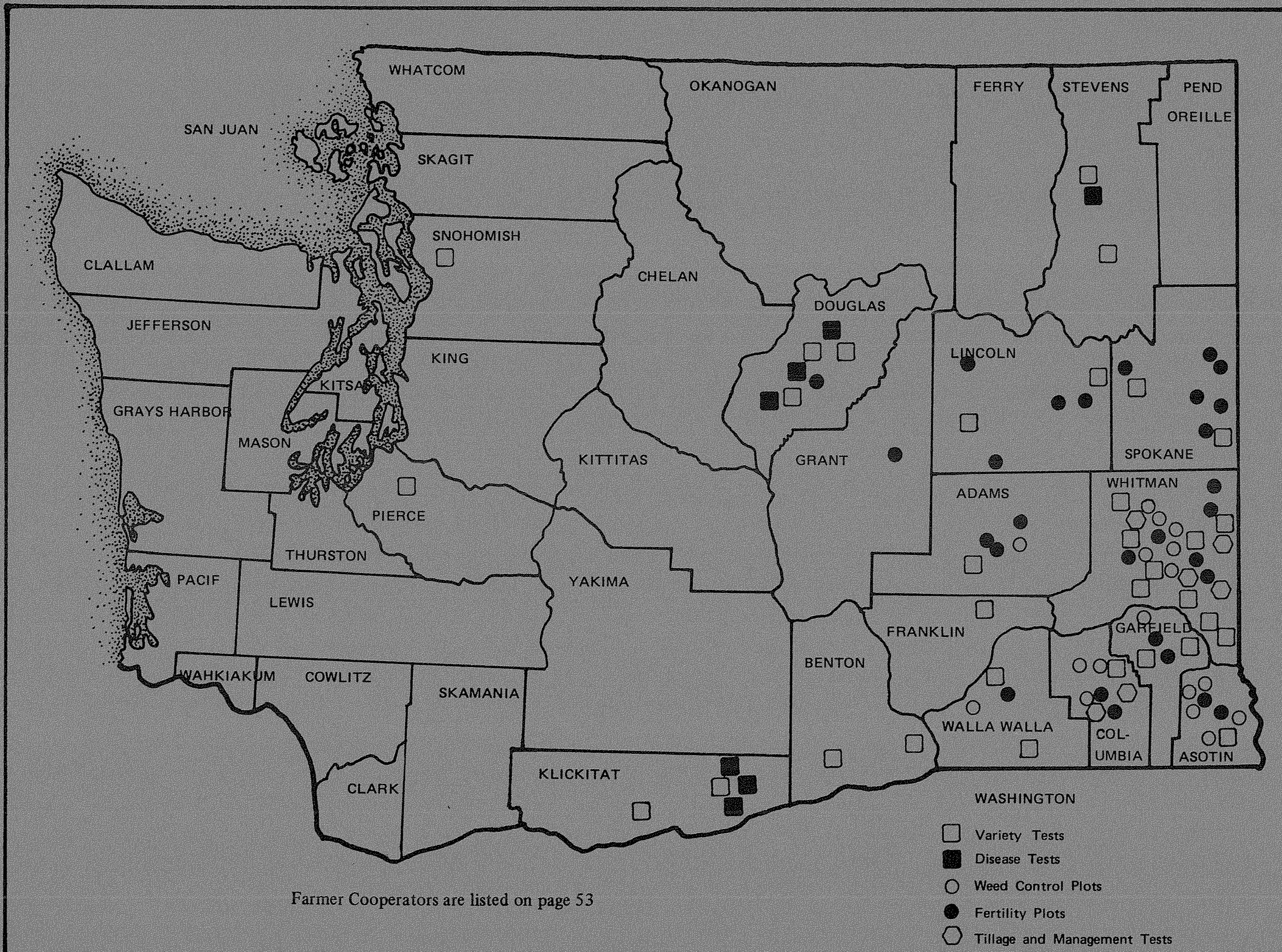
WSU FIELD DAYS

June 22, 1978
Dry Land Research Unit, Lind

June 28, 1978
Palouse Conservation Station
Field Day, Pullman

July 6, 1978
Spillman Farm, Pullman



Farmer Cooperators are listed on page 53

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 residence and machine storage built shortly after the station was established. The old barn was dismantled in April 1973. A small elevator was constructed in 1937 for grain storage. A modern office and attached greenhouse were built in 1949 after the old office quarters were burned. In 1960 a 40' x 80' metal shop was constructed with WSU general building funds. In 1964 an addition to the greenhouse was built with a Washington Wheat Commission 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 61st field day. Visitors are welcome at any time. Their suggestions are appreciated.

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 was 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. 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.

George Varner, was appointed farm manager in 1974.

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 summer fallow and crop years.

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

Month	Temperature °F.		Precipitation		Precipitation
	Max.	Min.	1977	1978	57 yrs. av. (in)
January	34	22	.21	1.15	1.03
February	42	24	.22	1.01	.87
March	53	32	.75	.58	.73
April	63	35	.08	1.62	.63
May	72	42	.70		.75
June	83	45	.48		.89
July	90	52	.06		.24
August	90	50	1.19		.34
September	79	45	1.60		.54
October	65	38	.18		.87
November	47	29	.82		1.21
December	37	26	2.28		1.29
			8.57		9.39

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.

HARD RED WINTER WHEAT BREEDING AND TESTING

E. Donaldson, M. Nagamitsu, Jerry Knodel

The Hard Red Winter Wheat Breeding and Testing programs in Washington are conducted from the Dry Land Research Unit at Lind. Primary emphasis is placed on increasing yields of winter wheats for the 8 to 12 inch rainfall areas by combining the higher yield potential of the soft white winter wheats with the better yielding hard red varieties and selections. Crosses are also made to incorporate the desired quality, disease resistance, rapid emergence, winterhardiness and agronomic traits into single lines. Every attempt is 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.

Selections On Increase For Possible Release:

WA 6364 and WA 6365 are hard red winter wheats with grain yields 10% better than Wanser. They have adult resistance to the stripe rust races presently found in the Pacific Northwest. They are white chaffed, stiff strawed and taller than Wanser with a plant and head type similar to Wanser. Emergence and growth habit appear to be similar to Wanser. Their weaknesses include a lack of adequate resistance to common bunt and the foot rots. WA 6365 appears to be better adapted to higher yield potential environment than WA 6364.

Disease Nurseries:

Cercosporella Foot Rot: (1976-77) Ten lines yielded better than Cerco in the inoculated preliminary trial under irrigation at Lind. Two of these lines yielded competitively under dry land. All are being tested under irrigation with *Cercosporella* inoculation and under dry land conditions. In addition about 50 lines selected from single rows are being yield tested this year. Bulks and head rows from crosses having one resistant parent are seeded in the inoculated area.

Stripe Rust:

A nursery containing two replications of single rows of all entries in the yield trials is planted under sprinkler irrigation. This trial is not inoculated. Last year stripe rust moved into the nursery late and was so spotty that no valuable data could be obtained.

Snowmold:

For the second year in a row no snow mold was present in the Waterville nursery.

Common Bunt:

A nursery containing two replications of single rows of all entries in the yield trials is inoculated with a composite of races and planted in November. Last year, several preliminary selections of hard red winter wheats showed fair to good resistance. Since one of the adapted hard red varieties used as parents show resistance, the identification of these lines represents progress in our efforts to combine the resistance in the white wheats and snowmold parents into better adapted red selections.

Some agronomic characteristics of recommended varieties and the older varieties they replace are given for six locations in eastern Washington in Table 2, Lind; 3, Horse Heaven Hills; 4, Connell; 5, Finley; 6, Waterville; and 7, Harrington. These data are from rod row nurseries. Data from these and other trials in eastern Washington are used to make variety recommendations. Variety recommendations for the different rainfall areas are included in this brochure in the section by Dr. Kenneth Morrison.

Table 2. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries, 1952-77.

Variety	Av. Plant ht.	Av. Test wt.	1977 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	26	61.8	22.1	38.1	126	13
Luke	24	60.5	20.9	34.0	123	9
Sprague	26	60.9	22.8	33.0	123	7
Daws	29	59.7	18.3	34.5	120	4
Moro	30	59.0	25.6	36.7	119	14
Paha	27	60.2	22.7	37.9	130	11
Faro	28	58.1	21.2	39.6	110	4
WA 6155	28	59.4	20.3	36.6	102	3
Wanser	31	61.9	22.5	34.9	113	14
McCall	30	62.1	25.6	37.2	118	13
WA 6364	28	63.2	25.8	30.3	129	2
WA 6365	28	62.0	25.3	29.7	127	2
Kharkof	32	60.5	20.7	29.9	100	23

Table 3. Summary of agronomic characteristics of winter wheat varieties grown in the Horse Heaven Hills in rod row nurseries, 1951-77.

Variety	Av. Test wt.	1977 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	60.2	3.3	20.0	124	7
Luke	59.8	*	21.8	118	6
Sprague	60.4	3.0	18.7	120	5
Moro	57.5	3.3	18.5	120	9
Paha	59.0	3.6	19.0	118	7
Wanser	60.4	3.2	19.0	120	10
McCall	60.9	3.0	18.6	117	10
Kharkof	60.1	2.7	17.4	100	17

*Not grown

Table 4. Summary of agronomic characteristics of winter wheat varieties grown at Connell in rod row nurseries, 1975-77.

Variety	Av. Test wt.	1977 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	62.3	17.9	34.7	107	3
Luke	61.6	*	43.7	112	2
Sprague	61.7	19.2	35.3	108	3
Moro	59.0	21.1	40.5	124	3
Paha	60.7	20.0	39.0	120	3
Wanser	62.5	20.6	35.0	107	3
McCall	62.9	22.9	35.8	110	3
Kharkof	61.2	19.4	32.5	100	3

*Not grown

Table 5. Summary of agronomic characteristics of winter wheat varieties grown at Finley in rod row nurseries, 1975-77.

Variety	Av. Test wt.	1977 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	63.4	15.6	32.5	111	3
Luke	62.3	*	44.8	124	2
Sprague	62.5	22.0	34.8	119	3
Moro	60.5	26.4	40.7	138	3
Paha	61.8	19.9	39.2	133	3
Wanser	63.6	18.9	30.7	105	3
McCall	63.8	22.6	31.5	107	3
Kharkof	62.0	16.1	29.4	100	3

*Not grown

Table 6. Summary of agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries, 1952-77.

Variety	Av. Test wt.	1977 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	62.3	54.2	46.1	125	10
Luke	61.3	57.5	49.0	142	7
Sprague	60.8	40.0	41.8	127	5
Moro	59.3	49.0	44.8	122	10
Paha	60.8	52.9	47.5	135	8
Wanser	62.1	47.8	41.3	113	11
McCall	62.2	45.4	42.7	116	10
Kharkof	61.2	36.3	34.6	100	20

Table 7. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row nurseries, 1952-77.

Variety	Av. Test wt.	1977 Yield bu/a	Av. Yield bu/a	Yield % Kharkof	No. years grown
Nugaines	62.0	20.7	39.5	135	12
Luke	61.0	27.6	40.4	142	9
Sprague	61.4	21.3	42.8	140	7
Daws	60.8	21.7	39.3	128	4
Moro	59.4	20.2	38.1	130	12
Paha	60.7	16.1	39.9	141	10
Barbee	58.9	*	44.4	135	5
WA 6155	59.2	21.1	42.3	144	3
Wanser	62.4	26.2	38.1	132	11
McCall	62.8	30.3	41.0	143	11
Kharkof	61.3	19.1	34.0	100	24

*Not grown

RECOMMENDED VARIETIES - WHEAT, OATS, BARLEY

AREA	WINTER WHEAT	SPRING WHEAT	OATS	SPRING BARLEY	WINTER BARLEY
EASTERN WASHINGTON					
14 Inches or More Rainfall	Nugaines Luke Paha Hyslop McDermid Daws Barbee Stephens Faro	Fielder Urquie	Cayuse Park Appaloosa	Steptoe Unitan Larker - malting barley Belford - for hay only Vanguard - malting barley Blazer - malting barley	Kamiak Boyer
EASTERN WASHINGTON					
Less Than 14 Inches Rainfall	Wanser McCall Moro Paha Nugaines Sprague Barbee Faro	Sawtell Wampum Wared Twin		Steptoe	
CENTRAL WASHINGTON					
Under Irrigation	Nugaines Hyslop Daws Stephens Wampum Wandell (Durum)	Fielder Urquie Sawtell Wared	Cayuse Park Appaloosa	Steptoe Vale 70 Belford - for hay only	Boyer
Snow Mold Areas	Sprague				

WHEAT, OATS, AND BARLEY

Dr. Kenneth J. Morrison
Extension Agronomist
Washington State University

Winter Wheat

Nugaines

Nugaines is a soft white semi-dwarf 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 the hard red winter wheats McCall or Wanser but is hardier than Luke and Paha.

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

Nugaines is resistant to most races of common bunt, and has moderate resistance to flag smut. Nugaines was developed by SEA-USDA and Washington State University.

Luke

Luke is a soft white semi-dwarf 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 *Cercosporella* foot rot, snow mold, and stripe rust.

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 is susceptible to leaf rust and flag smut. It emerges well for a semi-dwarf. Luke was developed by SEA-USDA and Washington State University.

Daws

Daws is a soft white common semi-dwarf 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.

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

McDermid

McDermid is a semi-dwarf 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. The variety is resistant to stripe rust and leaf rust, and intermediate in reaction to mildew and *Septoria.* McDermid has shown a slightly lower yield than Nugaines in yield trials in Washington. The variety has performed the best in the north-central areas of Oregon and southern areas of Washington. It is susceptible to *Cephlosporium* stripe.

McDermid was developed by Oregon State University.

Hyslop

Hyslop is a soft white semi-dwarf winter wheat that yields well in high rainfall areas or with irrigation. Hyslop has a slightly better yield record than Nugaines where winterkilling 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, and Nugaines.

Hyslop is resistant to common bunt, stripe and leaf rusts, moderately resistant to mildew, and susceptible to flag smut.

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 from white to gray-brown and the heads are small and awned. It has high tillering capacity from early seedings, 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 rust, leaf rust, and *Cercosporella* foot rot.

It has excellent emergence and adequate winterhardiness.

Sprague was developed by SEA-USDA and Washington State University.

Barbee

Barbee is a semi-dwarf 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. 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 SEA-USDA and Washington State University.

Paha

Paha is a short, standard height, white club wheat variety. It is susceptible to some races of stripe rust, leaf rust, powdery mildew, and flag smut. It has moderate resistance to *Cercosporella* foot rot. 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 wheat desired by domestic and foreign markets.

Moro

Moro is a soft white club winter wheat with brown chaff.

Its chief advantages are resistance to stripe rust and excellent emergence.

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 a good pastry flour; however, it has a higher flour viscosity than older club varieties.

Moro is a medium-tall club variety with white kernels. Moro does not have the high yield potential of Nugaines 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 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; 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 is highly resistant to flag smut.

Wanser is recommended for the southern half of the Big Bend. Its 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 this area. McCall recovers rapidly in the spring which is another advantage for the northern area.

McCall has good winterhardiness, though less than Wanser. Both Wanser and McCall are more winterhardy than Nugaines or the club wheats.

Wanser and McCall are shatter resistant.

Wanser mills somewhat better than McCall. McCall has slightly better bread-baking quality than Wanser. Neither is suitable for production of soft white wheat products.

Wanser and McCall were developed by Washington State University and SEA-USDA.

Spring Wheats

Urquie

Urquie is a semi-dwarf soft white spring wheat developed by Washington State University and SEA-USDA.

Urquie is intended as a replacement for Marfed, which it is similar to in dual purpose baking properties but distinctly superior to in milling yield, and generally superior to Marfed in grain yield, test weight, and other features. Urquie is also more lodging resistant than Marfed and has distinctly superior cold tolerance, such that it is expected to serve as a facultative winter and spring wheat in areas with milder winter conditions. The test weight of Urquie is equal to that of Fielder and Marfed, and superior to that of Twin. Urquie is expected to yield competitively with Fielder and Twin, especially in the dryland areas of Washington. Urquie is resistant to many prevalent races of stripe rust but is susceptible to leaf rust and has moderate susceptibility to mildew.

Fielder

Fielder is a soft white spring wheat developed by SEA-USDA and the Idaho Branch Experiment Station at Aberdeen, Idaho. Fielder is a semi-dwarf, stiff-strawed, white-chaffed, awned variety with moderate resistance to leaf rust, moderate resistance to prevalent races of stripe rust, but 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 Marfed.

Fielder has only pastry quality, but has milling properties superior to Marfed.

Walladay

Walladay is a soft white facultative spring wheat proposed for release by Washington Agricultural Research Center and the SEA-USDA. Walladay heads from very late spring plantings at Pullman, while showing high winter survival from fall plantings. Facultative wheats can be seeded in the spring or fall. Walladay is similar in general appearance to its Luke parent.

The variety has produced high yields from both spring and fall plantings. The winterhardiness of Walladay is adequate for areas in southeast Washington but probably is not equal to that of standard winter wheats in areas or seasons with severe winters.

Walladay is medium height, semi-dwarf, white-chaffed, with stiff white straw. It is a bearded variety with soft to semi-soft kernels. The straw height averages about two or three inches shorter than Urquie and Fielder under higher rainfall conditions. Walladay is resistant to stripe rust in the adult stages but susceptible in the seedling stage. Its leaf rust resistance is superior to Fielder and Urquie. It is less dwarf bunt resistant than Luke. It is susceptible to stem rust and mildew.

Wared

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

Wampum

Wampum is a hard red spring wheat. The straw is standard or tall but is lodging resistant. Yields are slightly higher than Wared. It is resistant to leaf and stripe rust.

Wampum has excellent milling and baking properties for bread.

Wampum was developed by Washington State University and SEA-USDA.

Sawtell

Sawtell is a semi-dwarf hard red spring wheat developed by the SEA-USDA at the Aberdeen, Idaho, station and was released in 1977 jointly by Idaho, Oregon, and Washington. In Washington, Sawtell has shown higher yield potential under low rainfall conditions than other hard red spring wheats. 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 a grain of about 1 percent lower protein than other hard red spring varieties. Sawtell carries moderate resistance to stripe and leaf rusts and is moderately susceptible to mildew. In 1976, Sawtell was moderately susceptible to stripe rust at Pullman.

Durum

Wandell

Wandell is a durum wheat developed by Washington State University for use under irrigation in the Columbia Basin and irrigated areas. Wandell is a semi-dwarf, spring, late-maturing, amber durum variety. It is resistant to mildew, stripe rust, and is very lodging resistant. It has light tan chaff and awns.

The original cross was made at the North Dakota Agricultural Experiment Station and additional selections made from that cross at Washington State University.

Wandell or other durum wheat varieties should not be growing where mixtures with other varieties may occur.

Spring Barley

Steptoe

Steptoe is a six-row, rough-awned, spring feed barley with a higher yield record than Unitan or Gem. The test weight is higher than Gem and about equal to Unitan. Steptoe heads about the same time as Unitan and about five days later than Gem. The variety has stiff straw with better lodging resistance than either Gem or Unitan. The straw is about the same height as Gem but 3 to 4 inches shorter than Unitan. The heads are erect with rough awns; the seed and the kernels are the same size as Gem, but slightly larger than Unitan. Steptoe is recommended to replace Gem and Unitan. The variety is not acceptable for malting.

Steptoe was developed by Washington State University.

Blazer

Blazer, a six-row malting-type barley with rough awns, was developed at Washington State University.

Blazer is expected to replace Traill and Larker, midwest malting barleys presently grown in Washington, Oregon, and Idaho.

Blazer produces higher yields than Traill and Larker and has greater resistance to shattering and lodging.

Blazer yields in eastern Washington have averaged 500 to 700 pounds higher than Traill and Larker.

Test weight of Blazer is slightly lower than Traill or Larker, but plump kernel percent is about the same as Traill.

The variety was developed by Washington State University.

Vanguard

Vanguard is a two-row malting barley recommended to replace Piroline. The variety has a 250-pound-per-acre higher yield record than Piroline. It has better lodging resistance. Vanguard matures about the same as Piroline and is the same height. It is a two-row, spring barley with rough awns. The seed size is slightly smaller than Piroline. The variety was developed at Washington State University.

Klages

Klages is a two-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 Vanguard but the malting quality exceeds Vanguard and Piroline.

Klages was developed by the University of Idaho.

Larker

Larker is a white-kerneled, semi-smooth-awned, six-row malting barley. It has moderate resistance to lodging, is high in test weight, and is about equal to Traill in height. Larker yields have averaged above Traill. It heads 2 or 3 days 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.

Karl

Karl is a mid-season, white-kerneled, Traill-type malting barley with rough awns. The variety was developed by SEA-USDA and the University of Idaho. It averages about 8 percent higher than Traill in yield. Karl is usually 3 to 4 inches shorter and normally heads two days earlier than Traill. It has good test weight and kernel weight. It is slightly superior to Traill 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.

Belford

Belford is a six-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 only in eastern Washington high rainfall areas and in central Washington under irrigation.

Winter Barley

Luther

Luther is a mutant selection derived from treating seed of Alpine with diethyl sulfate. Luther has a higher yield record than Alpine or White Winter. It is more lodging resistant than these two varieties because Luther is 5 to 7 inches shorter. Tests indicate that this short-strawed mutant responds to fertilizer in most locations and can be fertilized with a minimum of lodging. Luther is more winterhardy than Alpine and considerably more winterhardy than White Winter.

Luther is a feed barley developed by Washington State University and is not acceptable to the malting industry.

Kamiak

Kamiak is a winter barley developed by Washington State University similar to Hudson in appearance. It has produced higher average yields than Hudson. It is about equal to Luther in most locations. Kamiak is equal to Hudson in winterhardiness with slightly larger kernel size than either Hudson or Luther. It is more lodging resistant than Hudson with shorter straw, but it is slightly taller than Luther. The test weight of Kamiak is higher than Luther, but slightly lower than Hudson. The variety matures about the same as Hudson but is at least ten days earlier than Luther. Kamiak does not have small, glume hairs which cause "itching" during the threshing of Luther.

Kamiak performs well in eastern Washington where Hudson was being grown.

Boyer

Boyer is a winter barley developed at Washington State University. It is a six-row, white-chaffed variety with rough beards but it does not have the severe "itching" characteristics of other winter varieties such as Luther.

The high yielding, relatively short, stiff-strawed barley has a higher yield than Kamiak or Luther. Boyer is slightly more winterhardy than Luther and about equal to 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. The seed of Boyer was available in 1976 for commercial production.

Oats

Cayuse

Cayuse is a high yielding, moderately early spring oat recommended in Washington. Cayuse was developed at Washington State University from selections 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 compared with 37 for Park.

Cayuse has fair tolerance to the most serious oat disease in Washington—yellow dwarf 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 in any Washington locations since testing began in 1959.

Although Cayuse is susceptible to node blackening and stem break, in the eastern part of the United States, these diseases do not affect oat yields in Washington.

Park

Park is an attractive, stiff-strawed, high yielding spring oat with plump, short, white kernels. It can be distinguished from most other oat varieties by its upright leaves, which are dark green in color. Park is a mid-season oat and is medium high. It rarely grows over 42 inches in height under irrigation. The heads are medium-short and erect. Park has yielded about the same as Cody or Shasta. Park is recommended to replace Cody because it has more uniform straw height and kernel size. Park can be grown in eastern Washington in areas with 14 or more inches of rainfall or on irrigated land in central Washington and in western Washington.

Appaloosa

Appaloosa is a yellow-gray spring oat released by the Washington Agricultural Research Center. Appaloosa has a higher yield record compared with Cayuse but a slightly lower average test weight. The variety is a mid-season spring oat with straw one to two inches shorter than Cayuse. It is more resistant to lodging. The groat and percent protein of Appaloosa are similar to Cayuse. Because of its greater barley yellow dwarf tolerance, Appaloosa is expected to replace the varieties Cayuse and Park for hay and grain production.

SOFT WHITE WINTER WHEAT IMPROVEMENT
USDA, Science and Education Administration

Clarence Peterson, Dave Henderson, Steve Hayward, and Mary Robocker

Washington produced 101,305,000 bushels of wheat in 1977 on 2,985,000 acres for a 33.9 bushel per acre average. This is below the ten year average of 42.5 (1964-73) bushels per acre. Grain yields and bushel weights were drastically reduced because the area received about 50% of its average precipitation. The yields were hurt the most on recrop. Plant diseases were a minor problem but some damage was caused by insects. Green bugs and oat-bird cherry aphids were numerous during the fall of 1976 in early-seeded fields. Hessian fly was reported to have caused some damage in irrigated fields from Pasco to Yakima. Two virus diseases, yellow dwarf and wheat streak mosaic reduced the production of a few fields. Mildew was very prevalent during the early spring. A sulfur deficiency was noted in 1977 in many of the winter wheat fields early in the spring.

Objectives

The goal of the USDA wheat breeding program is the development of high-yielding, excellent quality, disease resistant soft white winter wheats for efficient and consistent production in the Pacific Northwest. Considerable effort is devoted to the development of wheats for early seeding and wheats adapted for production under minimum and no-till management systems.

New Varieties

Daws, CI 17619, is a soft white common semidwarf winter wheat that is superior to Nugaines in winterhardiness. It is resistant to stripe rust and common bunt. Daws is moderately resistant to flag smut and *Cephlosporium* stripe. It is susceptible to leaf rust, snow mold, dwarf bunt and *Cercosporella* foot rot. Daws emerges slower than Nugaines. The grain yield of Daws (see Table 1) is equal to or slightly higher than that of Nugaines. The milling and flour qualities of Daws are similar to those of Nugaines. Daws is recommended for production in Idaho, Oregon, and Washington.

Stephens, CI 17569, is a soft white common semidwarf winter wheat that is resistant to the local races of stripe rust and common bunt. It is susceptible to leaf rust, flag smut, dwarf bunt, snow mold and *Cephlosporium* stripe. Emergence characteristics of Stephens are similar to those of Nugaines. The grain yield of Stephens (see Table 1) is equal to or slightly higher than that of Nugaines and Hyslop. The milling and flour characteristics of Stephens are similar to those of Nugaines. Stephens is recommended for production in Idaho, Oregon, and Washington.

Faro, CI 17590, is a soft white club semidwarf winter wheat that is resistant to stripe rust and common bunt. It is moderately resistant to *Cercosporella* foot rot and *Cephlosporium* stripe. Faro is susceptible to flag smut, dwarf bunt, leaf rust, and snow mold. It has slightly exceeded the grain yield of Paha (see Table 1). Faro is similar to Paha in winterhardiness, milling and flour quality. It is recommended for production in Oregon and Washington in the areas where Paha is being grown.

Barbee, CI 17417 is a soft white semidwarf club that is resistant to the local races of stripe rust, flag smut, and common bunt. It is moderately resistant to dwarf bunt, *Cephlosporium* stripe and *Cercosporella* foot rot. Barbee is susceptible to leaf rust and snow mold. It emerges slower than Paha. Grain yield of Barbee is equal to or slightly better than that of Paha (see Table 1). The milling characteristics of Barbee are similar to those of Nugaines. The flour qualities of Barbee are similar to those of Paha. Barbee is recommended for production in Idaho and Washington.

New Promising Selections

WA 6155, is a soft white club semidwarf winter wheat that has adult resistance to stripe rust. It is moderately resistant to common bunt, *Cephlosporium* stripe, and *Cercosporella* foot rot. WA 6155 is susceptible to flag smut, dwarf bunt, leaf rust and snow mold. Grain yield of WA 6155 has been slightly higher than that of Paha (see Table 1). Its milling and flour qualities are similar to those of Paha. WA 6155 is on increase for possible release.

WA 6242, is a soft white common semidwarf winter wheat that has resistance to stripe rust, common bunt, and dwarf bunt. It is moderately resistant to flag smut, leaf rust and *Cephlosporium* stripe. It is susceptible to snow mold and *Cercosporella* foot rot. It is also susceptible to lodging under high production. Grain yield of WA 6242 is generally slightly higher than that of Nugaines and Daws (see Table 1). Its milling and flour qualities are similar to those of Nugaines. WA 6242 is on increase for possible release.

Triticales

The triticale 6TA476 continues to perform very well and has equalled the yield of the spring wheat Fielder (see Table 2). It is a medium tall triticale and has about a 48 lb. per bushel test weight. A new selection VT75229 looks very promising and has competed very well with 6TA476 (see Table 3). It is a spring triticale that has winterhardiness similar to the spring wheat, Urquie.

Table 1. 1976-77 yield data (bushels per acre) on soft white winter wheats grown at 5 locations in Washington.

	Pullman	Pomeroy	Walla Walla	Clyde	Lamont	Average
Nugaines	83	55	61	31	66	59
Hyslop	88	53	63	31	55	58
McDermid	83	57	58	33	57	58
Stephens	89	64	56	30	52	58
Daws	84	59	57	36	60	59
Luke	89	56	66	32	64	61
WA6242	90	57	64	34	64	62
Paha	72	51	62	27	56	54
Barbee	77	52	54	26	54	53
Faro	77	56	65	32	65	59
WA6155	83	56	66	22	60	57

Table 2. Average yields (bushels/a) of Fielder spring wheat and 6TA476 triticale grown in Washington for 4 years at a number of locations.

	1974	1975	1976	1977	Average
Fielder	39	47	44	46	43
6TA476	44	46	48	42	45
No. of Locations	14	8	14	16	52

Table 3. Yield (bushels/a) of 2 winter wheats and 2 triticales at Pullman, Wash. for two years.

	1975-76	1976-77	Average
Luke	70	90	80
Daws	83	87	85
6TA476	91	86	89
VT75229	93	93	93

WINTERHARDINESS

Donald W. George, Beverly Hunter, and James Eldridge

The mild 1977-78 winter produced no injury of winter wheat varieties either at Pullman or in the two plantings at Central Ferry where even spring barley was uninjured. Several crown freeze tests were run, identifying the least cold hardy experimental lines, but without clearly distinguishing among levels of the most hardy lines. The newer entries from the breeding program appear to be acceptable.

A uniform low level of barley yellow dwarf (BYD) infection appeared to be present throughout the early-seeded nursery, making those plants unreliable for freeze testings. The later-planted nursery did not show BYD symptoms but grew slowly, resulting in smaller than optimum plants for testing. Fall growth in the Pullman nursery was much slower than usual, with plants reaching only the 2- to 3-tiller stage and too small for reliable testing.

Much valuable phenological data were obtained; and as a result of increased technical assistance, the data were analyzed in greater detail than has been possible in the past. This will help understand plant development as it relates to planting date and season.

STAND ESTABLISHMENT AND RELATED PROBLEMS

Donald W. George, Beverly Hunter, and James Eldridge

CORRECTION!

I made an incorrect statement in last year's Field Day brochure to the effect that "cool weather during a critical 5-day period [during the soft dough stage] is known to result in low dormacy." The statement should have read "is known to result in *high* dormacy."

Recently-published research shows that there are two periods during grain development in which temperature influences post-harvest dormancy. According to European researchers working with barley, at 12 to 16 days after first head emergence (probably soon after anthesis) low temperature reduces post-harvest dormancy; and later, during the "mealy-ripe" (soft dough) stage of grain development, high temperature reduces dormancy. By inference then high temperature at anthesis and/or low temperature during soft dough will result in increased post-harvest dormancy and possibly in emergence and stand problems. No precise temperature limits have been defined.

Other recent work in Sweden shows that, at least in some lines of rye, very low alpha-amylase activity does not cause a reduction in field emergence ability. If true also in wheat, it may be possible to develop varieties having low alpha-amylase (resistant to head sprouting) which will nevertheless emerge well once the period of post-harvest dormancy has passed.

GENETIC STUDIES ON TOLERANCE TO *CERCOSPORELLA* FOOT ROT

**by R. E. Allan, G. W. Bruehl, J. A. Pritchett
M. A. Patterson, M. L. Robocker**

This year we are fortunate to have an excellent field test for *Cercosporella* foot rot. Other field tests have given us some clues as to what traits relate to tolerance to this serious disease. With few exceptions, late flowering relates to increased tolerance. A difference of as little as two days can significantly influence the amount of yield lost. Short plant height often relates to tolerance to the disease but we have found exceptions. Measuring yield loss is a better indicator of tolerance than are reduced test weight or plant height. When foot rot is present, lodging is almost always a good indicator of lack of tolerance to the disease. In many populations the lines showing the greatest tolerance lack maximum yield capability. This association could be important since it could mean that in order to achieve high tolerance we might have to settle for second best for yield potential. None of these indicators (lodging, flowering date, plant height, test weight) will accurately predict tolerance to foot rot. The best measure is still direct comparison of yields of foot rot infested and foot rot uninfested adjacent plots.

This year we have a test of this type that includes five crosses involving six foot rot tolerant and one foot rot susceptible parent. Indications are that we will get a severe test and by next year we should have a clearer understanding as to whether such tolerant European sources as Svalof 814, Viking, Cappelle, N98, Cerco and Druchamp carry similar or different genes for tolerance. We also have over 2,000 F_3 lines of populations involving locally adapted parents crossed with the highly foot rot tolerant source *Aegilops ventricosa*. This material is planted at Central Ferry. We plan to harvest it early and reseed these lines early in September. As a bonus we had an excellent early spring infestation of stripe rust at Central Ferry which has given us a chance to classify this material for resistance to this disease as well.

MULTILINE WHEATS MAY HAVE A FUTURE IN WASHINGTON TO COMBAT STRIPE RUST

**by R. E. Allan, R. F. Line, J. A. Pritchett,
M. A. Patterson, and M. L. Robocker**

Use of multiline cultivars to combat stripe rust now appears more feasible than ever before. Many of our conventional pure line cultivars have been compromised by new races of stripe rust. Previously resistant wheats that are now attacked by stripe rust biotypes include Moro, Paha, Coulee, Yamhill, Fielder, Fieldwin, Norco, Pitic 62, Produra, and Prodax. The adult resistant forms typical of Nugaines, Hyslop, and Luke have remained effective but other methods of resistance are needed to complement these types. We have collected extensive information on the agronomic performance of a Paha-type multiline over a three-year period. Multiline varieties do not rely on only one form of genetic resistance—rather they are composed of mixtures of plants each of which has a different type of resistance. Although each component of a multiline differs for genetic resistance to stripe rust they are similar agronomically and morphologically. Our Paha-type multiline consists of nine components.

Multilines are used to control crown rust of oats and rusts in South America. They work because they keep the pathogen off balance. If a new virulent race appears, it still can only attack a small portion of the plants that make up the multiline. Because resistant and susceptible plants are intermixed, fewer spores are produced so the spread of rust pathogen is slowed down.

Our major concern has been whether we could get a multiline that could yield competitively with our conventional wheats. We have summarized tests from 18 site/years of tests. At nine of these sites, stripe rust was moderate to severe whereas at the other sites it was either minor or absent. Where stripe rust was less serious the nine component multiline outyielded Paha by about 13%. At the locations where stripe rust was a definite factor the multiline surpassed Paha by 20%. The multiline yielded higher than we would expect based on the mean yield of its nine individual components. It actually exceeded the mean of these lines by 6%.

The multiline also compares favorably in yield to the nine individual components. Among a total of 162 possible comparisons, the multiline had a lower yield on only 16 occasions, it exceeded the individual components 45 times and equalled the component yields 101 times. Our results clearly showed that this Paha type multiline compares favorably in yield to the overall mean yield of its components, to Paha and also shows excellent yield stability and general adaptation to our environmentally diverse growing areas. The individual components had narrow adaptation.

This multiline also proved to have satisfactory test weight. It did lodge somewhat more than the mean of all its components but less so than Paha. Milling and flour tests were also favorable. We think there could definitely be a place for multilines for fall-sown wheat in Washington. They may have broader adaptation and better yield stability than pure line wheats. We probably don't need to adhere to rigid recovery of all of the genetic background of a recurrent type parent such as Paha.

There is definite merit in growing cultivars composed of plants which are not completely alike genetically. Such cultivars are diverse enough in their make-up that they can "roll with the punches" that Mother Nature throws.

EVALUATION OF WHEAT SELECTIONS UNDER NO-TILL CONDITIONS

by R. E. Allan, J. A. Pritchett, M. A. Patterson, and M. L. Robocker

Our initial tests under no-till culture on spring wheat residue showed that club selections were better adapted to this erosion control practice than their lax types. Awnless lines also yielded 7 to 16% more grain than their awned counterparts with no-till. Semidwarf growth habit may not be essential under no-till. Two gene semidwarf isolines showed particularly poor adaptation and standard height types generally produced the highest yields. Omar and Burt backgrounds were generally better adapted to no-till than Brevor and Itana genetic backgrounds.

This year our tests have been expanded to include 120 advanced breeding lines and genetic stocks. These tests have been sown on no-till pea and spring barley stubble. Because of the 1977 drought there was very little residue so differences between the conventional and no-till management systems will probably be minimal this year.

OBSERVATIONS ON THE WINTER DISEASES OF WHEAT AND BARLEY, 1977-1978

G. W. Bruehl

Pythium snow rot killed winter wheats in a test nursery on the Goldmark Ranch. Not only is Sprague susceptible to this disease, but we found no wheats resistant to it. Fortunately for Washington, this disease occurs only under very special winter conditions and it usually involves running water. True snow molds occur under better drained conditions.

Speckled snow mold caused by *Typhula idahoensis* damaged a nursery on the David Peterson Ranch near Mansfield sufficiently to enable us to select promising wheats. This was the first meaningful test in three years. We will test those of promise as quickly as possible in the hope of replacing Sprague with a wheat with better straw.

Typhula incarnata, the mold fungus that often attacks below ground, forming reddish-brown "radish-like" sclerotia under the basal leaf sheaths, killed at least 50% of Kamiak and Luther on the Bob Kramer Ranch near Harrington. We are going to start a program to determine the importance of winter fungi in the survival of winter barley in north central Washington, cooperating with the barley breeders.

CONTROL OF STRIPE RUST AND LEAF RUST

Roland F. Line

Three rusts (stripe rust, leaf rust, and stem rust) occur on wheat in the Pacific Northwest. Stripe rust appears as golden-yellow, long, narrow stripes on the leaf surface and glumes; leaf rust appears as small, red pustules on the leaf surface and leaf sheath; and stem rust appears as larger, red-brown, diamond-shaped pustules on the leaf surface and stems. Stripe rust and leaf rust over winter on wheat and increase during the spring. Stripe rust develops during the cool temperature of early spring. Leaf rust develops slightly later. Stem rust usually appears late in the season and seldom causes damage. Therefore, most research in Washington is on control of stripe rust and leaf rust. The major emphasis is on: (1) monitoring the diseases to determine where they are, what wheats are vulnerable, and the potential importance of new races; (2) identifying and utilizing various types of resistance; (3) evaluating fungicides at various rates and schedules for control of rusts; (4) studying the factors that contribute to rust epidemics; and (5) determining the amount of damage caused by the rusts so that priorities can be determined. The research is conducted at several field sites throughout the region and under controlled conditions in the greenhouse.

The monitoring program involves: (1) planting trap plots, consisting of varieties that differentiate races and varieties with various types of resistance, at sites throughout the region, and (2) collecting rust specimens and testing them on selected wheats under controlled conditions. Races of rust are identified by their ability to attack certain varieties. New races can arise by mutation and thus are able to attack varieties that were previously resistant. In 1974, two new races appeared on wheat in the Pacific Northwest–one on Yamhill in the Skagit Valley, and one on Paha near Walla Walla. In 1975 and 1976, each of the races severely damaged the varieties on which they occurred causing losses as great as 50%. In 1975, a third race appeared on Norco. Consequently, Norco was not released to be grown in the area. In 1976, the Norco race plus at least one new race were found to also attack the spring wheat, Fielder. Since then, several new races have appeared. Because of the dry weather, stripe rust only caused slight losses in 1977. This spring (1978) the weather has been favorable for stripe rust, and it may cause significant losses. At least four races of leaf rust occur in the area. The newest race attacks Norco and Hyslop which have been resistant in the past. Most existing varieties are susceptible to leaf rust.

Research on resistance to stripe rust and leaf rust is being conducted at field sites where the rusts occur and under controlled environmental conditions. Several types of resistance to stripe rust have been identified. Some types are only effective against certain races, such as the resistance of Paha, Moro, and Yamhill. Other types are effective against all races but are affected by temperature and stage of growth. Gaines, Nugaines, Wanser, McCall, Hyslop, McDermid, and Luke all have various degrees of the latter type of resistance, which is referred to as nonspecific resistance. They are completely susceptible in the seedling stage and at later stages when the temperature is low, but are relatively resistant in later stages at high temperatures. The various types of resistance are being incorporated into new varieties. A similar project on evaluation of wheats for resistance to leaf rust has been initiated and several types of resistance have already been identified.

As part of the research program we are evaluating fungicides at various rates and schedules at several locations. Some systemic fungicides have provided good control of both rusts. They are even more effective when the varieties have some resistance. Preliminary studies using seed treatments look promising. Integration of resistance and chemical control with changes in management practices to reduce inoculum or rate of disease development appears to have great promise in controlling the rusts.

CONTROL OF POWDERY MILDEW

Roland F. Line

Powdery mildew is prevalent throughout the region, especially in areas with higher rainfall and in irrigated fields. Accurate measurement of the damage caused by mildew is difficult. The amount of damage caused by mildew depends upon the amount of mildew and the environment. In general, mildew is not as destructive as the rusts. Mildew frequently occurs in the same fields with rusts, consequently, studies on resistance to mildew and chemical control are often made in conjunction with studies on control of the rusts. Most varieties grown in the region are susceptible to mildew.

CONTROL OF SMUT

R. F. Line and Jack Waldher

Flag smut is found in most counties of Washington and is most severe in Klickitat County, Washington. It is only important in the Pacific Northwest. Wanser and Raeder are very resistant; Nugaines, Gaines, Moro, and Barbee have relatively high degrees of resistance; Luke, Hyslop, and McDermid are moderately susceptible and Paha and Faro are very susceptible. A few new, systemic chemicals will control flag smut. Of those that are effective, only Vitavax has been cleared by the Environmental Protection Agency for use as a seed treatment. It will control both seedborne and soilborne flag smut. Planting early and planting 2-3 inches deep increases flag smut severity. Higher soil temperatures increase the disease. The most effective control program for flag smut appears to be a combination of several methods.

Dwarf bunt (TCK) has become more important in recent years because of restriction on the sale of contaminated grains in certain countries. At present, cooperative studies, involving Dr. Duran and Dr. Schafer in Plant Pathology, and several plant breeders, are in progress to obtain information on the factors that contribute to dwarf bunt, the mechanisms of dwarf bunt resistance, and to identify new resistant wheats.

Common bunt is under control at present because of seed treatments and resistant varieties. However, if the present treatments were not available it could again become a problem. In cooperation with Dr. Hoffmann at Logan, Utah, Jack Waldher is evaluating new sources of resistance, new breeding lines, and new seed treatments for control of common bunt as well as control of dwarf bunt.

RESEARCH ON WATER STRESS AND DRYLAND FOOT ROT OF WHEAT

R. J. Cook and R. I. Papendick

Research is continuing at Lind, Washington to evaluate both white and red winter wheats for ability to withstand water stress and resist dryland foot rot caused by *Fusarium*. The site at Lind was infested with the *Fusarium* in 1975-76 and contains about 30,000 spores of the *Fusarium* per cubic inch of soil to a depth of 4 inches.

In 1977, 49 varieties (including hard red varieties) were selected as superior in resistance to dryland foot rot and drought hardiness out of 1810 tested. The year was the driest on record and provided excellent conditions for a very severe and hence useful test. The drought of 1977 was thus used to significant advantage and the results obtained represent a significant step forward towards further improvements in wheat for the dryland area.

The 1977 season was also used to provide maximal base information on the nature of water stress in wheat and to document the magnitude of water stresses possible in wheat. Data were collected at 9 locations starting in April and continuing until the crops in the respective fields were dead. As an example, at Pullman in fields of winter wheat following winter wheat, stress readings after heading were as low as -50 bars (equivalent to a suction of 750 lbs/in^2), and the plants were still alive.

For 1978, 180 wheat varieties are under test. These varieties represent the best wheats from the 1977 test, plus lines from breeding programs in Idaho (including Aberdeen), and the Great Plains states. They are under study in hopes of finding the best-performing wheats when seeded early (August 28) with excessive N (about 150 lbs/A) and with *Fusarium* present to kill and hence eliminate the weakest lines. In addition, 12 wheats representing widely diverse types and genetic backgrounds are under study in replicated plots at Lind to determine the nature of their drought hardiness.

TAKE-ALL OF SPRING AND WINTER WHEAT

R. J. Cook, K. J. Moore and E. Reis

Take-all, caused by the soilborne fungus known as *Gaeumannomyces graminis*, can be a serious disease of recropped wheat grown under heavy irrigation in eastern Washington. The disease was particularly serious last year in certain hard red spring wheat fields under pivot irrigation. This disease is also important in the higher rainfall area of western Washington, and may occur in certain wet years in the annual cropped dryland areas of eastern Washington and adjacent Idaho.

Our research on take-all is currently at Lind with irrigated and winter wheat. Results of the trials of the past three years can be summarized as follows:

1. No-tillage as used for erosion control increases take-all by leaving more infested plant residue (more fungus) on the soil surface in close proximity to the crown. Infection of the crown is the most lethal kind.

2. The plot at Lind is now in the 10th consecutive year of irrigated wheat and certain nutrient deficiencies have developed, especially phosphorus. Research in this plot is showing that take-all is more severe on phosphorus deficient plants. Of special interest is our evidence for the 2nd year that take-all can be reduced somewhat by phosphorus application at the Lind site. We are currently studying the effects of trace minerals such as zinc for further reduction of take-all.

3. In a study of alternate crops grown in rotation with wheat, potatoes, alfalfa (without grasses), and oats all helped eliminate the take-all fungus from soil. However, soybeans served as a host for the fungus so that take-all in wheat after soybeans is just as severe as in wheat after wheat. We are currently expanding this study to determine the influence of peas, lentils, and dry beans on take-all.

SOIL FUMIGATION FOR WHEAT

R. J. Cook

Trials with soil fumigation to eliminate diseases of wheat are underway for the fourth consecutive year at Lind, and also at several locations in the Pullman area and in adjacent Idaho. The major objective is to use fumigation as a tool to help reveal the existence of soilborne disease organisms. By eliminating these organisms, some not yet identified, we hope to learn more about the true growth potential of existing wheats under modern-day management practices.

The fumigants used this year include replicated trials of chloropicrin (400, 100, 50, or 25 lbs per acre, depending on the site and trial); Telone II at 20 or 25 gal per acre; and Telone IIC (a mixture of Telone plus 17% chloropicrin) at 20 or 25 gal per acre. These fumigants are all injected by machine. In addition, several fumigation trials have been established on no-till plots using 400 lbs methyl bromide per acre applied under a plastic tarp without disturbing the soil in the plot area.

The most conspicuous responses of wheat to soil fumigation include (1) greatly increased tillering, (2) 2-6 inches greater height at heading, and (3) up to 1 week earlier heading. This response occurs with chloropicrin at 100 lbs or more per acre and with Telone IIC, but not with Telone II alone. Possibly the response is due to elimination of a soil organism that reduces tillering and plant height and delays heading. Organisms known to have this effect on wheat are currently under study. We have made detailed microbiological studies of fumigated soils over the past 3 years and have ruled out many suspects, but have not yet identified with certainty which organisms are responsible for the "symptoms" eliminated by soil fumigation.

At Lind, either chloropicrin at 100 or more lbs per acre, or Telone IIC, but not Telone II controls take-all based on results to date. In 1977, yields were again 35-40 bu/A without fumigation and 80-100 bu/A with chloropicrin or Telone IIC. Unfortunately, at Lind we can find no evidence for carry over benefits of fumigation, i.e., the response one year does not occur in that plot the second year without refumigation.

Much interest now exists in the annual-cropped area of eastern Washington and adjacent Idaho to produce wheat without tillage (no-till) and thus obtain better control of soil erosion. However, there is a "wheat sickness" problem in no-till and not apparent with tillage that shows up as small yellow plants beginning at the seedling stage. Weeds then get ahead of the crop. Soil fumigation eliminates the wheat sickness problem in no-till which is good evidence that the problem is due at least partly to soil microorganisms. Our fumigation plots indicate that there is no physical restriction of wheat growth by the heavy straw residue on the soil surface. Soil moisture availability with recrop is apparently even better with no-till and this is especially apparent at Pullman in this year of severe drought. Studies are underway to determine the role of specific soilborne pathogens in the wheat sickness problem in no-till in the Palouse.

SPRING WHEAT IMPROVEMENT

C. F. Konzak, M. A. Davis, M. Wilson, Pullman
E. Donaldson, M. Nagamitsu, Lind, Collaborators

The spring wheat research in Washington is conducted utilizing mainly the research facilities at Pullman (medium rainfall), Lind (low rainfall), and Royal Slope in the Columbia Basin (irrigated), with offstation regional research trials via grower cooperation near Connell, Dayton, Harrington, the Horse Heaven, Pomeroy, Walla Walla and Waterville. Extension observation trials are conducted at these and a number of other locations in the wheat growing areas of Washington. New varieties, lines, and plant selections are being tested in preliminary nurseries with each entry being evaluated at all three main locations during the same year. By this method it is possible to more quickly estimate the probable adaptation and potential of varieties and lines and to select those that warrant further and wider testing in the offstation trials.

Among the nurseries grown at the three station locations, several can be seen by those attending the field days, including the Regional Facultative Wheat Nursery and the combined Western Regional and State Uniform Spring Wheat Nursery. The Midwestern Uniform Regional Hard Red Spring Wheat Nursery and the International Spring Wheat Nursery (CIMMYT) are sown at Pullman with observation plots at Lind. The main crossing blocks and parental lines are at Pullman. Virtually all new crosses are made at that location because of the more favorable conditions for crossing and regular adaptability of new parental sources. Many new foreign introductions and other new germ plasm sources are evaluated and some used in crossing each year.

Objectives: The general scope of WSU spring wheat research is indicated in Table 1 which lists the trials and numbers of selections under evaluation in 1977 and 1978. Major emphasis in breeding and selection continues to be yield performance for specific and general conditions, with crosses being made to incorporate the necessary quality, disease resistance, cold tolerance (facultative characteristics), and desirable agronomic traits into single lines. Research to improve the potential for higher content and nutritional value of the protein in hard red wheats is receiving increased emphasis, as is research on a new dual purpose quality type. Preliminary yield tests of some higher protein derivatives from crosses between local and Argentine wheats are included in the 1978 research at Pullman.

The 1978 Western Regional and Washington State Spring Wheat Nurseries include new varieties from the Washington State cereal research program and the states of California, Idaho, Oregon, Minnesota and Utah as well as promising new entries from private breeders.

Because of the drought season in 1977, considerable variability in yield performance of selections and varieties was encountered. In spite of early planting on summerfallow, high yields at Lind were in the 15 bu/A range. However, the dry season did permit some selections of lines less adapted to moisture stress conditions. Yields of early planted plots at Royal Slope (irrigated) were in the 90-100 bu/A range in spite of a heavy infestation of aphids, some carrying barley yellow dwarf virus (BYDV). A seed treatment control test at Royal Slope indicated yield losses due to BYDV in the 20-30% range. In 1978 the main nursery trials at Royal Slope will be sprayed using a systemic insecticide, but seed treatment tests (unsprayed) will also be conducted. Greenhouse and field data obtained in 1977 via cooperation of Dr. R. F. Line and graduate student Gene Milius have now established the presence of new stripe rust and leaf rust races. The Fielder resistance to the stripe rusts is no longer effective, nor is the resistance of Sawtell. However, the new release Wampum carries excellent resistance to old and new stripe rust races, and the

Table 1. Research Trials and Number of Selections Under Test in W.S.U. Research

Nurseries	Coordinator	1977 Locations ( )	1978 Locations ( )	1977 Entries	1978 Entries
COOPERATIVE TRIALS–					
Western Regional Spring Wheat Nursery	USDA–MT	25 (3)	25 (3)	28	28
Western Facultative Wheat Nursery	WSU	9 (5)	12 (6)	24	12
Tri-State Spring Wheat Nursery (WA, ID, OR)	WSU	6 (3)	7 (3)	20	35
International Spring Nursery	CIMMYT–Mex	60 (1)	60 (0)	not avail.	50
International Durum Yield Nursery	CIMMTY–Mex	27 (1)	27 (1)	not avail.	25
International Durum Elite Nursery			12 (1)	–	50
International Spring Wheat Observation Nursery	CIMMYT–Mex	40 (1)	60 (1)	300	300
International Winter/Spring Wheat Observation Nursery	CIMMYT–OSU	25 (1)	25 (1)	450	250
WSU RESEARCH TRIALS–					
Private Breeders Selection Nursery	WSU	(3)	(4)	25	32
Washington State Regional SWS		(9)	(9)	33	33
Washington State Regional–HRS		(6)	(6)	27	27
WSU Advanced Trials (2nd season rep)		(3)	(3)	100	120
WSU Preliminary (1st season rep)		(3)	(3)	320	500
WSU Single Plot (4-row)		(3)	(1)	650	1100
F_4 - F_5 Single Row Evaluations		(1)	(1)	25000	20000
F_3 Bulks		(1)	(1)	600	500
F_2 Bulks		(1)	(1)	450	800
High protein lines–single rows		(1)	(1)	2500	3000

( ) Number of Washington State Locations resistances of Twin, Urquie and Walladay are effective. However, all soft white wheats including new varieties are susceptible to a new leaf rust race. World Seeds 1 appears to carry some moderate resistance to the new race but the resistance is not fully evaluated. The leaf rust resistance of the hard red spring wheats, Wared, Borah, Prospur and Wampum is still effective.

The new rust races pose a serious threat to soft white spring wheat production in the area, since nearly all of the winter wheats grown are highly susceptible to the disease and provide inoculum to infect the spring wheats. A crash program effort has been initiated to identify new resistance sources and to identify advanced and preliminary lines with usable resistance. The 1978 plantings already reflect the results of that effort. The tests showed that a large portion of very promising new high yielding selections from WSU, Idaho and Oregon were susceptible to the new leaf rust race. Nevertheless, a number of resistant WSU lines have been identified. Some of these are already undergoing the final series of field tests. New crosses made in the greenhouse already incorporate new resistance sources identified in the fall of 1977, and a winter increase in Chile of F_4 bulks of several crosses has advanced new breeding lines into the selection stage. A winter increase of new selections is planned for New Zealand in 1978-79.

New Quality Development. A totally new combination of quality traits appears to have been achieved in a number of WSU soft white spring and facultative wheat lines. This new quality type combines the processing characteristics (bread and pastry properties) of typical hard red wheats with those of the common soft white wheats.

As such, these wheats should offer advantages to the PNW market in their suitability and blendability at all protein contents. Small pilot scale tests of the new quality type are in progress and larger scale industry cooperation tests are planned for 1979. Some of the new dual quality wheats show competitive yield performance with current soft white spring wheats, but their level of disease resistance is as yet incompletely known. Numerous new cross combinations have been made and more will be made to study the inheritance and recombination of the new traits.

VARIETY DEVELOPMENT

Soft White Spring and Facultative:

URQUIE—Developed at Washington State University with cooperation of USDA–ARS and released by Washington and Idaho in 1975 as a replacement for Marfed. This new high milling and baking quality common soft white semidwarf spring wheat variety carries an effective adult plant type of resistance to stripe rust. Urquie also produces better test weight grain than Twin under virtually all cultural conditions. Earlier tests indicated that Urquie was better adapted to the low rainfall areas than either Fielder or Twin. Tests in 1977 indicate that Urquie will perform as well as Twin and Fielder in the higher rainfall areas and under irrigation, while retaining its superiority in the low rainfall area.

The greater cold tolerance of Urquie compared with Marfed, Twin and Fielder should permit earlier spring planting which is desirable for achieving highest yields. A fair supply of Registered Seed was available via WSCIA for 1978 planting.

WALLADAY—Increased in 1977 as WA6153. This semidwarf, facultative soft white common spring wheat probably will be released in Summer 1978. Walladay carries resistance to some races of leaf rust and is moderately to highly resistant to stripe rust. Its quality is similar to Fielder. Performance tests to date indicate that Walladay has equal to greater yield potential than Fielder.

Its later maturity than Twin or Fielder may permit higher yield potential under irrigated culture, but may be a disadvantage in late spring plantings. However, it has done well in moderately early plantings in the Dry Land area. Walladay has greater cold tolerance than Urquie and may be suitable for late fall and mid winter and very early spring seedings in areas where this practice may be desirable or necessary due to severe freezing injury to winter wheats. A small Foundation and additional Breeder Seed stock increases are in production in 1978. WA6153 was substituted for WA6101 using the same name, because of its superior quality and disease resistance. However, the stripe rust resistance of Walladay may not be adequate for fall seeding in areas of heavy stripe rust attack, as in Western Washington.

Hard Red Spring Wheats:

SAWTELL—Formerly ID000047, a semidwarf hard red spring wheat developed by the USDA–ARS at the Aberdeen, Idaho station, was released in 1977 jointly by Idaho, Oregon and Washington. In Washington, Sawtell has shown comparatively higher yield potential under low rainfall conditions than other hard red spring wheats. Under irrigation its performance has not been exceptional but appears similar to other, better hard red spring wheats. Under some conditions, it has tended to produce grain of about 1% lower protein than other hard red spring varieties. Sawtell carries moderate resistance to stripe and leaf rusts and is moderately susceptible to mildew. Sawtell is susceptible to the new stripe rust and leaf rust races that attack Fieldwin.

WAMPUM—Formerly WA6105, developed by Washington State University with USDA–ARS cooperation is a short standard height stiff strawed hard red spring wheat with good milling and baking properties. Wampum tends to be better adapted to higher rainfall and irrigated culture than other hard red spring wheats and may find its widest use in that area except when needed for overplanting injured hard red winter wheats. Wampum appears to carry different types of resistance to stripe and leaf rusts than other hard red spring varieties now in production. It is also resistant to powdery mildew. Foundation and Breeder seed were produced in 1977. Wampum carries resistance to the new leaf and stripe rust races and to the local races of Hessian Fly. It may carry tolerance to barley yellow dwarf virus.

TRI-STATE SPRING WHEAT NURSERY

C. F. Konzak

Plant breeders in the three Northwest states cooperating on variety releases interchange test material for advanced lines one season before the lines become candidates for entry into wider testing in the Western Spring Wheat Regional Nursery. The Tri-State Spring Wheat Nursery thus serves to provide wider scale tests on a larger number of promising lines than would otherwise be possible, and tends to increase the possibility that those selections finally entered into the wider testing program will have variety potential.

PRIVATE BREEDERS SELECTION NURSERY

C. F. Konzak, M. A. Davis, and M. R. Wilson

Since 1976 a new test set of trials has been established to evaluate promising new materials developed by private plant breeders which would likely be produced for sale in Washington State. We invited private breeders to send us their advanced lines and current varieties for inclusion in these tests.

The 1978 nurseries include selections from four private breeders–Germains, Northrup-King, Western Plant Breeders and World Seeds. In 1979 we also expect to have materials developed by North American Plant Breeders. Some of their lines are being observed at Pullman in 1978. Growers attending the Field Days at any of the three main stations (Pullman, Lind and Royal Slope) and Harrington will be able to observe and compare private as well as publicly developed wheats.

IMPROVING PROTEIN CONTENT AND NUTRITIONAL COMPOSITION

C. F. Konzak

Crosses made several years ago using germ plasm sources obtained from the Nebraska-USAID program and from several other sources have advanced to the stage where lines with potential for significantly increased contents of protein or dibasic amino acid (including lysine) have been identified. Some preliminary selections are now being tested for stability and adaptation in unreplicated trials at the three main stations. Other selections are being increased to permit confirming tests and wider evaluation while the best materials will be used as parents in furthur crosses.

Generally, the high protein germ plasm sources have been poorly adapted for quality wheats, hence the early crosses have little potential. Thus, several breeding cycles are necessary in order to exploit the potential of these materials in developing competitive or higher yielding locally adapted varieties.

We now have identified selections with ability to produce a high content of probably more nutritious protein in the flour.

WESTERN REGIONAL SPRING WHEAT NURSERY

K. J. Morrison, P. Reisenauer, C. F. Konzak, M. A. Davis, M. R. Wilson,
E. Donaldson, M. Nagamitsu

This cooperative research trial of spring wheat performance potential and adaptation usually includes 25 to 30 entries, some soft white, a few or no hard white and a high proportion of hard red spring wheats. The same nursery is grown at about 25 locations throughout the West, ranging from Canada to Arizona. WSU's 1978 entries include five soft white and four hard red spring wheat selections.

Included along with this nursery at most locations are a group of standard and recently released commercial varieties, and the Washington State Soft White Spring and State Hard Red Spring Wheat Regional Trials. Either the State Soft White or State Hard Red series is grown at several other sites in the State of Washington. The standard, commercial and recent varieties are included in all County Extension trials of spring wheats in the State.

Washington did not join Idaho in the release of Dirkwin (ID106) because its performance was only slightly superior to that of Twin and its quality (test weight) was no better.

BARLEY BREEDING AND TESTING PROGRAMS IN WASHINGTON

R. A. Nilan, C. E. Muir, A. J. Lejeune
K. J. Morrison, and P. E. Reisenauer

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 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. Because of their malting quality 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 multipurpose varieties at Pullman, selection and testing programs at Lind (dry land) and Davenport (winterhardiness), and testing programs at Royal Slope (irrigated), Walla Walla, Dayton, Pomeroy, Vancouver, Puyallup, and Mount Vernon.

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 at Pullman are summarized in Table 1. This table also includes some advanced selections which will be discussed below.

6-Row Spring

The most promising "multipurpose" line within the 6-row spring barley types is WSU Sel. 6591-69 (11312) [Table 1]. It yields more than Blazer and about 85 to 90% of Steptoe, is earlier maturing, has shorter, stiffer straw, and possesses the quality of Larker. Preliminary tests indicate it is superior for livestock feed. It is much more susceptible to winter conditions than Steptoe and, therefore, would not create a winter volunteer and survival problem as does Steptoe. It will be recommended for release in the fall of 1978.

2-Row Spring

The next 2-row malting variety will probably come from selections from crosses involving Klages. These selections are higher yielding than Vanguard, Klages, or Kimberly, are about 85 to 90% the yield of Steptoe and have the quality of Klages. With their plump kernels, thin husks, and high soluble protein they should be excellent for livestock feed.

Winter Barley

All selections with the winter 6-row and 2-row types 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 winterhardy. More progress has been made with the 2-rows than with the 6-rows.

Field Days

Visitors at Lind will see a number of the previously described varieties and selections (Table 1) in winter and spring nurseries.

Visitors at the Field Day at Pullman will have an opportunity to view in demonstration plots early and late seedings of 20 current varieties and new advanced selections of spring 6-row and 2-rows and 12 current varieties and new advanced selections of 2-row and 6-row winter types.

Table 1. Comparative Yields of Barley Varieties and Types
Pullman, 5 Year Average (lbs. per acre)

Spring		Winter	
6-Row			
Feed		*Feed*	
Steptoe WSU	4814	Boyer WSU	6120
Unitan	4205	Kamiak WSU	6197
		Luther WSU	5654
		White Winter	4286
Malting		*Malting*	
WA6591-69	4595	Under Development	
Blazer WSU	4200		
Traill-Larker Type	3696		
Karl	3601		

Spring		Winter	
2-Row			
Malting		*Malting*	
WA9037-75	4525	Under Development	
Vanguard WSU	3994	Sel. 2464-70 (Ack. 989 x R.T.H.) WSU	5126
Kimberly	3755	Ackerman's 989	4954
Piroline	3730		
Klages	3364		
Heines Hanna	3149		

OAT IMPROVEMENT

C. F. Konzak, M. A. Davis

Cayuse continues as the most widely adapted high yielding oat variety available for production in Washington. However, some new selections in the Northwestern States Regional Oat Nursery show potential as replacements for Cayuse. Corbit, recently released by the Idaho station, has shown only similar yielding ability to that of Cayuse in most Washington trials. WA6014, recommended for release as Appaloosa, has for 4 years shown superior yielding ability in Washington trials and greater barley yellow dwarf tolerance than Cayuse. Appaloosa has a slightly lower to equal test weight than Cayuse. The test weight of Corbit had been equal to Cayuse in Washington trials. In 1977, both Appaloosa and Corbit outyielded Cayuse by about 20% in one trial, but in others, Cayuse proved equal or superior in performance. Breeder and Foundation seed of Appaloosa are being produced in 1978. New Washington selections WA6392 and WA6394 show promise of higher yield performance and equal or better test weight than Cayuse.

Oat growers should also take special note of the hulless oat variety Terra, recently released in Canada. This variety yielded almost comparably with Cayuse in trials at Pullman in 1976 and in extension trials in 1977, if the yields were adjusted for the hulls: hulless oats might prove to be especially valuable for swine and poultry feeds.

The increased interest in oats for feed appears to be such that a greater effort in oat improvement may be merited. Additional research has been initiated to recombine the high BYDV tolerance and high yields of WSU selections with larger, more plump kernels and with hulless and semidwarf height types available as germ plasm.

SOIL FERTILITY MANAGEMENT FIELD TRIALS FOR WHEAT PRODUCTION

Fred Koehler, Marvin Fischer, Emmett Field, and Raymond Meyer

There are 29 field experiments concerning soil fertility management for wheat production being conducted in 1978. These are distributed throughout the wheat producing area of eastern Washington from Waterville to Walla Walla (see map and lists of grower cooperators for locations).

A comparison of no-till with conventional tillage under different fertility treatments with both winter and spring wheat is being conducted at three locations. At other sites source and rate of nitrogen application under a no-till system of production are being studied. The use of a nitrification inhibitor with fall applied fertilizer is being studied at a number of sites.

At 12 locations the use of spring top dressing with nitrogen for winter wheat is being studied. Treatments include rate and source of nitrogen as well as the use of sulfur in addition to nitrogen, and in some cases different dates of application are used.

At Spillman Farm there is a long term study on the effect of soil acidity on wheat and pea production. Three levels of soil acidity have been established and superimposed on these treatments are sources of nitrogen (ammonium N versus nitrate N) and the use of trace elements. To date there has been no effect on wheat yields.

Other experiments include further studies on nitrogen sources and rates for winter wheat, source and rate of phosphorus fertilizer, use of sulfur, time and methods of using dry fertilizer in a wheat fallow rotation, rates and sources of nitrogen and sulfur for spring grain, and sources and methods of application of various kinds of fertilizers with a no-till system.

Because of the extremely dry year, the no-till experiments in 1977 produced little positive results. In all cases, these experiments were located on winter wheat stubble so there was no residual moisture available for the crops. In one case (Columbia County) winter wheat yields were greater under no-till than with conventional tillage, even though in both cases yields were extremely low. There were essentially no responses to spring top dressed nitrogen fertilizer because of the extremely low soil moisture situation.

LOOKING AT CROP ROOTS

A. R. Halvorson
Extension Soil Scientist

A high-yielding crop must have a good root system. Looking at some wheat fields this spring, spots of short, yellow wheat were clearly evident in the midst of an otherwise excellent appearing field. These spots were of variable size and were scattered across entire fields from low-lying areas to well up on the hill. Also, in many cases, these spots crossed all fertilization or tillage operations. There is no evidence that these "spots" are areas that repeatedly show up, as "poor areas," in the same place each year—except possibly in the usual wet areas in the bottom land. These "poor" areas will almost certainly yield less than the "good" part of the field. There are of course the usual poor areas related to erosion etc., but many of the "poor" areas observed this spring are unrelated to any readily observable characteristics.

Examination of the roots from the "good" and "poor" areas clearly show a marked difference in root vigor and root development. The plants in the poor area are only a third to one-half the height (5 to 6 inches vs. 12 to 14 inches) and are markedly pale green. A tissue test showed nitrate nitrogen present in the plant tissue from the "good" area, but no nitrate nitrogen in the plants from the "poor" area. Why the big difference in development and vigor of the roots in the two areas? The general pattern of nitrate nitrogen in the soil profile this spring was that it had been moved down to the 4th and 5th foot. The crop making good growth evidently had roots to that depth, but obviously the areas making poor growth did not. Other soil characteristics detectable either by observation or by the standard soil test seem to be the same for both areas.

What caused the restriction or delay in root development in some areas, and why it is so irregular and seemingly so unrelated to any obvious soil difference is not answerable at this time. It seems that with such big differences in growth between the two areas, there should be a clearly definable difference in some soil characteristics. Maybe only a slight change in one or more of the soil physical properties has a big influence on root development. In that case, the problem of identifying those properties and expressing them in terms of a measurable unit will be difficult. It is probable that the problems described will continue and maybe increase.

WATER USE-EFFICIENCY OF TILLED AND NO-TILLED WINTER WHEAT WITH SUPPLEMENTAL IRRIGATION AT LIND

V. L. Cochran and D. C. Thill
USDA, Science and Education Administration, Federal Research

Summer fallow practices in the Pacific Northwest are more efficient at storing and conserving water than any other place in the world. Still, 50% of the rainfall is lost to evapotranspiration without benefit to the crop. Previous work at Lind using supplemental irrigation on recrop to accomplish deep movement of fertilizer N resulted in higher winter wheat yields than was anticipated for the amount of water applied plus that received as rainfall. This suggests a potential for improved overall water use-efficiency by fall supplemental irrigation of recrop, thus avoiding the over-summer loss of water to evaporation during fallow. Further improvement in water use might be attained by no-till practices as has been experienced in other parts of the country. Therefore, an experiment was set up to compare supplemental irrigation on recrop winter wheat with and without tillage. Three dates of irrigation were selected. Four inches of water were applied on August 15, September 1, and September 15 to a new site at each date. Planting followed the irrigation by two weeks with the exception of the August 15 irrigation which was planted at the same time as that irrigated on September 1. A John Deere HZ drill was used for both the tilled and no-tilled planting. Spring supplemental irrigation to wheat following fallow will be included in next year's study. This treatment was omitted this year because of the unusually low water storage in fallow soil as a result of the drought.

Soil water was determined on April 1, and the early irrigation had 1 inch less stored water than the corresponding tillage treatment irrigated on September 1. For both irrigation dates, the tillage treatment had approximately 1 inch less water than the no-till. The late irrigation (September 15) had the same amount of water as did the no-till irrigated September 1, with no difference between tillage treatments. Thus, water storage can be increased by delaying irrigation or by no-tillage. However, the late irrigated and no-tillage treatment, regardless of the irrigation date, had poor plant growth in early spring.

In addition to the date of irrigation and seeding study, a separate experiment was initiated at an adjacent site to determine the efficacy of various herbicides in supplemental irrigated conventional, and no-tillage wheats. Herbicides being treated include diclofop (Hoelon), trifluralin (Treflan), bromoxynil plus MCPA (Bronate or Brominal plus), metribuzin (Sencor or Lexone), R-40244 and linuron (Lorox) applied at various stages of crop and weed development. Control of such weeds as downy brome (Cheatgrass), mustard species, and Russian thistle are being evaluated.

CROP RESIDUE MANAGEMENT IN NO-TILL WINTER WHEAT

V. L. Cochran, L. F. Elliott, and R. I. Papendick
USDA, Science and Education Administration, Federal Research

No-tillage plantings effectively reduce soil erosion, but often reduce crop yields. This is particularly true where large amounts of crop residues remain on the surface, such as in the center of the combine path or in low areas of the field. The plants in these areas are often chlorotic and stunted. Toxin(s) leaching from the decomposing straw has been found to cause reduced root growth in winter wheat. The toxin(s) appears after cool, wet periods of three or more days and disappears during prolonged dry periods. The toxin(s) is rapidly deactivated in the soil, thus the plant must be in close contact with the decomposing residue to be injured.

Injury to the plant occurs at two growth stages: when the seedling is emerging and contacts crop residue pushed into the seed furrow; and when the secondary roots are forming. Where the plant emerges through a residue matt, it sets a high crown, often in the residue matt. Consequently, the secondary roots must grow through this matt before entering the soil. At this time, it is particularly susceptible to injury.

Grain drills designed to move the residue away from the seed row would avoid placing the seed in direct contact with the straw and would also allow normal crown set. Thus, the effect of the toxin on either the primary or secondary root would be minimized. A study evaluating the feasibility of moving the straw away from the seed row has been underway for the past two seasons. However, due to the dry winter, no toxins were found last season and any damage to the crop due to residue was minimal compared to damage from the drought. This past season has been a good test, however. Preliminary results indicate a 25% reduction in stand and tiller counts caused by no-till planting of winter wheat into winter or spring wheat stubble compared with conventional tillage. Very little damage has been observed where the straw was moved away from the seed row and yields comparable to the tilled treatment are expected.

WHEAT MANAGEMENT AND PRODUCTION

A. J. Ciha and D. J. Metteer
USDA, Science and Education Administration

Objectives:

The main objectives of this crop management and production program are: 1) to examine various types and varieties of winter wheat grown under various erosion control systems, and 2) to examine production and cultural practices of spring wheat and barley grown in Washington.

Ongoing Research:

In the fall of 1977, 42 varieties and parent lines of winter wheat were planted at three locations (Pullman; Dayton; Gifford, ID) into either spring barley or winter wheat stubble which had been prepared by one of three tillage systems (conventional, conservation, and no-till). At the Spillman Agronomy Farm and at St. John, 12 varieties of winter wheat were planted for a crop rotation and management study. In this study, three management systems (conventional, conservation, and no-till) were used to prepare the stubble from the previous crop (spring barley, spring wheat, and peas).

The major emphasis of the spring grain research centers on the use of production and cultural practices for maximizing returns from spring barley and wheat grown under conventional tillage systems.

Last year on the Spillman Agronomy Farm with both spring barley and wheat maximum yields were obtained from the early planting date (April 4). A delay in planting to April 14 reduced yields 6% and by delaying planting until April 25, yields were reduced 20% from the April 4 planting averaged across all barley varieties tested. The spring wheat varieties examined showed an average yield reduction of 5% and 17% by delaying planting to April 14 and April 25, respectively, from that of April 4. Seeding rates of 0.6, 1.4, and 2.1 bu/acre had no significant effect on yield for either spring barley or spring wheat. This study is continued this year on the Spillman Agronomy Farm and at Dayton.

Experiments to examine the effect of tillage (conventional, conservation; and no-till) on small grain production have been initiated at Pullman and Dayton.

WEED CONTROL RESEARCH

D. G. Swan and T. L. Nagle

In the spring of 1978, a Section 18 emergency use was granted for metribuzin (Lexone, Sencor) to be used in certain areas of Washington. The purpose of this use was for the control of downy brome (cheatgrass) in winter wheat.

We have conducted research with this chemical and the following is a summary of the results in eastern Washington from 1969-1976.

WINTER WHEAT–*Metribuzin application rates of 0.25-1.2 lb/A active ingredient.*

FALL APPLICATION

Preemergence–crop visual injury was 0-30 percent. Downy brome (cheatgrass) control was 20-80 percent, and all rates caused a yield reduction.

Postemergence–winter wheat 2- to 4-leaf stage of growth. Crop visual injury was 0-100 percent, downy brome control was 60-100 percent, and wheat yield reductions were measured most of the time.

Postemergence–winter wheat 10-leaf stage of growth. Crop visual injury was 10-50 percent, and downy brome control 90-100 percent. The low rates did not reduce yield.

Combination–metribuzin 0.25-1.2 lb/A plus terbutryn (Igran) 0.6-1.2 lb/A. Growth stage same as above. Crop injury was 0-40 percent, and downy brome control 90-100 percent. Low rate did not reduce yield.

SPRING APPLICATION

Postemergence–winter wheat 4- to 6-leaf stage of growth. Crop visual injury was 0-50 percent. Downy brome control was 40-100 percent, broadleaf weed control was 100 percent. The low rate did not reduce yield. High rates reduced yields over half of the time.

Postemergence–early-seeded winter wheat 30- to 50-leaf stage of growth. Crop visual injury was 0-30 percent, and downy brome control was 40-90 percent. The low rate did not reduce yield, and the higher rates reduced yield about half of the time.

Combination–metribuzin 0.25-1.2 lb/A plus terbutryn 0.6-1.2 lb/A. Growth stage same as above. Crop visual injury was 0-20 percent, and downy brome control was 80-90 percent. There was no yield reduction due to treatment.

The following two tables give a general summary.

Table 1. Summary of weed control data comparing metribuzin applied in the fall and spring to winter wheat in eastern Washington, 1969-1976.

Treatment	Wheat visual injury	Downy brome control	Yield bu/A
	%	%	
	Fall applied		
Metribuzin	60	90	24
Weedy check	0	0	33
	Spring applied		
Metribuzin	10	70	41
Weedy check	0	0	42

Table 2. Summary of weed control data comparing rates of metribuzin applied to winter wheat in eastern Washington, 1969-1976.

Treatment	Rate lb/A	Wheat visual injury	Downy brome control	Yield bu/A
		%	%	
Metribuzin	0.25-0.3	20	70	39
Metribuzin	0.5 -0.6	40	80	35
Weedy check	—	0	0	44

Note: This information is preliminary and not to be construed as a recommended weed control practice. For further information on the use and status of metribuzin, see your local county Extension agent.

WEED CONTROL RESEARCH

R. D. Schirman, D. C. Thill and J. R. Pust
USDA, Science and Education Administration, Federal Research

1. Weed control in zero tillage winter wheat

Adequate fall rain in 1977 promoted weed germination and allowed use of contact herbicides prior to seeding. Both glyphosate (Roundup) and paraquat (Ortho Paraquat CL) were highly effective. Winter and spring emerging broadleaf weeds were successfully controlled with herbicides such as bromoxynil or combinations including metribuzin (Lexone or Sencor). The metribuzin combinations with reduced rates of linuron (Lorox) or terbutryne (Igran) continue to appear promising in that apparent crop safety is greater than at rates required of the herbicides used alone. These combinations had given satisfactory control of problem weeds, such as downy brome, in 1976-77 when use of preplant herbicides was not possible because of delayed weed emergence.

Under the higher moisture conditions, such as exist at Pullman, we feel it is essential to alternate spring and winter crops. When recropping under zero tillage minor weed escapes rapidly build to severe infestations.

2. Herbicides as spring tillage aid

Some conservation tillage systems, such as fall chiseling, often lead to increased spring weed problems that require multiple spring tillages to prepare a satisfactory seedbed. We evaluated late winter-early spring herbicide treatments to reduce the number of tillages required prior to seeding.

Glyphosate (Roundup) or Paraquat (Ortho Paraquat CL) suppressed winter weed growth and allowed satisfactory seedbed preparation with one or two less tillage operations (depending on implement). This in turn allowed earlier seeding of the crop. Cost of the herbicide is comparable to that of the added tillage operations.

RUSSIAN THISTLE CONTROL IN SPRING WHEAT

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Spring wheat is planted as part of a crop rotation sequence or used as a reseeding practice to replace inadequate winter wheat stands in the intermediate and low rainfall, wheat producing regions of Washington and Oregon. Seedling emergence of Russian thistle, a major weed problem in spring wheat, occurs concomitantly with that of spring wheat. Presently, 2,4-D is the only herbicide recommended for the control of Russian thistle in spring wheat. To insure good weed control, yet avoid any crop injury, applications must be timed so that the wheat is about 6 inches tall and the thistle has 5 or less leaves. In addition, Russian thistle germinates continuously throughout the spring so that early herbicide applications will miss later germinating thistle.

In the spring of 1978, a limited screening program was established to test the efficacy of several herbicides for the control of Russian thistle in spring wheat. Herbicide treatments include 2,4-D, bromoxynil (Buctril or Brominal), MCPA, Dowco 290, and metribuzin (Lexone or Sencor) applied at a particular stage of crop and weed development. This research will be expanded next year to include additional herbicides at various rates and times of application to better evaluate Russian thistle control practices in spring wheat.

RUNOFF AND EROSION PREDICTION AND CONTROL

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A continuing effort of the SEA-FR Land Management and Water Conservation Research Unit at Pullman is to adapt the Universal Soil Loss Equation (USLE) to the region for use as a soil and crop management planning tool and to predict the effect of changes in management on soil erosion and water quality. The USLE uses factors for rainfall and runoff, soil type, slope length and steepness, crop management, and erosion control practice in predicting long term average soil losses in tons per acre. The first generation adaptation was developed in 1974 and is currently being used by the Soil Conservation Service in applicable portions of Idaho, Oregon, and Washington. The equation has recently assumed more importance as the only tool available to assess the effect on soil erosion of the Best Management Practices developed under Section 208 of Public Law 92-500.

An erosion survey across Whitman and Latah counties and a more localized study to determine the effect on erosion of slope length and steepness are part of the USLE effort. Soil loss is measured with the rill meter, a 6-foot wide device that photographically records soil loss. The erosion survey had been conducted for three seasons and the slope length and steepness study for four seasons prior to the 1976/77 erosion season when no erosion occurred. Results indicate that slope steepness has much less effect on erosion here than in the Midwest.

Runoff plot studies to compare the effect of land treatment on runoff, soil loss, and water quality have been installed on and near the Palouse Conservation Field Station (PCFS) and near Rockford and Fairfield on cooperators' land. The PCFS study is in cooperation with the

Agricultural Engineering and Agronomy/Soils Departments of WSU. The Rockford study is at the request of the Intermountain Grass Growers Association and the Washington Department of Ecology to help assess total effects of alternatives to the grass seed field burning practice.

The plot studies at the Palouse Conservation Field Station 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. No erosion occurred in that season and the 1977/78 results are not yet available.

Results from the Rockford study indicate critical periods for erosion in blue grass seed production are the year of establishment and the season immediately following sod plow-out, because of the excess tillage required to break up the sod. Established blue grass usually produces moderate to high volumes of sediment-free runoff. Most of the results of this study can be attributed to tillage and/or soil moisture effects.

A study of the size distribution and energy properties of rainfall in the Palouse, initiated in 1973, is nearing completion. The results will be used in the rainfall and runoff factor in the USLE and in the design of a rainfall simulator being designed and constructed by the Agricultural Engineering Department of the University of Idaho. The rainfall simulator will be used in field testing of crop management practices and will speed testing of the effectiveness of new management systems.

A new project of the Land Management and Water Conservation Research Unit in cooperation with the Agricultural Engineering Department of the University of Idaho is to evaluate the effect on soil erosion and water quality of the Five Point Program of the Latah Soil Conservation District. The Five Point Program consists of the following elements: (1) Restricted summer fallow, (2) Minimum tillage, (3) Contour seeding, (4) Divided slope farming, and (5) Seeding critical areas. The study was undertaken as part of the Section 208 area-wide waste treatment planning effort established by Public Law 92-500, Water Pollution Control Act Amendments of 1972. The study includes runoff plots to evaluate the effect on runoff and soil loss of such treatments as divided slope and minimum tillage, rill meter studies to evaluate more conventional treatments, and downstream sampling sites to attempt to relate water quality to upland treatment. The project was started in the fall of 1976, but because of the drought, little or no data were collected in 1976/77. The only visible erosion occurred on fields planted to winter wheat after peas. This past winter was more typical with several runoff events starting in late November. Again the winter wheat seeded into pea residues suffered the largest soil loss and produced the largest amount of sediment moving past the downstream gauging station. There was no winter wheat following summer fallow in the study area.

The 27 square mile Missouri Flat Creek Watershed is the site of a sediment transport study to determine the total amount of sediment transport from the watershed, the daily and seasonal variation in water quality, and the delivery ratio, or the proportion of soil eroded from uplands and stream banks that reaches the South Fork of the Palouse River.

BREEDING, DISEASES AND CULTURE OF DRY PEAS

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The objective of the dry pea breeding program is to develop high yielding disease- and insect-resistant varieties adapted to the Palouse region. 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 parental material, hybridizing the resistant lines with commercial varieties, 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-yielded common Alaska by over 15%.

Garfield is resistant to *Fusarium* wilt race 1, is larger seeded, and has a longer vine habit when compared with most Alaska strains. The increase in plant height should improve harvesting ease, especially on ridges where lack of vine has been a problem. Garfield does not differ from Alaska in resistance to seed bleaching, powdery mildew, or mechanical damage. 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 the small-sieve checks. 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 should improve harvesting ease on the ridges where lack of vine 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 has been apparent since 1973 when it was determined that many small-sieve strains were susceptible. The release of Tracer should fill this need and also offer needed yield improvement.

The apparent resistance to pea root rot shown by Garfield and Tracer is an attribute that is responsible for their increased yields and also may be a factor in stabilizing dry pea production from one year to another and from location to location within a given year. We were hoping to identify breeding lines that showed additional yield improvements over Garfield and Tracer in 1977; however, in view of the severe drought, firm conclusions as to yield potential of the lines tested could not be made. Pea lines WA403952 and WA403323 were in the yield class of Garfield and Tracer but more importantly, they represented earlier flowering, earlier maturing lines. All the lines tested were resistant to *Fusarium* wilt race 1 and had acceptable plant height. These breeding lines are being retested in 1978 along with a number of lines that have not been yield tested before.

The severe drought in 1977 drastically affected yields of yellow peas; however, WA410088 compared favorably with Latah for yield, plant height, seed size, and earliness. WA510287 was a 'leafless' type with improved lodging resistance. It was slightly smaller in seed size and slightly later blooming than Latah. Because of the abnormal year, these selections will be retested in 1978. The objective is to identify an earlier flowering, earlier maturing line that will equal or exceed the yield of Latah.

Pea seedborne mosaic virus has caused problems in our breeding program and is a potential serious threat to both dry peas and lentils. Because of the obvious threat this virus poses to the industry, we are incorporating resistance to the virus into the major pea varieties grown in the region. These varieties include five dry peas, ten freezer and canner peas, and one Austrian winter pea. We are now in the third backcross and plan to make a total of six backcrosses. This project should be completed in about two years. The virus-resistant derived varieties will be a means of preventing new virus outbreaks.

It has been known for some time that the 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 infection obtained by planting late in June has reached epidemic proportions at about bloom. Lines showing resistance are increased and evaluated for agronomic characteristics, especially yield, and will be used as parental material.

Lines with pea seed weevil-resistance parentage that showed resistance to *Fusarium* wilt race 1 are being evaluated in 1978 for resistance to the insect. Hopefully, an agronomically acceptable line can be identified and used as a control measure for the insect. Work is also underway to control the pea leaf weevil through development of resistant varieties. Resistance or tolerance to the leaf weevil is associated with vigorous plant types with high leaf area.

LENTIL RESEARCH 1977-1978

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A continued effort in lentil research at Pullman is to develop lentil plants that produce high seed yields and quality seeds on disease resistant plants. The objectives are to develop heat tolerant lentils that resist flower and pod damage in spring seasons when air temperatures are relatively high. A second objective is to develop lentils adapted to fall sowing and early harvesting the following summer.

Laboratory Research

Studies have shown that lentil plants grown at temperatures between 65° and 75°F produce more seeds per plant than do plants grown from the same seed source at 75° to 80°F. To develop heat resistant lentils, a heat resistant source of germplasm for parents was located in seeds imported from Asian and North African countries. From these materials parental plants were selected, tested, and crosses were made with commercially acceptable lentils. Selections from crosses have produced heat tolerant, commercially acceptable type lentils. Screen tests indicate that progeny from lentil crosses are both susceptible and resistant to high temperature stresses. These different stress patterns indicate the resistance probably is genetically inherited.

Two heat resistant lentil lines, developed from crosses, will be grown in research plots on the WSU Agronomy Farm in 1978 and can be seen on the Field Day tour.

Field Research

Seed of heat tolerant lentil lines, developed from crosses, were planted in test plots with seed of lines developed from Plant Introductions that were not developed for heat resistance. Seed yield results showed the heat resistant lines consistently produced numerically higher yields than the other tested lentil lines. Symptoms of high temperature injury to lentil plants were measured by growing plants in controlled chambers, and in field plots, and measuring the seed yield differences following different levels of heat treatments.

Lentil plants grown commercially and in experimental plots frequently die without apparent causes. Also, chlorophyll deficient plants, and sterile flowers have been observed. Other observations show that some lentil seeds fail to germinate when sown in the field or tested in laboratory germinators. Since research studies have shown these deleterious factors are genetically controlled, and might be a factor causing low lentil seed yields, we studied the problem. Crosses made between normal appearing plants produced segregating progeny with yellow-green plants, floral-sterile plants, and seeds that did not germinate. This information supports observations that lentils have deleterious genetic factors that may reduce seed yields. Also, this information opens the direction towards developing lentil lines without early growth stage kill, and floret sterility.

Winter Hardy Lentils

Winter hardy lentils sown in a breeding nursery in October 1976 at Pullman, WA, were severely damaged by root rots. Factors responsible for the high incidence of root rots were the drought that occurred during the winter months of 1976-1977, and the presence of pathogenic fungi. In October and November, after seeding and germination, little precipitation occurred. Cold and drying winds caused the soil to separate along drill rows and exposed roots, cotyledons, and lower stem tissue. The point of initial infection appeared at the lowest level, in the opened drill row. The fungus most frequently isolated from infected lentil stems and roots was *Pythium ultimum.*

TREES AND SHRUBS FOR DRY LAND PLANTING

Many species of trees and shrubs are included in the Station forestry project for farm-home landscaping and windbreaks. The first plantings are over 40 years old. The present testing program at Lind was started in 1928 by the Dry Land Research Unit and the Department of Forestry and Range Management, Washington State University. Plantings have been made at intervals since then. This Station planting is one of the best in the West for studying trees and shrubs adapted to dry land conditions.

Initial observation tests of woody species are carried on at the Soil Conservation Plant Materials Center at Pullman. Secondary tests are carried on cooperatively at experiment stations at Prosser and Lind, Washington, and Moro, Oregon. Station Circular 450, 1965, summarizes the results of these adaptation tests of trees and shrubs for the intermountain area of the Pacific Northwest.

A standard dry land windbreak planting consists of a minimum of three rows. When properly established, these give excellent protection from the winds. The windward row should be a tough, fast-growing shrub. Caragana is the best shrub for this purpose. Lilac is slower growing, but is hardy and makes a good dense hedge. Nanking cherry and blue leaf honeysuckle show good promise for the windward row. Where a taller shrub is desired, Russian-Olive appears to be the best adapted shrub, although a wild crab-apple shows promise.

To give the windbreak height, a black locust is still the best deciduous tree. Green ash may also be used. Austrian pine and ponderosa pine are the outstanding evergreen trees, both being superior to Scotch pine. Douglas fir and blue spruce can be grown, but require more care and grow much slower. Rocky Mountain juniper is more difficult to establish than other evergreens, but is extremely hardy and vigorous when once established.

A shelterbelt planting requires considerable work. To survive under dry land conditions, trees and shrubs require continuous clean cultivation. Space rows between trees so available machinery can be used. Transplant trees and shrubs as soon as you get them. All evergreens require special care when transplanting. Transplanted evergreen stock has survived better than seedling stock. Although transplanted stock is more expensive, the superior survival compensates for the extra cost.

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Farmer Cooperators

Variety and Disease Plots

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Bayne Farms	Horse Heaven	Robert Kramer	Harrington
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Bud Benedict	Asotin	Paul Mader	Pullman
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Earl Crowe	Farmington	State Highway	Washtucna
Roy Eslick	Dayton	Stueckle Brothers	Colton
Francis Fitzgerald	Clarkston	Morton Swanson	Palouse
Garfield County Highway	Pomeroy	Turner Brothers	Dayton
Gary Gluck	Touchet	WSU Farm	Pullman

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