe are the main disease problems associated with the present triticale in the Pacific Northwest. Ergot infects the lines that are partially sterile each year. Cephalosporium stripe reduced grain production of some of the triticale lines by 70 percent in 1979/80. It was difficult to determine if any of the lines were resistant because the disease was quite erratic.

Table 1. Data on 3 Winter Wheats and 6 Triticales Grown at Pullman, Washington in 1980/81

	Plant Height inches	Test Weight lbs/bu	Yield bu/A*	Origin
Wheat				
Daws	41	54.8	92	USDA-WSU
Luke	41	55.2	100	USDA-WSU
Stephens	41	55.1	116	OSU
Triticale				
A476 (Palouse)	59	50.1	102	Jenkins
VT076730	56	51.0	103	USDA-WSU
VT080010	51	50.0	118	USDA-WSU
TOPO 121	49	53.5	128	CIMMYT
Juanillo 168	55	53.7	131	CIMMYT
Beagle	53	48.2	84	CIMMYT

\* bu/A based on 60 lbs. per bushel

## SPRING WHEAT MANAGEMENT

A. J. Ciha and H. E. Murray  
USDA/ARS

### Annual Cropping of Spring Wheat

Continuous spring seeding of wheat has been examined at Lind and Harrington the past several years. The 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.

In 1981 annual cropping of spring wheat at Harrington and Lind resulted in an average grain yield across all cultivars and treatments of 22 and 13 bushels per acre, respectively. The low average yields were due to severe stripe and leaf rust on several of the spring wheat cultivars. The highest yielding spring wheat cultivar at Harrington was 'Dirkwin' at 30 bushels per acre. The plot at Harrington represented the fourth continuous crop to be removed from this research plot. The available soil moisture at seeding has been found to be generally greater with the fall chisel than the no-till or spring tillage. This suggests that breaking the soil surface in the fall improves water infiltration during the winter.

Computer estimates of production costs for winter wheat grown under summer fallow and spring wheat grown under continuous annual cropping were made (Table 1). These estimates are based on 2000 acres of crop land and take into account all costs of production. While the winter wheat-summer fallow costs are for a 2-year period and the annual cropping costs are for a single year, the estimated costs of production indicate the potential for using annual cropping in the 14-18 inch rainfall areas. If winter annual weeds, soil erosion, or other production problems exist with a winter wheat-summer fallow system, the spring grain annual cropping system in the intermediate rainfall areas of southeastern Washington would be advantageous.

### Planting Date and Rate of Seeding

A five year (1977-81) study at Pullman, WA using eight spring wheat cultivars showed that increasing seeding rate above 85 lbs. per acre resulted in no increase in grain yield. Grain yields for a 40, 85, and 130 lbs. per acre seeding rate were 51, 56, and 57 bushels per acre, respectively, when averaged over all years and treatments. Delaying planting date past the first week in April resulted in a reduction of grain yields. The 5-year average grain yields for an early (end of March-first of April), a normal (mid-April), and a late (first of May) seeding date were 60, 57 and 47 bushels per acre, respectively. There was a significant cultivar x planting date and cultivar x seeding rate interaction for grain yield which suggests the importance of selecting cultivars which have the greatest yield potential for the production conditions they will be exposed to.

The test weight values for an early, normal, and late planting date were 58.8, 59.7, and 58.3 lbs. per bushel, respectively, while the test weights for a 40, 85, and 130 lbs. per acre seeding rate were 58.6, 59.1, and 59.1 lbs. per bushel, respectively.

### Row Spacing and Seeding Rate

In 1981, a rate of seeding (30, 60, 90, and 120 lbs./acre) and row spacing (6 and 12 inch) experiment was initiated at Lind and Pullman, Washington using 8 spring wheat cultivars. Six inch row spacing had significantly greater yields than 12 inch row spacing at both Lind and Pullman. Increasing the seeding rate to 120 pounds per acre significantly increased grain yield at Pullman, while seeding rates about 90 lbs. per acre at Lind gave no yield advantage. There was no row spacing x seeding rate interaction for yield at either location. However, at Lind there were significant cultivar x row spacing and cultivar x seeding rate interactions for yield while at Pullman the interactions were not significant. Again, these cultivar interactions suggest the need to be able to identify specific cultivars for the production practices they will be exposed to.

Table 1. Comparison of production costs for winter wheat-summer fallow  
vs. annual cropping with spring wheat

Winter Wheat-Summer Fallow	Costs/Acre (\$)			Breakeven	
	Fixed	Variable	Total	Yield	Price
9-12 inch rainfall	112.32	67.76	180.08	40	\$4.50
14-18 inch rainfall	134.76	79.91	214.67	50	4.29
Annual Cropping					
9-12 inch rainfall	65.44	53.19	118.63	24	4.94
14-18 inch rainfall	74.77	59.49	134.26	32	4.19

## MICROBIAL ANTAGONISM OF WINTER WHEAT GROWTH<sup>1</sup>

L. F. Elliott and J. K. Fredrickson  
USDA-ARS and Washington State University

Often during cold, wet springs in the Palouse, such as the spring of 1981, the winter wheat grows poorly, the plants are yellow, and in some cases, stand loss occurs. The problem is more severe when crop-residue management systems are changed from complete incorporation (till) to surface (no till) or to surface with slight soil incorporation (stubble mulch). In some cases, the problem does not appear to result from causes such as phytotoxicity, and there is no noticeable damage by pathogens.

For these reasons, the number of inhibitory pseudomonads on the root surface of affected plants (growing in heavy crop residues) was compared with those on the root surface of unaffected plants (crop residues removed). It was found that significantly greater numbers of inhibitory pseudomonads (as determined by bioassay) were present on the root surface of winter wheat plants growing in heavy crop residues. The pseudomonads from the roots of the plants growing in the heavy residues were more strongly inhibitory, also. When several winter wheat cultivars were tested, there was a great deal of difference in the amount of root growth inhibition among the cultivars caused by the inhibitory pseudomonads. These results indicate that, if the inhibitory pseudomonads are causing a significant problem, there is a possibility that plant varieties can be developed to avoid the problem.

The studies are being continued, and again, this spring, the roots of winter wheat seeded into heavy crop residues appear to have significantly greater numbers of inhibitory pseudomonads than roots from winter wheat seeded into soil where crop residues were incorporated.

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<sup>1</sup>This work is supported in part by the O. A. Vogel Fund.

## TESTING THE CONCEPT OF MULTILINES AND BLENDS OF WHEAT

R. E. Allan, R. F. Line, C. J. Peterson, J. A. Pritchett,  
L. M. Little, M. L. Baldrige

Crew was approved for release in October of 1981. It represents the first multiline wheat cultivar produced in North America. Crew is a mixture of ten wheat lines which are very similar agronomically and physiologically. The lines differ mainly for resistance to stripe rust. At least nine different genes for specific resistance are represented among the components. Several also have adult-type general resistance. Four of the lines also afford some economic resistance to leaf rust, a disease that has caused severe yield losses in recent years.

Multilines such as Crew should help reduce vulnerability of the state's wheat crop to losses caused by stripe rust. Currently, four of the five stripe rust resistant club wheat varieties all have the same single gene for resistance. If a race were to become prevalent that could attack this gene, all four varieties would be rendered useless at once. Because Crew is a blend of several lines, each with genetically different forms of resistance, a single change in virulence by the stripe rust pathogen would probably not cause much damage. Only one plant out of ten would be vulnerable to rust attack. Even if stripe rust developed on the few susceptible plants in the multiline, the spread of the disease would be greatly reduced. This is because most neighbor plants of the susceptible plants would be resistant and therefore "dilute" the new race's ability to subsequently infect other plants.

We have expanded the concept of multiline cultivars in our 1982 tests to include nine new multilines and blends in addition to Crew. These nine multiline/blends are comprised of 51 different components. A brief description appears below for six of them:

Type	No. of Lines	Composition of components for rust resistance
Luke type	4	100, and 25% resistant (stripe and leaf rust, respectively)
Hyslop type	7	100, and 86% resistant (stripe and leaf rust, respectively)
Paha type	11	100, and 18% resistant (stripe and leaf rust, respectively)
Barbee type	8	100, and 63% resistant (stripe and leaf rust, respectively)
Faro type	10	100, and 0% resistant (stripe and leaf rust, respectively)
Moro type	5	100, and 40% resistant (stripe and leaf rust, respectively)

Crew and these new multilines will be on display at Spillman Farm in two different yield trials. These are also in off-station tests at Colton, Clyde, and Walla Walla, Washington.

## TWO POTENTIAL VARIETIES DERIVED FROM WHEAT GENETICS

**R. E. Allan, J. A. Pritchett, C. J. Peterson,  
L. M. Little, M. L. Baldrige**

Two new wheat selections continued to show promise in 1981 and may be released in the near future. WA 6698 is a high yielding semidwarf club wheat that has combined resistance to foliar diseases. WA 6914 is a semidwarf common white winter wheat that has outstanding seedling vigor.

WA 6698 is an Omar-type semidwarf wheat that apparently has the slow-rusting type of resistance to leaf rust. It also has resistance to powdery mildew. Both its leaf rust and mildew resistance are derived from a spelt-type selection. WA 6698 has specific or seedling resistance to stripe rust. This resistance probably comes from the spelt parent as well. We have tested WA 6698 since 1978 and it has proven to be markedly superior to all other club wheat cultivars for yield ability in both Washington State and Regional tests. Below is a summary of WA 6698 yield performance in Washington tests during 1980 and 1981 crop years:

	Cultivars								
Test/Yrs.	Tests	WA6698	Crew	Tyee	Faro	Jacmar	Barbee	Daws	Nugaines
						(Bu/Ac.)			
1980, CJP, REA	13	70	66	66	65	63	67	69	60
1981, CJP	14	70	61	60	57	58	57	63	54
1981, REA	4	82	59	63	56	49	54	73	57
All Tests	31	73	63	63	60	59	61	67	57

WA 6698 has higher test weight than all other currently grown club wheats. It has been rated as highly satisfactory for overall milling and baking quality. It emerges and has coldhardiness comparable to Faro. WA 6698 is vulnerable to common bunt because it has only one gene for resistance. It is susceptible to *Cephalosporium* stripe disease and shows moderate susceptibility to strawbreaker foot rot which is typical of most club wheat cultivars. We plan to ask for preliminary approval to produce Breeder Seed of WA 6698 in the fall of 1982.

Five years of tests have shown that WA 6914 has outstanding stand establishment capability. WA 6914 was developed by repeatedly intercrossing semidwarfs which demonstrated improved seedling vigor and selecting among only the best emergers. WA 6914 apparently derives its superior seedling vigor from PI 178383 and a spring wheat named Spinkcota.

Comparisons among WA 6914 and several other cultivars for emergence rate index and final stand over 5 years of tests are given below:

Kind	Emergence Rate Index						Final Stand					
	1977	1978	1979	1980	1981	Avg.	1977	1978	1979	1980	1981	Avg.
WA6914	215	166	188	366	179	233	66	69	70	82	53	68
Daws	83	148	121	117	61	106	70	78	57	67	53	65
Nugaines	169	97	124	133	107	126	74	71	57	59	59	64
Sprague	251	184	175	160	217	197	76	82	64	66	67	71
Moro	223	214	212	187	324	232	72	75	60	54	71	66

Yields of WA 6914 have been very competitive with other common white winter wheat cultivars. In 29 site/years of tests we have obtained these average yields: WA 6914, 81 bu/ac; Daws, 78 bu/ac; and Nugaines, 70 bu/ac.

WA 6914 has moderate resistance to both leaf and stripe rust, moderate tolerance to *Cephalosporium* stripe disease and has two genes from PI 178383 for resistance to common and dwarf bunt. It is slightly taller than Daws and has been rated satisfactory for soft wheat milling and baking quality. It was placed in Regional tests the fall of 1981.

## BARLEY BREEDING AND TESTING PROGRAMS IN WASHINGTON

Steven E. Ullrich, Robert A. Nilan, Carl E. Muir, D. A. Deerkop  
Kenneth J. Morrison and Patrick E. Reisenauer

Barley production in 1981 in Washington was over 1 million tons from nearly 800 thousand acres. The acreage was up considerably from 430 thousand acres in 1980. The forecast for 1982 barley acreage is equal to or greater than that of 1981.

### 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 malting and nutritional 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. Such varieties, whether 2-row, 6-row, spring or winter, will have quality that will meet malting industry standards and they should be superior in feed quality. Thus, they will meet all market demands for barley grown in this state.

The program involves the development of winter and spring, 2-row and 6-row multi-purpose varieties at Pullman with selection and testing at Lind (dry land), 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 recent barley release (1979) was planted on over 33% of Washington's barley acreage in 1981 (11% in 1980). Its agronomic characteristics are described in the front of the brochure under recommended barley varieties for the state of Washington.

Advance was released without designation of its malting status. However, as a result of industry plant scale testing for malting and brewing, Advance was officially designated as a malting barley by the Malting Barley Improvement Association. Advance was tested for nutritional quality and was judged to be superior to Steptoe and equal to the best 2-rows in nutritional value.

Several 6-row selections are in advanced testing and show promise as having acceptable quality and improved yield. These include 14583-77 and 8366-78.

## **2-row Spring**

A new two-row spring multipurpose variety is currently being considered for release. It is a selection from a Klages x Zephyr cross known as Washington selection 9691-75. It will be named Andre in honor of Andy Lejeune, who had a major hand in its development. Andy, a former breeder here, passed away in 1980. Andre is higher yielding than Vanguard, Klages, or Kimberly, yields 90-95% of Steptoe and has the quality of Klages. Release of this line should reestablish the Palouse area as a major 2-row malting producing area, a market usurped by the superior qualities of Klages grown under irrigation in other areas. However, before official malting designation by industry, additional plant scale testing is required. Andre is being increased and foundation seed should be available in 1984.

Other 2-rows showing promise include 11296-76 and a semi-dwarf line 10698-76.

## **Winter Barley**

Winter survival data for this past winter at Pullman and Harrington is presented in Table 1. The long term average survival for Boyer, Kamiak and Luther is also present. The severe site at Harrington allowed for a determination of winterhardiness, as did the Pullman test due to the relatively cold and snowy winter this year.

Most new winter 6-row and 2-row selections are of the "multipurpose" type, i.e., high yield, suitable malting and feed quality. No selections are as advanced as those of the spring types, chiefly because these selections must also be winter hardy. Several feed type 6-row lines distinguished themselves in the past 2 years with excellent yields. One of these is a semi-dwarf type, 2905-75. Hesk and Scio are recent Oregon releases from Pendleton and Corvallis, respectively.

## **Field Days**

Visitors at Lind will see a number of the previously described varieties and selections (Table 1) in spring nurseries. There was differential winter survival this year in the winter nursery.

Visitors at the Field Day at Pullman will have an opportunity to view in demonstration plots seedings of 20 current varieties and new advanced selections of spring 6-row and 2-row and 18 current varieties and new advanced selections of 2-row and 6-row winter types.

Table 1. Yields of barley varieties and lines at several Washington locations,  
2 year averages, 1980 and 1981 (lb/acre)

Variety	Type	Pullman	Pomeroy	Dayton	Walla Walla	Average		
Spring Barley								
Step toe	6-row WSU	5700	4100	4100	4300	4600		
Advance	6-row WSU	5500	3800	3900	4500	4400		
Morex	6-row Minn	3500	2400	3200	4000	3300		
8366-78	6-row WSU	6000	3900	3200	4300	4400		
14583-77	6-row WSU	6300	3700	3900	5400	4800		
9691-75	2-row WSU	5500	4500	3900	5000	4700		
Klages	2-row Idaho	5100	4300	3100	3900	4100		
Vanguard	2-row WSU	5200	4200	3600	4000	4200		
10698-76	2-row WSU	5600	3800	3800	5200	4600		
11296-76	2-row WSU	5700	4200	3700	4500	4500		
Winter Barley								
							% Survival 81-82 Pullman Harvest	
Boyer	6-row WSU	6500	3700	3300	4500	4500	20	20
Kamiak	6-row WSU	5000	2400	4000	4200	3900	100	30
Hesk	6-row Oregon	5800	--	--	--	--	43	20
Scio	6-row Oregon	5900	--	--	--	--	27	20
2905-75	6-row WSU	6800	4600	3400	5000	5000	88	23
1623-75	2-row WSU	4800	3900	3700	3900	4100	85	30

## OATS

C. F. Konzak

Progress in oat improvement has continued and should benefit growers in the area. Idaho and USDA have recently released a new oat having Cayuse parentage. Named Border, this oat produced the highest yields of all entries at Pullman in 1981. It obviously must carry the Cayuse tolerance to BYDV. An oat variety recently released from Illinois named Ogle, was visibly the most BYDV symptom-free variety in 1981 tests. It out-yielded all others in 1980 and was a high yielder in 1981. Ogle and Border both have white grains of higher test weight than Cayuse. Appaloosa continued to produce a slightly higher yield than Cayuse in Washington tests. The new oat releases will be more widely tested at Washington locations in 1982.

## STRAWBREAKER FOOT ROT

G.W. Bruehl, R. Machtmes, T. Murray

We are no longer testing fungicides for the control of this disease.

Mr. Murray, a graduate student, has studied the internal anatomy of mature wheat stems near the soil line. He found that the thickness of a lignified ring of cells in the stem was correlated with resistance, the thicker the ring the more resistant the wheat. The fungus digests pectin and cellulose fairly well, but it does not destroy the lignified ring. The most resistant wheat we have, VPM-1 from France, had the thickest hypodermis, or lignified ring. Sprague had the thinnest.

The relationship between the lignified ring and resistance has held true for two seasons and three locations, meaning that genetics or heredity is more powerful than environment. If these studies are verified by experience, it means that resistance bred into wheats should be dependable.

Last year we put volcanic ash on heavily inoculated and on lightly but naturally infected wheat. The ash increased the severity of the light infection but had no effect on the severe infection.

Foot rot resistant selections are in trials at Puyallup, Lind and Pullman with severe inoculation procedures.

## CEPHALOSPORIUM STRIPE

G.W. Bruehl, R. Machtmes, T. Murray

Work under a Vogel Fund Award is in progress. *Cephalosporium gramineum*, the fungus that causes this disease, lives in straw of diseased plants until the straw rots. The fungus produces an antibiotic that is effective against many molds. Evidence indicates that the antibiotic aids the pathogen in maintaining itself in the straw. Straws killed prematurely by the fungus are higher in sugars and nitrogen than straw of healthy plants, and these straws should decompose more rapidly than those of healthy plants, but they don't. This is evidence that the antibiotic is acting in nature in a way favorable to the pathogen.

We are studying the time and method of infection.

## WINTER DISEASES OF WHEAT AND BARLEY

G. W. Bruehl, R. Machtmes, C. Peterson

E. Donaldson, S. Ullrich, D. Jacobs

*Selection 77-99* (WA 6820), a hard red winter wheat with some snow mold resistance, passed its Miag milling and baking trial. In 1979 and 1981, it outyielded McCall in the nurseries of Bruehl and Machtmes; in 1980 Hattan beat it in all our plots. In 1981 it yielded well in Donaldson's plots (Table 1).

Table 1. Yields of Sel. 77-99 and commercial hard red winter wheats in Donaldson's nurseries in the 1980-81 season

Location	Variety			
	77-99	Wanser	McCall	Hattan
Lind—dryland	44.0	34.1	31.9	43.0
Lind—irrigated	54.0	58.0	45.7	43.5
Harrington	47.9	--	--	50.9
Waterville	59.8	44.4	--	51.9
Horse Heaven	41.3	36.8	--	38.9
Connell—irrigated	61.5	42.5	--	51.7
Average	51.4			46.7

This wheat should be considered for areas with moderate snow mold. (Pedigree—P.I. 167822/Sel.101, sel. 127//C.I. 9342/Itana, sel. 236/3/C.I. 9342/Itana, sel. 236-7//Sturdy). It has stronger straw than Sprague.

*Selection 77-294* (WA-6819), a soft white common winter wheat has slightly stronger straw and yields a few bushels more than Sprague under good conditions according to the data of Bruehl and Machtmes. It is as hardy and as snow mold resistant as Sprague, according to our 1980 results on the Goldmark Ranch, Okanogan County. It has passed the Miag milling and baking tests. Dr. Peterson grew Sel. 77-294 at seven locations, but Sprague was not grown so that other wheats are listed in Table 2 for comparison.

Table 2. Yields of 77-294 and other soft white common wheats and clubs in the Dr. C. Peterson's Nurseries, 1980-81 season

Location	Variety						
	77-294	Stephens	Daws	Nugaines	Tyee	Faro	Moro
Pullman	57.7	83.7	67.7	54.0	61.7	56.7	43.0
Pomeroy	66.0	80.5	70.5	65.0	54.0	56.5	43.0
Walla Walla	57.0	66.5	50.0	42.5	59.0	60.5	37.0
Ritzville	59.0	75.0	69.5	63.0	65.5	62.5	42.5
Lind	42.0	54.0	41.0	38.0	51.0	50.0	36.0
Harrington	54.0	59.0	57.0	51.0	57.0	59.0	42.0
Cunningham*	79.0	107.0	92.0	81.0	79.0	68.0	50.0
Lind*	70.0	83.0	79.0	65.0	77.0	67.0	54.0
Average	60.6	76.1	65.8	57.4	63.0	60.0	43.4

\* = irrigated

Sel. 77-294 may have value on the better soils in the snow mold area. (Pedigree—Unknown club of C. Peterson/Sprague.)

Twenty-eight of the most cold resistant winter barleys of the world were tested for resistance to *Typhula incarnata*, a snow mold fungus. Kamiak, a local barley, was among the best. We know that Kamiak cannot survive a severe exposure to this fungus. If it is really about as good as there is, there is little hope for extending the range of winter barley significantly. We plan to test these barleys once more before abandoning this effort.

## TAKE-ALL AND PYTHIUM ROOT ROT

R. James Cook and David M. Weller

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.

The symptoms of take-all include blackened roots, and the lower 1-2 inches of the stems of severely infected mature plants may be blackened by the fungus. Plants can die at any stage, but usually die after heading and show "white heads." Plants die in patches of various sizes. Take-all is important in eastern Washington mainly in the irrigation areas in fields where wheat is grown two or more consecutive years. The disease has become more common in the Palouse region, especially in no-till fields. The fungus lives in the crop residue and is especially successful when crowns of infected plants from one season are left intact and undisturbed (as with no-till); this creates a situation whereby the fungus can grow from a large food base directly into the plants of the succeeding crop.

Pythium may thin a stand of wheat by causing seed decay or seedling blight before or shortly after emergence. More commonly, Pythium damages the feeder roots of the plant beginning early in the life of the plant. This affects the tops in many ways; mostly the plants are uneven in height, they tiller less, heads are small and the plants appear poorly nourished. Pythium lives in soil as thick-walled spores, but is thought to obtain some of its nutrient supply from the fresh straw and chaff left lying on the soil surface (as with no-till), or blended with the top few inches of soil (as with minimum till), and thereby increase its population and ions typical of those prevalent with late-sowing and where the soil surface is insulated by residue. Both fungi, being parasites of wheat and barley roots, thrive with recropping of wheat and barley.

The best control for take-all in the Columbia Basin 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 as 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. Pivots irrigation is more favorable to the fungus. Thorough tillage helps control the disease by accelerating the death rate of the fungus. The trend, on the other hand, is toward less rotation, pivot irrigation, and less tillage and our research is now turned to other alternatives. Many forms of nutrient deficiency can favor the disease; good phosphorus fertility, in particular, can give some control. On a longer term basis, we are looking to develop a biological control involving antagonistic root-colonizing bacteria applied as a living seed treatment. Some encouraging field results have been obtained with this treatment in small plots. Larger-scale trials are now being planned.

Work on *Pythium* control involves a search for a chemical treatment for the soil or preferably the seed. 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*. One or two compounds with this potential are also now identified experimentally, but none are yet cleared for use.

The overall thrust of our program is to improve the health of roots of wheat and barley grown in the intensive management systems involving recropping and reduced tillage. 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 on the Station at Lind, all of our work is off station. Special arrangements can be made if desired to see these trials.

## **WILD OAT CONTROL IN WINTER AND SPRING WHEAT**

**L. A. Morrow, F. L. Young, and D. R. Gealy**  
**USDA-ARS**

Research is being conducted to determine wild oat control in winter wheat using fall applications of triallate granules followed by spring applications of post-emergence herbicides, and in spring wheat using reduced rates and combinations of the post-emergence wild oat herbicides.

Triallate granules applied in the fall would be expected to control fall- and early spring-germinating wild oats. However, it probably will not last long enough in the spring to control late-germinating wild oats. Reduced rates and/or combinations of post-emergence herbicides may be effective for the control of these later-emerging wild oat plants.

For the control of wild oat in spring wheat, reduced rates and combinations of post-emergence herbicides are applied and compared with each other in addition to spring application of triallate.

## **HERBICIDE EVALUATION FOR CHEMICAL FALLOW**

**L. A. Morrow, F. L. Young, and D. R. Gealy**  
**USDA-ARS**

Several herbicides are being evaluated for the control of annual weeds following harvest and continuing into the fallow year. This was started in 1982 and will continue for several years. The objective is to determine how long into the fallow year annual weeds, primarily cheatgrass and volunteer grain, can be chemically controlled with herbicides applied either in late fall, following harvest, or the following spring. After a single year, several herbicides, including some common ones, as well as experimental compounds, do appear to have the potential to fill this need.

## **GROWTH, DEVELOPMENT, AND CONTROL OF RUSSIAN THISTLE**

**F. L. Young, D. R. Gealy and L. A. Morrow**  
**USDA-ARS**

Two studies are being conducted on Russian thistle, a prevalent weed in the dry land wheat producing areas of Washington. The first study is to measure the growth and development of Russian thistle which is growing in spring wheat, winter wheat and fallow situations. Several plant growth and development characteristics will be measured throughout the growing season and include plant height, weight, and seed production.

The second study is to evaluate the efficacy of chlorsulfuron (Glean) for the control of Russian thistle. Chlorsulfuron will be applied at rates from  $\frac{1}{4}$  to 2 ounces/acre a.i., with and without a surfactant, at three times in a wheat/fallow rotation. Time of applications include after-harvest (late summer), during the summer fallow, and in the spring of the crop year. Long term residual control of Russian thistle will also be evaluated. Results from last year's after harvest application indicate that the addition of a surfactant (X-77) at .25% enhanced the control of Russian thistle at all rates when compared to each rate without surfactant.

## **MAYWEED (DOG FENNEL) INTERFERENCE IN SPRING BARLEY**

**F. L. Young, D. R. Gealy and L. A. Morrow**  
**USDA-ARS**

Mayweed is an annual, or winter annual, broadleaf weed prevalent in eastern Washington during cool, wet springs. It is somewhat resistant to applications of phenoxy herbicides and, when allowed to grow undisturbed, may severely compete with small grains for available light, nutrients and moisture.

A study is being conducted at the Palouse Conservation Field Station to evaluate the effect of mayweed density and duration on barley yield, yield parameters, and plant growth. Various densities of mayweed were established in plots planted to barley to evaluate the minimum density of this weed required to reduce crop yield. Also, mayweed will be allowed to compete with barley for various durations to determine the amount of time after crop emergence that mayweed may compete before a yield reduction occurs. This information can then be used to determine if the increased yield will offset the cost of weed control.

## **TANK MIXING HERBICIDES**

**Dean G. Swan**  
**Extension Weed Scientist**  
**Washington State University**

Sometimes wheat growers like to tank mix two or more herbicides in their weed control practices. If these tank mixes do not fall into one of the following categories the use may be inconsistent with the label.

Category 1. Instructions are on one or more of the labels.

Category 2. Covered by state registration.

Category 3. Recommended by the Experiment Station, State Department of Agriculture or common agricultural practices.

In Category 3, where the herbicide labels do not make a statement about tank mixing, applicators have been permitted to use tank mixes at their own risk if the site or crop, on which the mix is to be used, are registered on the labels of all the herbicides in the mix. ALL pertinent limitations, use directions and precautions are to be followed.

The risk of use rests with the grower. If the herbicide performance is not what was expected, the grower may not get much help in resolving the problem. On the other hand, if one or more of the labels has the instructions, (Category 1), the dealer, fieldman or industry representative will probably assist in resolving the problem. Moreover, the information on the labeled tank mix has been backed by research.

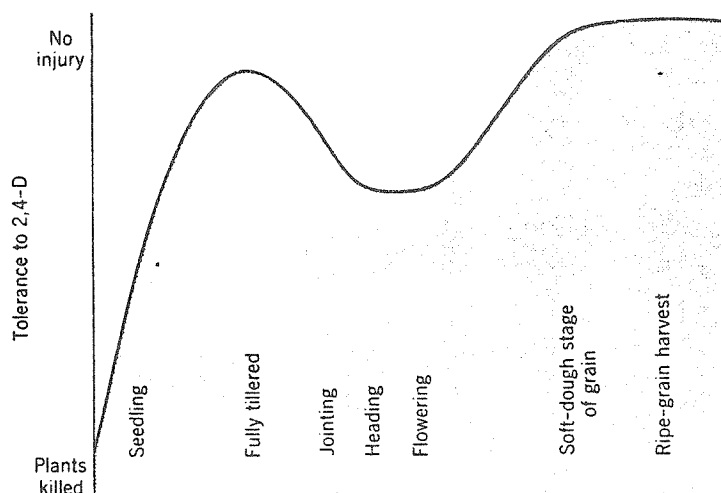
EPA has revised its policy by easing the requirement for approving tank mix labeling. EPA will now usually approve a tank mix label with less supporting data if certain conditions are met. Growers should have the backing of labeling for more tank mixes in the future.

References: WSU Weed Control Handbook—1981  
 WSU Pesticide Report, April 26, 1982

## WHEAT VARIETY TOLERANCE TO SELECTED BROADLEAF WEED HERBICIDES

Ralph E. Whitesides, Washington State University

The use of herbicides to control broadleaf weeds in small grains has become a widely accepted practice. Interest and use of herbicides for this purpose expanded tremendously in the late 1940's after the discovery of 2,4-D. The phenoxy compounds and their selective use in cereal grains were studied in detail during the late 1940's and 1950's. These studies resulted in the development of a growth stage scale used to determine the relative sensitivity or resistance of small grains to phenoxy herbicides. G. C. Klingman and F. M. Ashton in their text, *Weed Science Principles & Practices*, have summarized the early phenoxy herbicide work in the graph that follows. Their original information came from North Carolina State University from work completed between the years of 1948 and 1953.



Stages of small-grain growth and the degree of tolerance to excessive rates of 2,4-D, with most tolerant stage listed first. 1. Soft dough of grain stage to maturity. 2. Fully tillered; four leaves or more per plant; 5-8 in. tall. 3. Jointing stage through flowering. This includes the boot stage to the flowering stage. 4. Germination to four-leaf stage. (North Carolina State University.)

Klingman and Ashton conclude that herbicide applications at the four-leaf up to the boot stage have the smallest effect on the cereal crop. The text (where this information is discussed) was published in 1975 and more recent publications follow the same outline.

There have been some changes in phenoxy herbicide formulations during the past 30 years but the basic chemistry of the herbicide remains the same. Wheat varieties have changed dramatically, however, and in 1958 Price and Klingman reported that variety tolerance to 2,4-D has shown a great deal of variation.

Research work was initiated in 1981 to evaluate the response of three winter wheat varieties, Stephens, Daws, and Luke to a variety of herbicides. Each wheat variety will be treated at the two to three-leaf stage, the fully tillered stage, and in the boot, with standard broadleaf herbicides used in the Palouse Region plus chlorsulfuron (Glean). The experimental units will be carried through to harvest in an evaluation of varietal tolerance and varying growth stages. The herbicides and the rate applied are listed in Table 1.

Table 1. Wheat Variety\* Tolerance to Selected Broadleaf Weed Herbicides

Herbicides	Rate lb ai/A
2,4-D amine	0.75
MCPA amine	0.75
bromoxynil + MCPA	0.38 + 0.38
bromoxynil	0.38
chlorsulfuron + surfactant	0.25 oz. + 0.10% surfactant

\*Varieties tested—Daws, Luke, Stephens

## SOIL FERTILITY MANAGEMENT FIELD TRIALS FOR WHEAT PRODUCTION

Fred Koehler, Marvin Fischer, and Emmett Field

There are 17 field experiments concerning soil fertility management for wheat production in 1982. 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.

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.

## DISPOSAL OF POWER PLANT COAL ASH ON AGRICULTURAL LAND

A. R. Halvorson  
Extension Soil Scientist  
Washington State University

Land is being looked to as a place for disposal of many kinds of waste material. One of these wastes that will be in greater abundance in the future in our area is coal ash. The WSU power plant ends up with about 4,000 tons of coal ash each year. Such a quantity simply can't continuously be shoved back somewhere in a far, unnoticed corner. In a short time it becomes a problem. The quantity of ash produced by the WSU power plant is very small compared with that produced by a usual large coal fired electric power generating plant.

Is disposal of this waste on land a feasible alternative? What about on agricultural land? Are there any benefits—any problems? As is true for most solutions to problems, there are some good points and some bad points. The good points are:

1. It does have some value for neutralizing soil acidity.
2. It does contain some plant nutrients.
3. It may have a slight soil conditioning effect when used on very heavy textured soils (clay types).

Possible problem areas are:

1. May contain a high boron level (easy to over-fertilize with boron).
2. May contain an undesirably high level of heavy metals.
3. The constituents in coal ash vary a great deal, so to be sure of what is added, analysis will need to be made on a continuing basis.

An application of approximately 200 tons of ash per acre was made on a portion of an alfalfa field at the Palouse Conservation Field Station in 1980. This application resulted in an ash layer about 5 inches deep. A spring tooth harrow was used in an attempt to incorporate or mix the ash with the soil. In 1981 the area receiving the ash and the adjoining untreated alfalfa field was cut for hay. The relative yield of the two areas showed that the one treated with ash *and cultivated* with the spring tooth harrow produced about  $\frac{2}{3}$  of the yield of the untreated area. It was surprising that the yield was this good—because of the severe cultivation it received and the high rate of boron applied (at 200 tons of ash per acre). In May of 1982 the alfalfa on the ash treated area appears to be doing very well.

If ash is to be disposed of on agricultural land it will be applied at less than 200 tons per acre. The high rate applied at the Conservation Field Station was done to get an evaluation of what might be the upper limit of rates to apply.

## **RUNOFF AND EROSION PREDICTION AND CONTROL**

**D. K. McCool, K. E. Saxton, G. E. Formanek, and R. I. Papendick**  
**USDA, Agricultural Research**

### **Erosion Prediction**

Efforts continue to improve the regional adaptation of the Universal Soil Loss Equation (USLE). Sufficient data and field experience are now available to replace the first generation adaptation which has been in use since 1974. The major changes are in the rainfall and runoff erosivity and in the slope length and slope steepness factors. A computer-based system for determining crop management factors has also been developed. Factors under study but yet to be altered are those for soil erodibility and conservation practices. Since 1973, many farm owners and operators across Whitman and Latah Counties have allowed erosion measurements to be made on their property so the influence on erosion of climate and topography could be estimated more precisely. During the past winter, several cooperators across eastern Washington and northern Idaho have collected frost depth and air temperature data. These data will prove valuable in determining the extent and severity of soil freezing across the region and subsequent influence on frozen soil runoff. We thank our cooperators for their help in these studies.

### **Effect of Crop Management on Runoff and Erosion**

Runoff plot studies to compare the effect of land treatment on runoff, soil loss, and water quality have been installed on the Palouse Conservation Field Station (PCFS) in cooperation with the Agricultural Engineering and the Agronomy/Soils Departments of WSU and U of I. The studies include such treatments as conventionally seeded annually cropped winter wheat, a winter wheat/summer fallow rotation, no-till winter wheat seeding, no-till winter wheat seeding with vertical slotted mulch, and various rough tillages and standing stubble in preparation for spring crops. The vertical mulch is a new technique being tested to maintain water infiltration even under frozen ground conditions. Most of the studies were started in the fall of 1976. Since the 1976-77 runoff season, there has been only one severe runoff and erosion season at this location. That year, 1978-79, involved runoff on thawing soil. There was little difference in runoff from the various treatments (other than the slot-mulch). Winter wheat after summer fallow lost 11.6 tons per acre while conventionally seeded winter wheat after small grain lost only 2.4 tons per acre. In the less severe years since 1976-77, only the winter wheat after summer fallow produced significant amounts of runoff and soil loss.

The results from these plots and other limited studies indicate frozen and thawing soil is involved in 40 to 60 percent of the annual erosion depending upon location and crop management. More intensively tilled cropland will experience runoff and erosion from early fall to late spring, but conservation tilled cropland will experience runoff almost exclusively from only the most severe weather condition—rain on frozen soil. When runoff does occur from such conservation tilled cropland, erosion will be much less than from the intensively tilled treatments.

## PLANT SPECIES FOR DRY LAND CONSERVATION EFFORTS

Clarence A. Kelley, Manager  
Pullman Plant Materials Center  
Soil Conservation Service, USDA

A current high priority objective for the Pullman Plant Materials Center is to develop plants for wind and water erosion and deteriorated rangeland in the dry land regions of Central & Eastern Washington and Oregon. Particularly emphasized is the need for plants on coarse-textured soils in annual precipitation zones under 30.48 cm. (12").

Beginning in 1976 the PMC has been conducting a series of evaluation plantings at the Lind Dry Land Research Unit and the Plant Introduction Research Unit near Central Ferry, Washington. The primary purpose of these plantings was to compare several newer plant selections of grasses with Nordan crested wheatgrass, *Agropyron desertorum*. Nordan is generally considered the standard seeding recommendation for those areas under 12" annual rainfall.

Beginning in the fall of 1977 plantings were made for three consecutive years at both locations in the spring and fall each year. Establishment methods included greenhouse transplants (containerized plants), drilled seed and broadcast seeds. Species used to compare with Nordan were sheep fescue, canby bluegrass, bluebunch wheatgrass and thickspike wheatgrass.

As a result of these plantings, and previous evaluation, three new grasses are now on the market. Secar, bluebunch, wheatgrass, *Agropyron spicatum*; Covar, sheep fescue, *Festuca ovina*; and Canbar, canby bluegrass, *Poa canbyi*.

Secar, collected from a native stand on the 'old' Lewiston grade in Idaho, has the greatest overall potential for drought tolerance having been tested on sites with only 8" annual rainfall.

Nearly all of the fall and spring plantings at both stations are considered successful. Secar, bluebunch wheatgrass, *Agropyron spicatum*, and a selection of thickspike wheatgrass, *Agropyron dasystachyum*, are performing with excellence demonstrating good ground cover and erosion control potential.

Generally, the plantings at Central Ferry are better than those at Lind. This is believed primarily due to heavier textured soils, better seedbeds, and additional rainfall during the testing period.

Some other species with drought tolerant potential currently being tested by the Center include:

Thickspike wheatgrass, *Agropyron dasystachyum*  
Needle & thread grass, *Stipa comata*  
Sand dropseed, *Sporobolus cryptandrus*  
Siberian wheatgrass, *Agropyron sibericum*  
Fourwing saltbush, *Atriplex canescens*  
Winterfat, *Ceratoides lanata*  
Snow buckwheat, *Eriogonum niveum*

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

F. J. Muehlbauer, J. L. Coker, and R. W. Short  
USDA, Agricultural Research

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 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. The need for a small-sieve variety resistant to *Fusarium* wilt race 1 was apparent in 1973 when it was shown that many small-sieve strains were susceptible. The release of Tracer should fill this need and also offer needed yield improvement.

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. Three of the dry pea types are now in seed increase and should provide an excellent means of preventing new outbreaks of the virus.

WA610860 is a yellow pea selection that is earlier to bloom and mature than Latah and has comparable yield potential. This selection may be offered for release in 1982 pending results of 1981 yield tests.

It has been known for some time that pea seedborne mosaic virus will also attack lentils and is seedborne in that crop. Immunity to the virus was identified in the Plant Introduction collection, and is inherited as a single gene recessive. Incorporation of the resistance into commercial lentils is underway.

Preliminary selections are screened for resistance to powdery mildew at Pullman. Natural infections obtained by planting late in May have reached epidemic proportions at about bloom. Lines showing resistance to mildew are increased and evaluated for agronomic characteristics, especially yield, and are used as parental material.

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 1981 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.

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:* 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 slightly larger seeded. The line was recently approved for release, with the tentative name of 'Brewer,' 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 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. Promising lines being tested include the unifoliate types (CP258, Surutato 77) and the more common types (U-5, Mission, and ILC517).

## 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	<u>15</u>	<u>120</u>	<u>71</u>	<u>35</u>
	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.

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### Farmer Cooperators

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Robert Kramer  
 Quetin Landreth  
 Lehn Brothers  
 Lee Maguire  
 Jack McCaw  
 Kenneth McIntoch  
 Carl and Mac Mielke  
 Woodrow and Mac Mills  
 Lester Moos  
 Gary Morris  
 Stephen Naught  
 Henry Niehenka  
 John Oaks  
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 Wilbur  
 Colfax  
 Wilbur  
 Pullman  
 Dusty  
 Colfax  
 Gifford, ID  
 Pomeroy  
 Coulee City  
 Dayton  
 Ferdinand, ID  
 Colfax  
 Waterville  
 Moses Lake  
 Ritzville  
 Reardan

**Fertility, Tillage and Management**

Lynn Ausman	Asotin	Keith Mader	Palouse
Harold Boyd	Pullman	McGregor Ranch	Hooper
Arnold Clausen	Spangle	Ted McMillan	Cheney
Dan Dorman	Lacrosse	Don Moore	Dusty
Dry Land Research Unit	Lind	Don Ogle	Waterville
Roger Dye	Pomeroy	Kenneth Parks	Fairfield
Elmer Easton	Harrington	Tom Petty	Asotin
Gayle Gering	Ritzville	Glen and Chris Ramsey	Freeman
Gale Gfeller	Lind	Ralph Reifenberger	Fairfield
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Tom Hyslop	Espanola	Carroll Schultheis	Colton
Bill Iverson and Sons	Odessa	Harold Schultheis	Colton
William Jacky	Reardan	Leigh Schultheis	Uniontown
Maynard James	Wilson Creek	Tom Schultz	Reardan
Donald Lambert	Cheney	Larry Vincent	Gifford, ID

**Weed Control Experiments**

Asotin Co.	Clarkston	Larry Meliah	Walla Walla
Bud Benedict	Asotin	Bill Schwerin	Walla Walla
Harold Boyd	Pullman	Lee Shuithies	Uniontown
Meril Boyd	Pullman	State Highway Dept.	Washtucna
Doug Bruce	Farmington	Morton Swanson	Palouse
Norman Cavadini	Mansfield	Ben Stueckle	Colfax
Harold Cochran	Prescott	Jim Tetrick	Pomeroy
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Francis Fitzgerald	Clarkston	USDA Conservation Farm	Pullman
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McGregor Co.	Whitman Co. Wheat Growers
Nitagen Company	WilFac Inc.
Palouse Conservation District	

## LISTING OF COOPERATIVE PERSONNEL AND AREA OF ACTIVITY

Glenn Terrell.....President, Washington State University  
 C. A. Pettibone.....Acting Dean, College of Agriculture  
 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

R. E. Allan, J. A. Pritchett, L. M. Little,  
 USDA, Pullman.....Wheat Genetics  
 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. Cihra, H. Murray, 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

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

### Cereal Diseases

G. W. Bruehl, S. D. Wyatt, Pullman.....Cereal Viruses, Foot Rots and Other Diseases  
 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

F. J. Muehlbauer, USDA, Pullman  
 J. L. Coker, USDA, Pullman  
 R. Short, USDA, Pullman

### Weed Control

L. A. Morrow, USDA, Pullman  
 D. G. Swan, Pullman  
 H. H. Cheng, Pullman  
 T. L. Nagle, Pullman  
 F. L. Young, Pullman

### USDA Plant Material Center

Claurence Kelley, Manager

### Fertility and Management

A. R. Halvorson, Pullman  
 F. E. Koehler, Pullman  
 M. Fischer, Pullman  
 R. I. Papendick, USDA, Pullman  
 V. L. Cochran, USDA, Pullman  
 E. T. Field, Pullman  
 C. F. Engle, Pullman  
 L. F. Elliott, USDA, Pullman  
 D. McCool, USDA, Pullman  
 K. Saxton, USDA, Pullman

### Cereal Crop Seed Increase

J. D. Maguire, Pullman  
 T. D. Wagner, Pullman

### Spillman Farm Manager

Ray Nelson

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