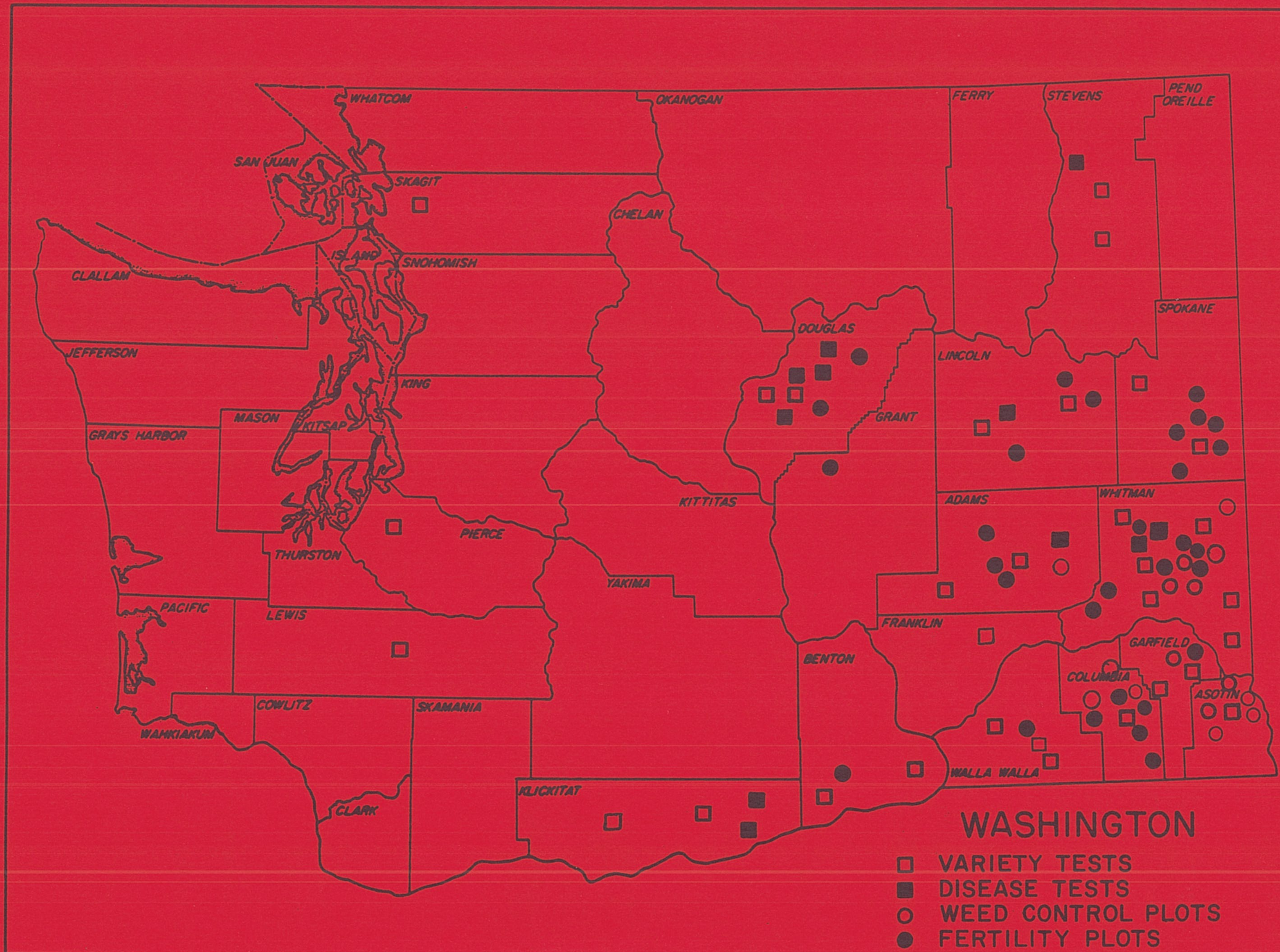
WSU FIELD DAYS

June 17, 1976
Dry Land Research Unit, Lind

July 8, 1976
Spillman Farm, Pullman


WASHINGTON
VARIETY TESTS
DISEASE TESTS
WEED CONTROL PLOTS
FERTILITY PLOTS
WHATCOM
OKANOGAN
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STEVENS
PEND OREILLE
SAN JUAN
SKAGIT
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KITTITAS
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WHITMAN
PIERCE
THURSTON
YAKIMA
PACIFIC
LEWIS
FRANKLIN
BENTON
GARFIELD
COLUMBIA
ASOTIN
COWLITZ
SKAMANIA
WAHKIAKUM
WALLA WALLA
KLICKITAT
CLARK

WELCOME TO THE FIELD DAY

The Field Day Brochure includes research at the Dry Land Research Unit, Lind and Spillman Agronomy Farm, Washington State University. Combining the information into one brochure gives you an opportunity to learn about the results of the wheat, barley, oat, pea, lentil, herbicide and fertility research programs being conducted in all areas of eastern Washington. It is hoped you will find information that will help you in your farming program.

The plant breeding work and the studies on diseases, weed control, wheat milling and baking quality, and barley malting quality are cooperative projects of Washington State University–College of Agriculture Research Center and the U. S. Department of Agriculture–Agricultural Research Service, and supported in part by funds from the Washington Wheat Commission, Washington Pea and Lentil Commission, Washington State Department of Agriculture, Washington State Crop Improvement Associations, Hail Insurance Adjustment and Research Association, and the Pacific Northwest Crop Improvement Association. In addition many commercial companies supply cash grants and materials for specific research programs.

The University farms do not meet all the research needs for disease resistance and the effect of the environment on different plant types. Farmer cooperators provide land at no cost to research workers for the testing program. Without the cooperation of these farmers the research program would be curtailed. The cooperators are listed on the contributors' page in support of research.

This brochure is intended to provide you with a brief progress report and to present some of the highlights of the programs you will visit. The articles will be supplemented by discussions and exhibits at the various stops to be made on the Field Day Tours.

Reports from the research conducted by Washington State University, as well as from neighboring states, is part of the educational program of the Cooperative Extension Service. Publications covering many topics that will aid you are available in the county agent's office. You can obtain a copy of these publications by visiting your local county agent's office.

Edwin Donaldson, Chairman, Dry Land Research Field Day, Lind
Kenneth J. Morrison, Chairman, Spillman Farm Field Day, Pullman

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HISTORY OF DRY LAND RESEARCH UNIT

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

Adams County has played an important part in the history of the station. The county donated $6000 to start the station and the land has been donated by the county. In the early 30's during the depression, Adams County kept the station alive with a small appropriation until the College could fund the operation again. In 1965 Adams County deeded 318 acres to Washington State University, two acres was 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 59th field day. Visitors are welcome at any time. Their suggestions are appreciated.

HISTORY OF SPILLMAN FARM

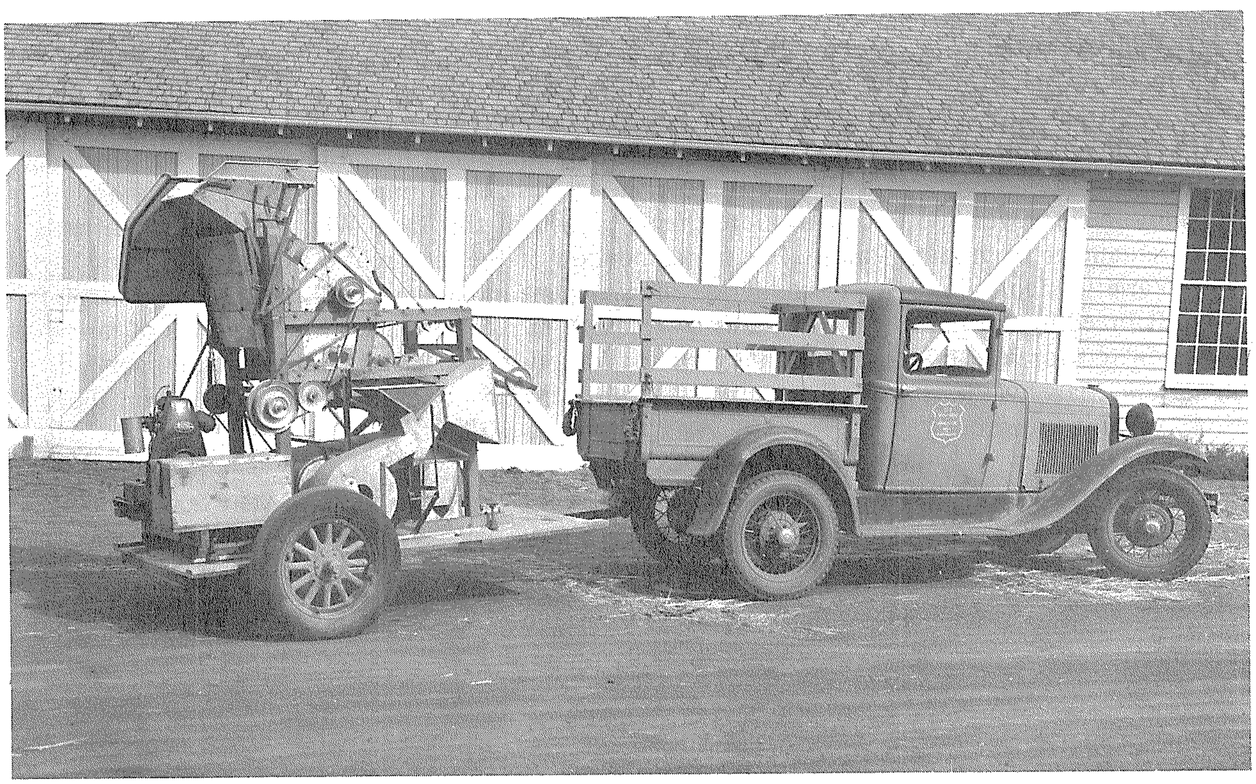
In the fall of 1955, 222 acres of land were acquired from Mr. and Mrs. Bill Mennet at the arbitrated price of $420 per acre. The money for the original purchase came as the result of a fund drive which raised $85,000 from industry and wheat growers. In addition $35,000 came from the Washington State 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.



Vogel nursery thresher built 1934.

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 ^{o}F.		Precipitation		Precipitation
	Max.	Min.	1975	1976	55 yrs. av. (in)
January	34	22	1.70	.93	1.05
February	42	24	1.26	.86	.88
March	53	32	1.15	.59	.74
April	63	35	.77	.65	.64
May	72	42	.74		.76
June	83	45	.58		.90
July	90	52	1.05		.24
August	90	50	1.02		.31
September	79	45			.54
October	65	38	1.52		.88
November	47	29	.71		1.24
December	37	26	1.46		1.28
			11.96		9.46

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.

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 Sprague	Marfed Idaed-59 Twin Fielder Urquie	Cayuse Park	Steptoe Unitan Larker—malting barley Belford—for hay only Piroline—malting barley Vanguard Blazer—malting barley	White Winter—18 inches or more rainfall Luther Kamiak Boyer
EASTERN WASHINGTON					
Less than 14 inches rainfall	Wanser McCall Moro Paha Nugaines Sprague Barbee	Wared—8-12 inches rainfall Wared—for reseeding in hard red winter Marfed—10 inches or more rainfall Idaed-59—12 inches or more rainfall		Unitan Steptoe	
CENTRAL WASHINGTON					
Under Irrigation	Nugaines Hyslop	Marfed Wandell (Durum) Twin Fielder	Cayuse Park	Steptoe Gem Belford—for hay only	Luther
Snow Mold Areas	Sprague				

WHEAT, OATS, BARLEY

Kenneth J. Morrison

Winter Wheat

Nugaines

Nugaines is a soft white semidwarf winter wheat with excellent test weight per bushel and 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. Nugaines has moderate resistance to flag smut.

Luke

Luke is a soft white semidwarf winter wheat. Luke is resistant to most races of common and dwarf bunt, and is well-adapted to areas where dwarf bunt is a problem. This variety is slightly better than most commercial varieties in resistance to *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 semidwarf.

Daws

Daws is a soft white common semidwarf winter wheat. The variety has about a 5-percent yield advantage over Nugaines. It is considerably 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.

McDermid

McDermid is a semidwarf soft white common winter wheat. It has weaker straw than Hyslop and the head is awned. McDermid is adapted to the dryland winter wheat-growing areas of the Pacific Northwest. McDermid has more winterhardiness than Hyslop, but not as much 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.

Hyslop

Hyslop is a soft white semidwarf winter wheat that yields well in high rainfall areas or with irrigation. Hyslop has a slightly better yield record than Nugaines where winterkilling is not a factor. Insufficient winterhardiness limits the use of Hyslop in Eastern Washington. Cold hardiness tests showed that Hyslop lacks 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 quality of Hyslop are similar to Nugaines.

Sprague

Sprague is a soft white common wheat developed for the snow mold areas. The chaff varies from white to gray-brown; 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.

Barbee

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

The variety has good stripe rust resistance and is resistant to flag smut and most races of dwarf smut. It produces an excellent flour, but it mills more like 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.

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 Omar.

The variety is adapted to areas that produce the quality of club wheat desired by domestic and foreign markets. Under conditions of relatively low rainfall and critical soil moisture at seeding time, Paha is expected to maintain its favorable, competitive position principally because of ease of stand establishment and early maturity.

The high susceptibility of Paha to dwarf and flag smut are expected to retard its widespread adoption in the intermediate rainfall areas.

Moro

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

Its chief advantages are resistance to stripe rust and excellent emergence. Moro is resistant to most races of dwarf bunt and common bunt.

It yields the same as Omar when stripe rust is not a factor. When stripe rust is severe, Moro produces much better yields than stripe rust susceptible varieties.

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 Nugaines, Moro will germinate and emerge much better than Nugaines from deep seedings in dry, dusty seedbeds.

Wanser and McCall

Wanser and McCall are hard red winter wheats developed for low rainfall areas of Washington. Both varieties yield as 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 seedlings—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.

Spring Wheats

Urquie

Urquie is a semidwarf soft white spring wheat developed by Washington State University and USDA, ARS.

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 to Fielder and Twin especially in the dry land areas of Washington. It has shown promise (in one test at Pullman) to compete with Nugaines under conditions where both showed good winter survival. Urquie is resistant to many prevalent races of stripe rust, but is susceptible to leaf rust and has moderate susceptibility to mildew.

Foundation seed of Urquie will be available for fall planting in 1976 and spring planting in 1977.

Fielder

Fielder is a soft white spring wheat developed by USDA, ARS and the Idaho Branch Experiment Station at Aberdeen, Idaho. Fielder is a semidwarf, stiff strawed, white chaffed, awned variety with moderate resistance to 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 two pounds per bushel more than Twin and about the same as Marfed.

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

Twin

Twin is a soft white spring wheat developed by USDA, ARS and the Idaho Branch Experiment Station at Aberdeen. Twin is an awnless variety of medium maturity.

Marfed

Marfed is an early season common soft white variety with medium tall stiff straw developed by USDA, ARS and Washington State University. It has a beardless white chaffed head. Marfed has some resistance to common smut. Marfed has fair seedling resistance to stripe rust and some mature plant resistance. Marfed is recommended in areas of eastern Washington with 10 or more inches of rainfall and for spring seeding under irrigation.

Idaed-59

Idaed-59 is a common soft white wheat developed by the University of Idaho that is very similar to Idaed in appearance and growth habits. It matures early and has short, medium stiff straw. Idaed-59 has a beardless, white chaffed head. It has fair field resistance to stripe rust and is resistant to the stem rust in eastern Washington. It resists shattering. In late seedings, Idaed-59 matures from 7 to 10 days earlier than other spring wheat varieties. In the higher rainfall areas, it is well suited to late seedings on heavy soils and early seedings on shallow soils. Like Idaed, some dry area seedings may not be uniform in height at maturity, making harvest difficult. Idaed-59 is recommended for spring seeding in the 12 inch and higher rainfall areas and for late seedings on irrigated land in central Washington.

Wared

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

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 semidwarf 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 be not 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.

Unitan

Unitan is a six-row barley with semi-smooth awns, white chaff and white kernels developed by the Montana State University. Kernel characteristics and test weight are similar to Gem. Unitan matures three to six days later than Gem. It is easier to thresh than Gem. Unitan is slightly taller than Gem and has about the same straw strength. In the lower rainfall areas, Unitan has yielded more than Gem. Unitan is adapted as a feed barley in both the high and low rainfall areas of eastern Washington.

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 500-700 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.

Piroline

Piroline is a two-rowed malting barley that has a higher yield record than Hannchen or Hanna, the standard two-rowed barleys that have been grown for malting purposes. The variety came from Germany.

Piroline is rough awned, with white kernels, and has a stiff straw that resists lodging. Piroline is about a week later than Gem and is recommended in the higher rainfall areas of eastern Washington.

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 dry land 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 at the University of Idaho.

Larker

Larker is a white-kerneled, semismooth-awned 6 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 midseason, white-kerneled, Traill-type malting barley with rough awns. The variety was developed by USDA, ARS and the University of Idaho. It averaged about 8 percent higher than Traill in yield. Karl is usually 3 to 4 inches shorter and normally heads 2 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 10 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-rowed, 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% less lodging.

The kernels of Boyer are larger and plumper than other winter barleys. The seed of Boyer will be 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 its high yielding ability. Discoloration results after severe attack by aphids carrying the virus.

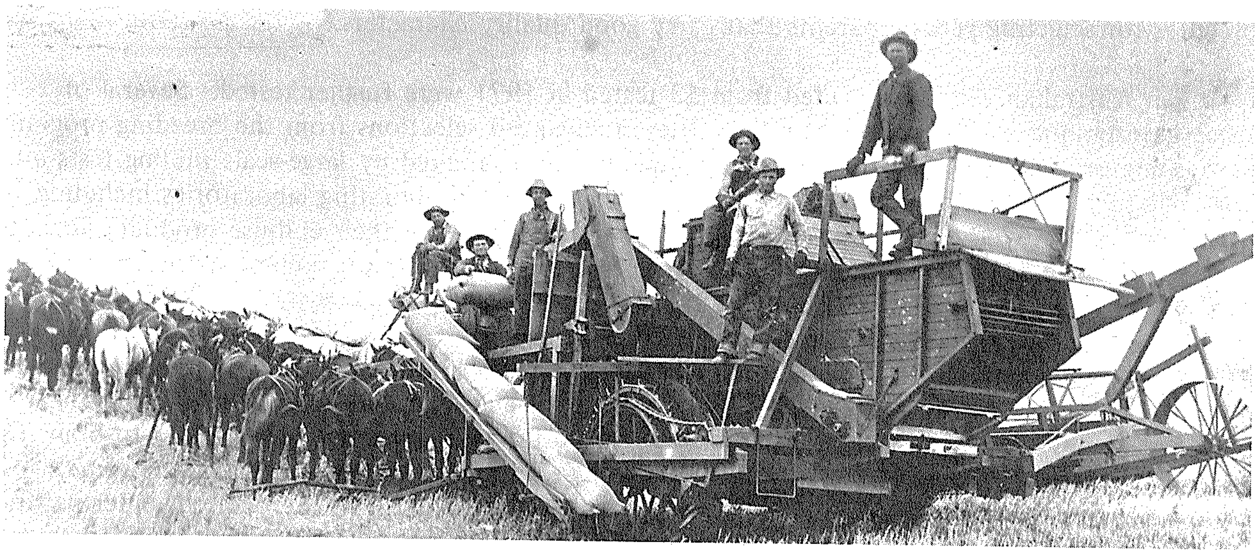
No other disease of consequence has attacked Cayuse in any Washington locations since testing began in 1959.

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, on irrigated land in central Washington and in western Washington.

Park was developed by the University of Idaho.



Haines Houser combine owned by Wlater Payne and Mr. Jain of Genesee, Idaho.

MILLING AND BAKING QUALITY
USDA, ARS, WESTERN WHEAT QUALITY LABORATORY

G. L. Rubenthaler, P. L. Finney, J. S. Kitterman, H. C. Jeffers,
P. D. Anderson, S. A. Boehme

Milling and baking quality was determined in cooperation with State and Federal scientists working on wheat improvement in the Western States. Quality of 815 new selections from preliminary and advanced nurseries (F_5 and later generations) was evaluated. A total of 269 of these selections were rated as having promising overall quality characteristics for their appropriate market class. The milling quality of 5,096 early generation (F_3 and F_4) selections was evaluated by semi-micro systems. Flour from the selections which appeared to have milling potential were further tested to estimate their baking quality for either pastry or bread products depending upon their market class. From these selections, 1422 (28%) were rated as promising in both milling and flour characteristics. This high percentage of good quality crosses is a credit to the breeders for selecting genetic parents that carry good quality characters.

Ten Australian varieties selected from 53 tested in 1971 were further tested. Several of these have unique dual-baking properties. Eleven advanced selections from the breeding programs in Washington, Oregon, and a commercial company were evaluated by large-scale milling tests on our Miag pilot mill. Sub-samples of the flours were sent to collaborating laboratories including Japan and Korea, who determined the value of these new lines for their end-use products. Results will be published in cooperation with the Pacific Northwest Crop Improvement Association in June 1976.

Several crosses involving high lysine and high protein were tested for their segregation for lysine and protein. Results indicate that: 1.) Magnif 41 and many derivatives of Frondoso and Atlas 66 are exceptional in contributing protein to the flour (high ratio of endosperm to bran protein), 2.) CI8500 seems to stand out as having high lysine/protein ratio, 3.) there is some environment-variety interaction in protein and lysine content when lines are planted under natural moisture and/or irrigated conditions, 4.) reciprocal crosses involving CI5484 and WA6090 seem to be significantly different in the segregation of protein and lysine contents in their respective F_2, 5.) CI6127 may contribute genes for both lysine and protein content.

Breads with equal loaf volumes and crumb characters were produced using various levels (.025-.75%) of malt (germinated wheat) and adjusting proof times (33-60 min.) in a no-sugar bread formula. Preliminary studies indicate potentials to increase lysine and other amino acids as well as most of the vitamins in wheat by controlled germination while retaining functional baking properties. Additional nutritional improvements are: decreased sugar and increased fiber content in the baked product, both of which are of concern to nutritionists and medical researchers.

HARD RED WINTER WHEAT BREEDING AND TESTING

The Hard Red Winter Wheat breeding program was started in 1951 with parent evaluation. Since 1952 crosses have been made each year to continually add new germ plasm for yield, quality, winterhardiness, and disease resistance. Many crosses have been between high yielding white wheat varieties and the better yielding hard red varieties to improve the yield potential of adapted hard reds. Disease resistance is of major concern in the program and includes crosses for stripe rust, smut, foot rot, and snow mold resistance.

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.

Stripe rust is prevelent in some of the off-station nurseries, but is not evident on the station at Lind. Screening for resistance in the early generation material will be difficult.

Snow mold was limited to small isolated spots in Douglas county last winter. The nurseries are not affected.

The common bunt nursery on the station had a good infection last year. A few resistant lines were identified and are being tested for dwarf bunt resistance this year.

Emergence was a minor problem last fall. Only on the Bayne Farms nursery (Horse Heaven) was any data obtained. Seeding moisture was deep and minimal with a shower occurring before emergence. A rain occurred before the emergence of the August 11 seeding in the "Date of Seeding" trials on the station.

The yields of recommended varieties for low and intermediate rainfall areas of Washington and Oregon are given in Table 2. In Tables 3, 4, and 5 some agronomic characteristics of recommended varieties and the older varieties they replace are given for four locations in eastern Washington. These data are from rod row nurseries. Table 6 gives the data from large scale field plots at Lind. Data from these trials and other large scale field plots 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.

New Selection

WA7003 is a mid-tall, hard red winter wheat with a grain yield slightly superior to that of Wanser. Emergence of WA7003 is better than Wanser under certain poor conditions. It has better stripe rust resistance than Wanser, and is equal to Wanser in resistance to flag smut, and common bunt. The milling and baking properties of WA7003 are about equal to Wanser.

Table 2. Yield of selected varieties in low and intermediate rainfall areas in Washington and Oregon, 1964-75.

Variety	Lind 9.5"	Moro, OR 11"	Location and Rainfall Pomeroy 14"	Pendleton, OR 14"	Average	No. years grown
Nugaines	39.8	35.8	65.6	75.7	54.2	11
Luke	38.2	38.5**	64.3	80.5**	55.4	8
Sprague	36.0	36.6*	59.7	79.5	53.0	4
Moro	38.8	31.9***	56.6***	61.5	47.2	12
Paha	40.6	34.2	61.6	74.2	52.7	8
Wanser	36.7	31.2	53.1	67.0	47.0	12
Kharkof	32.1	26.7	49.0	54.2	40.5	12
Station Av.	37.5	33.6	58.6	70.4	50.0	

*Not grown in 1975–3 yr data
**6 yr data
***11 yr data

Table 3. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries. 1952-75

Variety	Av. plant ht.	Av. test wt.	1975 yield bu/a	Av. yield bu/a	Yield % Kharkof	No. years grown
Nugaines	26	61.7	52.3	40.3	128	11
Luke	24	60.4	46.6	36.3	126	7
Sprague	26	60.8	53.2	35.5	125	5
Daws	32	58.7	47.8	48.4	142	2
Raeder	29	59.1	41.5	35.6	123	3
Moro	30	58.9	43.0	38.0	118	12
Paha	27	60.1	50.7	40.3	132	9
Barbee	26	59.0	48.7	37.6	133	5
Wanser	31	62.0	43.1	36.7	114	12
WA007003	36	59.9	43.2	42.7	125	2
McCall	31	62.2	48.7	38.9	118	11
Kharkof	36	60.5	31.9	30.6	100	21

Table 4. Summary of agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries, 1952-75.

Variety	Av. plant ht.	Av. test wt.	1975 yield bu/a	Av. yield bu/a	Yield % Kharkof	No. years grown
Nugaines	27	62.2	41.0	44.2	122	8
Luke	28	61.2	45.9	47.6	144	5
Sprague	28	60.6	46.5	40.0	136	3
Moro	35	59.3	40.3	43.8	120	8
Paha	28	60.9	53.3	46.0	135	6
Wanser	34	62.1	35.0	40.6	112	9
McCall	34	62.2	35.9	42.6	117	8
WA007003	32	56.7	36.4	36.4	126	1
Kharkof	38	61.3	28.8	34.2	100	18

Table 5. Yield in bushels per acre and percent of Kharkof for winter wheat varieties at two locations in rod row plots.

	HARRINGTON 1952-75			HORSE HEAVEN 1951-75		
Variety	No. years grown	% Kharkof	Av. yield bu/a	No. years grown	% Kharkof	Av. yield bu/a
Nugaines	10	138	41.3	5	127	23.8
Luke	7	143	42.0	5	122	22.8
Sprague	5	142	46.7	3	117	22.8
Daws	2	129	47.0	—	---	—
Raeder	2	121	44.0	—	—	—
Moro	10	131	39.3	7	120	20.3
Paha	8	149	43.2	5	123	23.1
Barbee	5	135	44.4	—	—	—
Wanser	9	132	39.1	8	119	20.7
WA007003	—	—	—	2	115	26.5
McCall	9	143	42.2	8	117	20.4
Kharkof	22	100	34.8	15	100	18.4

Table 6. Summary of agronomic data for winter wheat varieties grown at the Dry Land Research Unit in drill strip plots, 1954-75.

Variety	Av. date head	Av. plant ht.	1975 yield bu/a	Av. yield bu/a	Yield % Kharkof	Av. test wt.	No. years grown
Nugaines	5/31	25	45.4	39.2	125	61.2	10
Luke	6/4	26	46.8	40.2	124	60.0	6
Sprague	5/31	28	54.9	39.9	135	60.2	4
Moro	5/31	31	42.5	39.9	127	58.4	10
Paha	6/4	29	40.2	43.6	134	59.8	6
Burt	5/30	30	39.4	36.0	115	60.8	20
Cheyenne	5/29	32	32.9	34.7	109	61.5	18
Wanser	5/29	31	42.7	37.2	116	61.7	12
McCall	5/30	31	42.9	38.4	122	61.8	11
Kharkof	6/7	34	31.2	31.3	100	60.5	20

SOFT WHITE WINTER WHEAT

Clarence Peterson, Jr., Robert Allan, Donald George,
John Pritchett, David Henderson, and Steve Hayward,
USDA, Agricultural Research Service

Washington wheat growers produced 145.1 million bushels of wheat in 1975 on approximately 3.1 million acres for a 46.8 bushel per acre average. This is above the ten year average (1964-73) of 42.5 bushels per acre.

Plant diseases and insects reduced yields in some areas of the Pacific Northwest in 1974-75. Stripe rust was prevalent on Paha. A new race of stripe rust infected the foundation seed field of Norco and it will not be released. Dwarf bunt was a problem in isolated areas. A severe epidemic of Green bugs and Oatbird Cherry aphids occurred during the fall (1974) and many fields were infected with Barley Yellow Dwarf Virus.

New Varieties

Daws (CI17419, WA6099) a semidwarf soft white common winter wheat was released for production in Idaho, Oregon, and Washington. It has a bearded, common-type head with white chaff and soft white kernels. Daws is more winterhardy than Nugaines but not as winterhardy as Wanser. Daws is resistant to stripe rust and common bunt. It is susceptible to leaf rust, flag smut, and snow mold and *Cercosporella* foot rot.

The milling and flour characteristics of Daws are similar to those of Nugaines. The flour has excellent quality for pastries, cookies, and soft white wheat products.

Daws is recommended for seeding in areas where Nugaines is now grown. It has produced grain yields that were equal or superior to those of Nugaines (see table). Test weight of Daws is is generally 1 lb. below that of Nugaines.

* * *

Barbee (CI17417, WA5826) a semidwarf winter wheat was released for production in Idaho and Washington. It has a bearded, club-type head with brown chaff and soft white kernels. It is resistant to stripe rust, flag smut, common bunt, and some races of dwarf bunt. Barbee is susceptible to leaf rust, stem rust, and *Cercosporella* foot rot.

The milling characteristics of Barbee are equal to Nugaines but below those of Paha. The flour has excellent quality for pastries, cookies, and other soft white wheat products.

Barbee is recommended for seeding in areas where Paha is now grown. It has produced grain yields that were equal or superior to those of Paha (see table), but below those of Nugaines. Test weight of Barbee is generally 1 lb. below that of Paha. The emergence of Barbee is slower than that of Paha.

* * *

Raeder (CI17418, WA5988) a semidwarf soft white common winter wheat was released for production in Idaho. It has a bearded, common-type head with brown chaff. Raeder is similar to Nugaines in winterhardiness and emergence. It is superior to Nugaines in maintaining a stand in wet soils. The test weight of Raeder is generally 1 lb. less than that of Nugaines.

Raeder is resistant to flag smut, common bunt, stripe rust, and some races of dwarf bunt. It is susceptible to leaf rust, snow mold, and *Cercosporella* foot rot.

The milling and flour characteristics of Raeder are similar to those of Nugaines.

Raeder is recommended for seeding in the wetter locations in Northern Idaho where maintaining a stand of Nugaines is difficult. It should also be sown in the areas where dwarf bunt is present.

Possible Release

OR65116 is a semidwarf soft white common winter wheat that may be released for production in Idaho, Oregon, and Washington. OR65116 was developed by the Oregon State Experiment Station.

It is superior to Nugaines in grain yield (see table) but is similar to Hyslop in winterhardiness. It is resistant to stripe rust and it has a little tolerance to *Cercosporella* foot rot. It is susceptible to flag smut.

OR65116 is adapted for seeding in those areas where Hyslop is being grown.

* * *

OR7147 is a semidwarf soft white club winter wheat that may be released by the Oregon State Experiment Station for production in Idaho, Oregon, and Washington. It is resistant to stripe rust. OR7147 has equalled or surpassed the grain yields of Paha (see table). The emergence of OR7147 is slower than that of Paha. It has good milling and flour characteristics.

OR7147 is adapted for seeding in those areas where Paha is grown.

Cercosporella Foot Rot

5,247 lines from the USDA world wheat collection have been screened for *Cercosporella* foot rot resistance. Of these, forty-four lines appear to have some degree of resistance and they are in a replicated yield trial for 1975-76. One half of the nursery was inoculated with the *Cercosporella* foot rot organism.

The Western Region soft white winter wheat nursery plus 95 advanced lines are also in a replicated yield trial where one half was inoculated with the *Cercosporella* foot rot organism. Cerco, a soft red winter wheat, continues to exhibit good resistance.

Dwarf Bunt

A dwarf bunt screening nursery was established at Rice, Washington. Susceptible checks were infected over 80%. Eleven lines out of the 550 screened had 1% or less infection. These were given to Dr. Hoffman at Logan, Utah for further screening. We have 720 advanced lines in the nursery this year and 10,000 F3 lines.

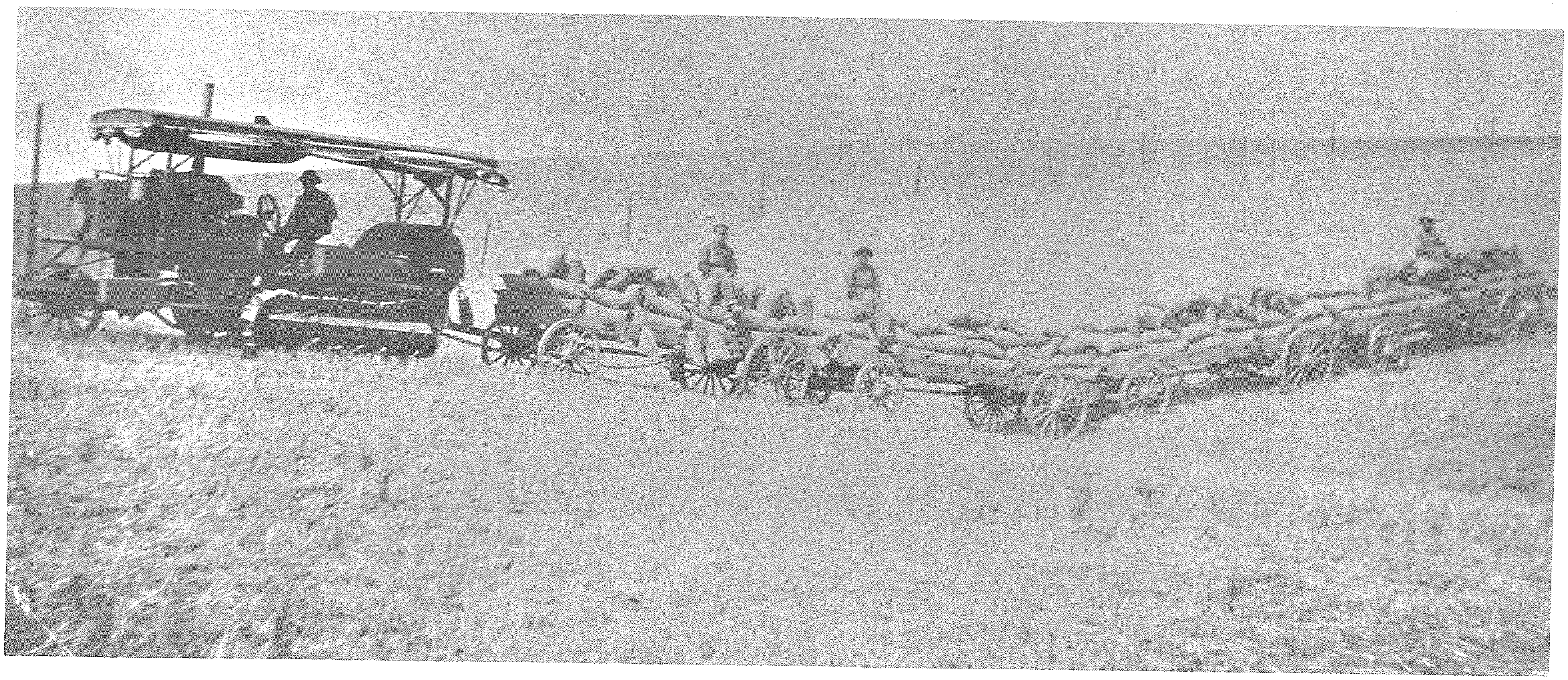
Triticale

The triticale 6TA476 developed by the Jenkins Foundation in California is the highest yielding triticale we have tested. It will yield about the same as the spring wheat Marfed. The test weight of the triticale is about 45 lbs. per bushel.

Table 1. Average yields and test weight data on soft white winter wheats for three years (1973-75).

LOCATION	SEEDING DATE	NUGAINES	HYSLOP	DAWS	RAEDER	OR65116	PAHA	BARBEE	PAHA*	OR7147*
Pullman	Sept. 5	61	67	69	66	77	62	63	62	59
Pullman	Oct. 5	60	68	67	60	66	50	57	37	43
Pomeroy	Sept. 15	61	56	61	60	60	61	63	64	64
Walla Walla	Oct. 15	71	73	68	68	72	62	64	59	66
Harrington	Sept. 4	43	43	47	41	44	36	44	43	44
Average		59	61	62	59	64	54	58	53	55
Test Weight		62.0	60.1	60.6	60.3	59.1	59.7	58.8	59.5	58.7

*Two years - 1973-74 & 1974-75



Bringing the sacked grain in from the field.

SPRING WHEAT IMPROVEMENT

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

The spring wheat research in Washington is conducted as a coordinated program utilizing the research facilities at Pullman (medium rainfall), Lind (low rainfall), and Royal Slope (irrigated) in the Columbia Basin. At these locations new varieties, lines, and plant selections are being tested in preliminary nurseries with each entry being evaluated at all three 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 testing.

Among the nurseries grown at the three locations several can be seen by those attending the field days, including the single plot nursery, the replicated nurseries for preliminary testing of new selections, and the combined Western Regional and State Uniform Spring Wheat Nursery. In addition, the Midwestern Uniform Regional Hard Red Spring Wheat Nursery and the International Spring Wheat Nursery (from CIMMYT) is grown at Pullman and with observation plots also grown at Lind. Single plant lines, and several preliminary nurseries are grown at both locations. The main crossing blocks and parental lines are grown at Pullman and virtually all crosses are made at that location because of the more favorable conditions for crossing and regular availability of new parental sources.

The 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.

The 1976 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, Montana and Utah as well as promising new entries from commercial breeders.

Summarized performance data and characteristics for varieties and promising selections grown in the dry land region during the 1974-75 seasons are presented in Tables 1, 2 and 3.

Table 1. Summary of agronomic characteristics of spring wheat grown at Lind in rod row nurseries, 1950-75.

Variety	Av. date head	Av. plant ht.	1975 yield bu/a	Av. yield bu/a	Yield % Marfed	Av. test wt.	No. years grown
Marfed	6/15	26	27.4	23.6	100	58.8	25
Twin	6/14	22	30.4	23.1	103	57.4	8
Fielder	6/13	23	26.1	20.2	88	59.2	5
Urquie	6/19	25	28.6	23.4	102	59.8	6
Fieldwin	6/16	24	27.2	26.0	96	59.4	2
Wared	6/15	23	26.9	20.4	89	59.5	7
Borah	6/13	21	24.1	19.5	85	58.7	5
Sawtell	6/16	24	28.7	23.2	102	57.4	3
WA 6100	6/24	25	27.9	25.2	93	58.5	2
WA 6101	6/24	25	27.8	26.5	98	57.7	2
WA 6105	6/18	28	25.7	25.0	92	56.9	2

Table 2. Yield in bushels per acre and percent of Marfed for spring wheat varieties at three locations in rod row plots.

Variety	HARRINGTON			WATERVILLE			HORSE HEAVEN*		
	No. years grown	% Marfed	Av. yield bu/a	No. years grown	% Marfed	Av. yield bu/a	No. years grown	% Marfed	Av. yield bu/a
Marfed	25	100	30.0	24	100	29.5	21	100	18.0
Twin	7	103	29.3	7	110	29.2	6	94	12.2
Fielder	5	104	28.9	5	104	28.0	4	101	16.1
Urquie	6	99	27.4	4	106	27.8	4	106	17.3
Fieldwin	2	101	26.2	2	116	27.1	—	---	---
Wared	5	99	27.6	5	101	27.4	5	95	13.2
Borah	4	103	25.9	4	99	25.9	2	87	11.7
Sawtell	3	106	25.4	3	119	26.8	1	94	16.3
WA 6100	2	84	20.9	2	122	28.5	—	---	---
WA 6101	2	91	22.8	2	116	27.1	—	---	---
WA 6105	2	91	22.7	2	118	27.5	1	108	18.6

*Not harvested 1975

Table 3. Summary of agronomic characteristics of spring wheat grown at Lind in drill strip plots, 1972-75.

Variety	Av. date head	Av. plant ht.	1975 yield bu/a	Av. yield bu/a	Yield % Marfed	Av. test wt.	No. years grown
Marfed	6/17	26	22.8	21.8	100	58.1	4
Twin	6/15	21	22.8	23.8	109	56.5	4
Fielder	6/19	27	22.0	25.4	97	56.5	2
Urquie	6/19	23	22.2	22.9	105	59.3	4
Wared	6/16	22	21.3	21.8	100	58.0	4
Fortuna	6/13	28	19.2	16.7	76	57.8	4
Springfield	6/15	22	23.2	17.8	91	55.8	2
Borah	6/20	24	17.9	17.9	79	54.4	1

WESTERN REGIONAL SPRING WHEAT NURSERY

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

This cooperative research trial of spring wheat performance potential and adaptation range, usually includes 25 to 30 entries of soft white, hard white and hard red spring wheats and is grown over a wide range of dry land and irrigated conditions from Canada to Arizona. WSU's 1976 entries include five soft white and four hard red wheats.

WA6101 is being increased as a potential variety. WA6157 has performed unusually well in Washington in 1974 and 1975. The hard red selections, WA6105, WA6108, WA6109 and WA6158 have excellent milling and baking properties. WA6105 is being increased and all will receive wider intrastate testing in 1976.

Western Facultative wheat nursery

This new cooperative trial initiated in 1975, includes 16 entries for 1976 sown both fall and spring at five sites in Oregon and at five sites in the fall and six in the spring in Washington. In the 1975 trials soft white spring habit Luke mutants (WA6150, WA6152 and WA6153) showed exceptional yield potential, while Urquie easily out performed Marfed.

SOFT WHITE SPRING AND FACULTATIVE (COLDHARDY SPRING) WHEAT IMPROVEMENT

C. F. Konzak, M. A. Davis, E. Donaldson
Grad Student: M. Khajehpour (Iranian Government Fellowship)

Demand for spring wheat seed was strong again in 1976, and may increase as conservation practices and cropping systems change. Yields of spring wheats in 1975 were unusually high, especially in the Palouse region, mainly due to the unusually heavy rainfall through June and July. Later plantings in 1976 are not expected to perform as well as those in 1975. Both stripe and leaf rust were prevalent on spring wheats in 1975, but neither caused significant injury to spring wheats.

New release

Urquie (CI17413), a soft white semidwarf, was released in July 1975 and Foundation Seed will be available in the fall of 1976. Urquie is especially adapted to the dry land region where it has consistently out performed Fielder and has produced nearly equal yields of higher test weight than Twin. Urquie carries mature plant type resistance to stripe rust, but is susceptible to leaf rust and mildews. Urquie has superior milling quality and is recommended as a replacement for Marfed. Urquie has shown facultative capabilities in several tests. Its winterhardiness level appears satisfactory for late fall sowings in the Walla Walla-Dayton area, but is inadequate for the Pullman area.

New selections

Two sister selections WA6100 and WA6101 true spring habit, soft white facultative lines selected from NOR10B11/P14//101,6539 are being increased pending consideration for possible release in 1977. These lines have shown winterhardiness superior to Urquie, indicating their facultative potential. Both appear to have the "Norco" type of quality. Both carry field resistance to stripe rust and leaf rust, some smut resistance as well as *Septoria* resistance. They are susceptible to several races of the stripe rust fungus. While of late maturity, these wheats appear to show exceptional potential under irrigation.

Excellent progress is being made in the development of soft white spring and facultative wheats with high milling and baking quality. Research work in induction of spring habit mutations in winter wheats, and crosses between winter and spring wheats have led to the development of soft white facultative lines with outstanding yield potential, disease resistance and quality. Some exceptional new milling soft white wheats were derived from complex crosses involving local wheats (*both* winter and spring) and plant introductions from Germany and the USSR.

Recently also, a number of lines with seemingly true dual-purpose processing properties have been identified. These lines have good pastry as well as bread-baking capability, though most have short mixing properties. In the last season, a few cross derivatives have been isolated which appear to have these dual baking properties, but have unusually strong and extensible protein characteristics. These lines will be more intensively evaluated in 1976.

Performance records of standard soft white varieties and promising new selections for 1974-75 are shown in Table 4.

Table 4. Performance of Soft White Spring Wheats 1974-75

Eastern Washington

Variety	Pullman 1974	Pullman 1975	Pomeroy 1974	Pomeroy 1975	Walla Walla 1974	Walla Walla 1975	Dayton 1974	Dayton 1975
Marfed	33.6	44.3	40.3	43.5	23.8	45.3	43.2	---
Fielder	34.1	53.9	50.4	51.1	33.1	35.4	47.3	---
ID87	46.1	59.3	55.6	47.4	29.3	40.1	48.7	---
Urquie	30.6	48.7	49.4	49.4	26.2	41.6	44.9	---
WA6100	37.7	51.0	43.1	52.0	27.0	40.2	46.0	---
WA6101	47.5	57.3	43.0	61.0	30.8	40.2	50.5	---

Dry Land Region

Variety	Lind 1974	Lind 1975	Harrington 1974	Harrington 1975	Waterville 1974	Waterville 1975
Marfed	26.8	27.4	21.9	28.0	29.5	17.2
Fielder	22.9	26.1	22.2	25.8	34.0	17.0
ID87	24.7	27.2	28.9	23.5	32.5	21.6
Urquie	26.8	28.6	24.2	25.1	35.2	20.2
WA6100	22.4	27.9	19.7	22.1	38.4	33.0
WA6101	25.2	27.8	20.7	24.8	18.0	21.1

HARD RED SPRING AND FACULTATIVE (COLDHARDY) SPRING WHEAT IMPROVEMENT

C. F. Konzak, M. A. Davis, E. Donaldson, M. Nagamitsu

Hard red spring wheat production has increased recently, especially in the irrigated Columbia Basin, to complement the occasional production associated with freeze injured hard red winter wheats.

New selections

WA6105—This semidwarf line has excellent milling and baking quality, high levels of resistance to local forms of stripe rust, leaf rust and mildew. Its yield performance is equal or higher than Wared from tests conducted to date. Plant lines are being increased in preparation for a possible 1977 release.

Other promising new lines

WA6108, WA6109—These semidwarf sister selections from the cross K68021 have outstanding milling and baking quality and have shown good resistance to local races of stripe and leaf rust, as well as high yield potential from preliminary trials. Plans are to select plants in 1976 for a potential Breeders Seed increase in 1977.

Modest progress in improving yield continues to be made in our HRS wheat breeding. Disease resistance adequate for local conditions has been obtained with relative ease. Improved hard red winter wheat parental materials developed at WSU and elsewhere are beginning to contribute to yield and other improvements, possibly also in coldhardiness. Recent emphasis has been placed on increasing the protein content in the hard red wheats, to make possible more consistent production of grain with adequate protein for bread making. A small number of lines from early crosses with parental materials from the Nebraska program, as well as some from WSU breeding are now in advanced replicated trials. Certain of these appear to have excellent baking quality. More recent crosses mainly with an induced semidwarf mutant of the Argentine high protein wheat Magnif 41 and with several plant introductions, have shown exceptionally high protein production capabilities, many lines from these crosses will be in single plot trials in 1977. Different plants segregating from some crosses with the Magnif 41 mutant parent produced as high as 17% or as low as 9% protein, clearly demonstrating genetic capability for high or low protein production.

Summarized performance records for standard varieties and promising new selections are shown in Table 5.

Table 5. Performance of Hard Red Spring Wheats 1974-75

Eastern Washington

Variety	Pullman 1974	Pullman 1975	Pomeroy 1974	Pomeroy 1975	Walla Walla 1974	Walla Walla 1975	Dayton 1974	Dayton 1975
Wared	37.4	51.4	46.8	43.3	35.7	43.7	47.3	—
WA6105	38.9	49.7	44.0	47.0	33.5	34.4	53.4	—
ID47	36.4	51.3	46.0	50.3	31.9	41.8	48.8	—
WA6158	—	45.5	—	50.2	—	44.5	—	—
Borah	40.2	42.0	50.1	43.6	30.9	40.5	43.8	—
WA6108	43.4	57.4	42.2	49.5	28.3	41.0	47.8	—
WA6109	34.4	64.1	45.2	47.5	31.7	45.6	49.0	—

Dry Land Region

Variety	Lind 1974	Lind 1975	Harrington 1974	Harrington 1975	Waterville 1974	Waterville 1975
Wared	22.6	26.9	18.0	25.8	29.7	18.9
WA6105	24.2	25.7	23.0	22.3	35.6	19.3
ID47	27.6	28.7	22.0	28.5	34.6	23.0
WA6158	—	23.7	—	19.0	—	19.7
Borah	21.9	24.1	20.8	24.0	28.9	14.4
WA6108	22.5	—	20.9	—	33.3	—
WA6109	21.8	—	19.4	—	31.6	—

WESTERN FACULTATIVE WHEAT NURSERY

This research trial was first initiated in 1975 and is coordinated by Washington State University.

Results from this first more limited scale trial, which included only soft white wheats indicate that several of the new lines, including Urquie may compete well with standard winter or spring wheats grown in the regions of test (Table 6). In particular, Spring Luke mutants WA6153, WA6150 and WA6152 appear to show unusual promise.

The 1976 trials include these lines, a number of true spring habit selections from "Norco" and four cross bred selections which appear now to have no more cold tolerance than Urquie. In the 1976 Pullman trials all four crosses plus Urquie and ID0033-12 were 90% killed out. Differential survival at other sites indicates Urquie still has sufficient frost hardiness for the Walla Walla-Dayton area. The Norco selections, and spring Luke mutants suffered no significant freeze injury at Pullman and none at other locations.

Table 6. Summary of Fall and Spring Planted Facultative Wheat at High and Low Fertilizer Rates In (Bu/A)

Fall Planted

Variety	Pendleton	Pullman	Dayton		Walla Walla		Average	% of
		High	Low	High	Low	High		Nugaines
CI014586	76.1	86.9	73.4	70.0	67.3	79.1	75.5	108.6
WA006153	83.6	66.6	75.4	75.5	65.2	73.4	73.3	105.5
WA006150	77.6	66.1	75.7	72.6	68.7	73.8	72.4	104.2
WA006152	77.3	67.8	75.1	71.2	67.8	71.3	71.8	103.3
CI013968	71.9	60.3	73.3	76.1	65.8	69.4	69.5	100.0
WA006149	74.0	55.4	75.8	79.2	66.2	69.8	70.1	100.9
CI017413	76.1	62.5	71.0	71.9	69.2	69.8	70.1	100.9
WA006154	68.7	62.3	73.5	67.8	64.1	70.3	67.8	97.6
WA006148	77.4	64.9	68.5	69.2	63.3	66.3	68.3	98.2
WA006151	74.5	63.6	68.3	63.6	68.6	72.4	68.5	98.6
WA006147	69.1	57.7	74.7	72.1	57.3	69.8	66.8	96.1
CI011919	57.6	47.8	66.9	64.3	52.6	57.6	57.8	83.2

Spring Planted

Variety	Pendleton	Pullman		Average	%
		Low	High		Fielder
WA006148	36.3	48.4	56.1	47.2	110.5
WA006153	39.6	44.8	51.0	45.1	105.6
WA006149	40.0	45.3	50.4	45.2	105.9
WA006154	41.7	43.6	49.1	44.8	104.9
WA006150	40.3	45.4	48.5	44.7	104.7
WA006152	37.7	49.7	47.8	45.1	105.6
WA006147	38.8	44.9	47.5	43.7	102.3
CI017268	30.3	50.3	47.5	42.7	100.0
WA006151	41.5	53.4	46.3	47.0	110.1
CI017413	37.6	43.1	44.3	41.7	97.7
CI011919	37.7	44.5	44.1	42.1	98.6
CI014482	42.2	22.7	18.6	27.8	65.1

QUALITY COMPARISONS OF WHEAT ISOLINES DIFFERING IN AWN EXPRESSION AND PLANT HEIGHT

R. E. Allan, G. L. Rubenthaler, P. Finney, S. Kitterman, H. Jeffers

What effect does semidwarfism and awn expression have on wheat quality? Do these traits in any way alter the end use properties of our wheats? To examine these questions we tested five isoline populations (closely related sister lines) of winter wheat grown at several sites in Eastern Washington and conducted milling and flour quality tests on them. The individual isoline populations differed for plant height (two gene semidwarf, one gene semidwarf, or normal) and awn expression (fully awned vs awnless).

Awnless types usually had test weights 0.5 lb/bu lower than their awned sibs. When semidwarf genes were present, awnless sibs had lower flour yields than the awned sibs in Brevor and Burt genetic backgrounds. Awned and awnless plants of normal height had no differences in milling or flour quality tests. Sometimes awned types had lower ash, a desirable flour quality trait. Flour protein of the awned and awnless types was usually very similar but at one site the awned sibs had 0.5% higher protein content for all three height levels. No significant differences occurred between awned and awnless types for bake absorption, mixing time, and cookie diameter.

Comparisons among the three height phenotypes in Omar, Burt, Brevor, and Itana backgrounds showed differences in some milling and flour quality traits but not in others. Flour yields and milling scores were highest for tall sibs in three populations. The two and one gene semidwarf types did not differ from one another in flour yield in any background but the one gene types had higher milling scores than the two gene types in the Omar and Burt backgrounds. Flour ash was consistently lowest for tall sibs in all backgrounds. Flour ash was highest in the two gene level in three of four backgrounds indicating this height level was somewhat inferior to the others for flour quality. Usually flour protein values did not differ among the three height classes but in the Burt background protein was 0.5% higher in the short vs the other height sibs; whereas in the Itana background the tall sibs had 0.6 to 1.0% higher protein than both semidwarf types. The plant height levels had similar loaf volume values in the Burt genetic background but tall sibs generally had larger loaf volumes than their one and two gene semidwarf sister lines in the Itana background. Mixing times were similar for height phenotypes of all populations except in the Itana background where the one and two gene semidwarf types had longer mixing times than their tall sibs.

The results show that the semidwarf trait can alter milling and flour quality depending on the genetic background involved. Usually semidwarfism has an adverse effect on quality, particularly the two gene level.

STAND ESTABLISHMENT DIFFERENCES AS RELATED TO GENETIC BACKGROUND AND SOURCE OF SEMIDWARFISM

R. E. Allan and J. A. Pritchett

We evaluated stand establishment of 135 isolines (closely related sister lines) that represented two gene semidwarf, one gene semidwarf, and standard height types under deep sown, warm soil conditions. Seven genetic backgrounds and two sources of semidwarfism were used. Results showed that genetic background and source of semidwarfism exert important effects on rate of emergence (ERI) as well as the total stand (TS) which is ultimately achieved. Semidwarfism has less effect on stand establishment in some backgrounds than in others.

The two gene semidwarf trait reduced ERI when compared to their respective standard height sibs within all backgrounds. The one gene semidwarf level reduced ERI in Omar, Itana, Marfed, and Nord genetic backgrounds. One gene semidwarf types had ERI values comparable to their standard height sibs in the Burt, Brevor, and Golden backgrounds.

Differences in TS values also occurred among the three plant height groups for 7 of the 9 populations. Total stand counts of two gene semidwarf types were below their standard height sibs for seven populations. The TS counts of one gene semidwarfs were different from those of the normal types for only threee populations.

Table 1 ranks the nine populations for ERI and TS values for the three height levels and for the overall population average. Golden consistently ranked the highest for both ERI and TS at all height levels. In fact the two gene semidwarf types of the Golden genetic background emerge as fast or faster than standard height types of Burt (Suwon 92 semidwarf source), Marfed, and Brevor and are equal to all of the one gene semidwarf types except Omar. Suwon 92/7*Omar ranks particularly well for both ERI and TS and placed much above its companion Sel. 14/6* Omar populations. This means that the Suwon 92 source of semidwarfism has a less deleterious effect on stand establishment than the Sel. 14 semidwarf source in the Omar background. The two Burt populations also differed in their ranking but in this case the Suwon 92 population usually ranked lower. Like the Golden background the Itana background was not too adversely affected by incorporation of the semidwarf trait. In contrast normal height Nord types ranked second for both ERI and TS but their two and one gene semidwarf sibs ranked much lower for ERI and somewhat lower for TS.

There is a close relationship between ERI and TS rankings for some populations and not in others. The ranks closely correspond for Golden and Omar but are quite divergent for Brevor and Nord. This means that ERI links closely to ultimate stand in some but not all genetic backgrounds.

Information from these tests should help us to breed varieties with more suitable stand establishment. Golden germplasm tolerates semidwarfism better than all other backgrounds and should be useful as a parent to improve both ERI and TS. Certain backgrounds such as Brevor and Nord should be avoided in two gene semidwarf breeding, yet Itana and Marfed are not too adversely affected by that semidwarf level. Most genetic backgrounds can tolerate the one gene semidwarf level without drastic effects on seedling vigor. Exceptions are Marfed, Nord, and Omar when the source of semidwarfism is Sel. 14. Breeders need to evaluate their material for both ERI and TS because the relationship between these two traits varies depending on genetic background.

Table 1. Emergence rate index and total stand rankings for three plant height classes among nine populations.

Population and genetic background	short		medium		tall		overall	
	ERI	TS	ERI	TS	ERI	TS	ERI	TS
Suwon92/7*Burt	5	7	4	7	8	8	7	7
Sel.14/7*Burt	8	9	3	5	4	5	5	6
Suwon92/7*Omar	4	4	2	2	3	3	2	2
Sel.14/6*Omar	7	6	6	6	5	6	6	5
Sel.14/7*Brevor	9	5	8	3	9	6	9	4
Sel.14/7*Itana	2	2	5	3	6	4	4	3
Sel.14/7*Nord	6	3	7	4	2	2	3	3
Sel.14/4*Marfed	3	8	9	8	7	7	8	8
Sel.14/7*Golden	1	1	1	1	1	1	1	1

HOW VULNERABLE ARE SEMIDWARF WHEATS TO DISEASE?

R. E. Allan and J. A. Pritchett

Semidwarf varieties now grow on 75 to 90% of the wheat area in California, Idaho, and Washington. The near universal use of this plant type may increase the genetic vulnerability of Pacific Northwest wheat. Our tests indicate that semidwarfs suffer proportionately greater losses to stripe rust, flag smut, and dwarf bunt than do non-semidwarf or normal types. Over a three year period the yield loss due to stripe rust was 34, 24, and 22% for two gene semidwarf, one gene semidwarf, and standard height sister lines, respectively, in an Omar genetic background. Yield losses were even greater in Burt isolines where the 3 year average losses were 51, 40, and 18% for two gene semidwarf, one gene semidwarf, and standard height types, respectively. Without question, in event of a new virulent stripe rust race, semidwarfs would be more vulnerable to loss than standard height types.

Semidwarfs are also more vulnerable to flag smut. Tests involving four genetic backgrounds over a two year period indicate that two gene and one gene semidwarf types averaged 63 and 56% flag smutted tillers compared to 47% for the standard height types. In moderately resistant backgrounds such as Itana, semidwarfs had nearly two times as much smut as their normal height counterparts.

Dwarf bunt tests were very similar to those with flag smut. Two and one gene semidwarfs averaged 40 and 34% more tillers with dwarf bunt than their normal height sister lines, respectively.

The relationship between disease damage and semidwarfism is more complex with strawbreaker foot rot. The two gene phenotypes had either more, similar, or less tolerance to the disease than non-semidwarf types depending on genetic background.

These tests show that the high yielding semidwarfs can give us increased vulnerability to diseases such as stripe rust, flag smut, dwarf bunt, and in some cases *Cercosporella* foot rot. Breeding varieties with high, stable resistance is even more important with semidwarf wheats than the older, taller types. Proper use of alternate control methods such as recommended chemicals and management procedures are even more critical when semidwarfs are grown.

MULTILINE VARIETIES MIGHT HELP CONTROL DISEASE

R. E. Allan, R. F. Line, and J. A. Pritchett

Developing resistant varieties often seems to be a never-ending battle and one we do not always appear to be winning. In the case of stripe rust four new races became prevalent once the varieties Pitic 62, Yamhill, Paha, and Norco were extensively grown. The demise of these varieties has proven one thing and that is we need to examine other means of controlling stripe rust.

One approach that could help is multiline varieties. Multilines consist of blends of similar components but each with a different gene for resistance. A multiline therefore has several distinct types of resistance and a new race of stripe rust will only be able to attack a small proportion of its plants. Multilines are a way of insuring genetic diversity for resistance in the variety rather than relying on just one genetic form. Because most of the population is resistant, the disease will have a hard time spreading within the multiline.

We've tested a club and a hard white winter multiline several years in Washington and the results are rather encouraging. In 1975 a Paha type multiline with 11 components outyielded the expected yield (the average of all 11 component yields) at all locations tested. In fact it outyielded the individual components in 37 of 44 possible comparisons. This good yield record was achieved even though two of the components were susceptible to races prevalent in the region during 1975. The multiline also approached its best components for test weight, as well as tolerance to lodging and *Cercosporella* foot rot. Clearly multilines could go a long way to reducing our genetic vulnerability. To be sure they will have to meet the same high quality standards of conventional varieties and so far quality tests indicate the two types we are currently testing have satisfactory quality characteristics.

The use of multilines could go beyond the obvious need for genetic diversity for disease resistance. They may pay off in situations caused by adverse weather, and less than ideal management. Preliminary data has shown that multilines may emerge, survive cold weather, commence spring growth more uniformly and adequately than their components over a range of environments.

EFFECT OF YELLOW DWARF ON DRYLAND WINTER WHEAT IN CENTRAL WASHINGTON AT LIND, 1974-1975 SEASON

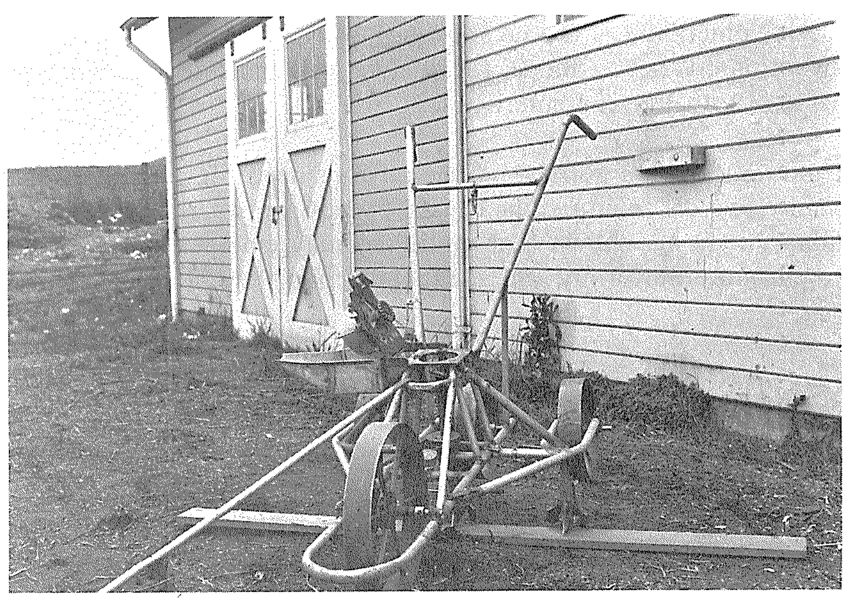
Edwin Donaldson, G. W. Bruehl, M. Nagamitsu

Several farmers near Lind obtained yields of winter wheat in the 60 bushel range: yet, in a date of seeding trial with eight varieties at the Lind Dryland Research Unit, no such yields were obtained. The wheats were seeded at 10-day intervals starting on August 2. The land was well fertilized. It was good, deep well summer fallowed and free of weeds. Stands from all seeding dates were good. Yields as good as those obtained by several ranchers should have been recorded.

Several farmers in the region reported "up-and-down" wheat in June, meaning mixtures of stunted and normal wheat. This same mixture of stunted and tall wheat occurred among all varieties seeded August 2-23 at Lind, with a little in the September 3 seeding. The stunting was attributed to yellow dwarf. Most commercial fields were seeded before September 1.

Yellow dwarf is caused by a virus spread by aphids. The virus attacks wheat, oats, barley, and some grasses. Severe stunting results when susceptible plants are infected early in life. Later infections, when the plant is further developed, are less damaging. The occurrence of yellow dwarf in a regular experiment led to the following observations.

Stunting was most widespread in the August 2 and 12 seedings, moderately serious in the August 23 seeding, rare in the September 3 seeding, and absent in the September 12 and subsequent seedings (Table 1). Among the common white wheats Luke suffered most and Sprague least. Among the hard reds, Wanser suffered most and Centurk least. Among the clubs, the over-all stunting scores of Paha and Moro were similar. The visual observations lead us to believe the September seedings escaped serious damage.



First Vogel three row nursery planter.

Table 1. Percent of plants judged to be seriously stunted by yellow dwarf at Lind, 1974-1975 season.

		Seeding Date					
		August			September		
Variety		2	12	23	3	12	Average
Wanser		89	78	57	5	0	45.8
McCall		68	63	38	5	0	34.8
Centurk		57	57	33	10	0	31.4
	Average	71.3	66.0	42.7	6.7	0	
Nugaines		60	63	18	25	0	33.2
Luke		73	83	63	5	0	44.8
Sprague		30	53	18	0	0	20.2
	Average	54.3	66.3	33.0	10.0	0	
Moro		95	87	30	0	0	42.4
Paha		82	88	47	0	0	43.4
	Average	88.5	87.5	38.5	0	0	

The yields (Table 2) reflect the stunting. Stunting was most prevalent in early seedings: yields were lowest in early seedings. All varieties show this trend, evidence that not one of these wheats was highly or even moderately resistant. Among the hard reds Wanser had the lowest over-all yield and Centurk the highest. Among the common whites, Luke had the lowest over-all yield and Sprague the highest. Thus, within these two groups of wheats, the stunting was directly reflected by reduced yields.

Table 2. Effect of seeding date on the yield of winter wheat at Lind, 1974-1975 season.

	Seeding Date					
	August			September		
Variety	2	12	23	3	12	Average
Wanser	24	26	28	38	36	30.4
McCall	28	25	28	37	40	31.6
Centurk	29	29	31	35	41	33.0
Average	27.0	26.7	29.0	36.7	39.0	
Nugaines	28	28	37	44	45	36.4
Luke	28	26	28	45	45	34.4
Sprague	32	32	34	47	45	38.0
Average	29.3	28.7	33.0	45.3	45.0	
Moro	27	28	33	36	37	32.2
Paha	30	27	33	49	48	37.4
Average	28.5	27.5	33.0	42.5	42.5	

Table 3. Thousand kernel weights of wheat at Lind, 1974-1975 season.

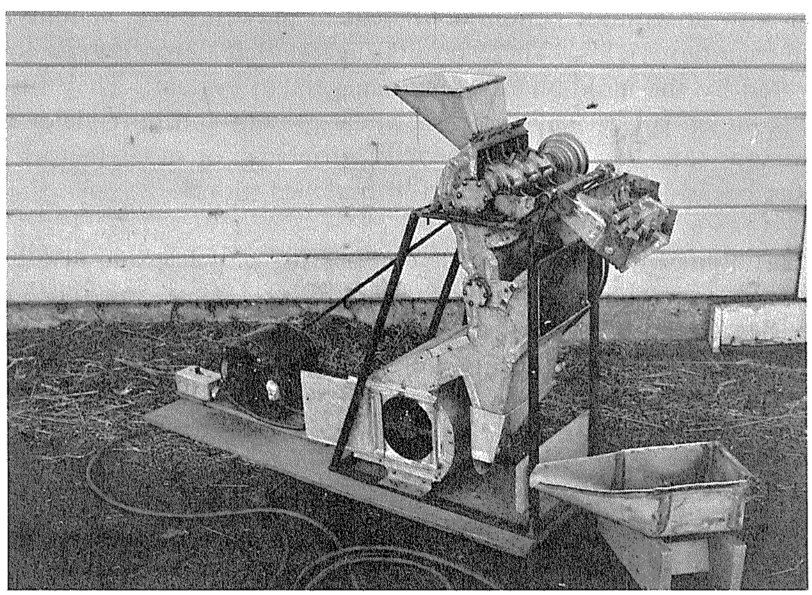
	Seeding Date					
	August			September		
Variety	2	12	23	3	12	Average
Wanser	28.1	27.5	28.8	29.9	33.7	29.6
McCall	26.0	26.2	25.7	28.5	32.5	27.8
Centurk	27.9	28.2	25.9	26.8	31.9	28.1
Average	27.3	27.3	26.8	28.4	32.7	
Nugaines	31.1	29.2	31.6	33.3	36.6	32.4
Luke	28.5	28.5	27.6	31.2	33.8	29.9
Sprague	27.6	25.2	27.3	29.9	31.2	28.2
Average	29.1	27.8	28.8	31.5	33.9	
Moro	25.5	24.5	23.9	24.7	25.5	24.8
Paha	30.9	30.2	25.6	28.5	31.0	29.2
Average	28.2	27.3	24.7	26.6	28.3	

With the clubs, however, the data are not so easy to interpret. Both Moro and Paha were similarly stunted, but it appears as if Paha was damaged more than Moro. Both yielded similarly in August seedlings, but Paha outyielded Moro greatly in September seedings. Thus, Paha had a greater potential yield in the 1974-75 season than Moro, but when diseased, the yields were the same.

It is unfortunate that no completely healthy wheat was adjacent to the sick wheat to establish the true level of loss. In large size plots grown under similar management on the station Wanser, McCall, Nugaines, Luke, Sprague, Moro, and Paha yielded 42.7, 42.9, 45.4, 46.8, 54.9, 42.5, 40.2 respectively. These plots were seeded September 6, 1974 and showed no visible symptoms of yellow dwarf. Thus, for each variety a significant loss due to yellow dwarf was obtained.

Bushel weights were not effected by the yellow dwarf virus. Thousand kernel weights (table 3) show that the size of the kernels were smaller in the infected plots. No attempt was made to separate kernels from healthy and infected plants so that actual effects were greater than shown. The clubs (Moro and Paha) showed the least effect.

With an increase in the irrigated area in the Columbia Basin and a wheat price which makes it a more competitive crop for irrigated culture, the trend will probably be toward more irrigated wheat; which will in turn decrease the green free period and increase the incident of aphids. The yellow dwarf problem in Central Washington is likely to become more frequent and more severe under present cultural practices, both for irrigated and adjacent dryland farmers.



First Vogel head thresher.

INFLUENCE OF MANAGEMENT PRACTICES ON CERCOSPORELLA FOOT ROT

R. James Cook and Jack T. Waldher

This research is conducted mainly on the Palouse Conservation Field Station near Pullman and can be observed on the Field-day tour of that station on July 1. The purpose of this work is to learn more about how tillage, straw management, and method of seeding affect the *Cercosporella* foot rot, also known as strawbreaker foot rot. Although carried out at Pullman where plot land is available, this work is relevant primarily to the intermediate rainfall area (e.g., Lacrosse, Dusty, St. John) where summer fallow is important, but also where soil erosion can be severe.

Most work to date has examined the influence of stubble-mulch tillage versus mold-board plowing on yields of Nugaines winter wheat and foot rot when early-seeded on summer fallow. Early-seeding is probably the best management available at present to control soil erosion on summer fallow, but is also the management most favorable to foot rot. Stubble-mulch tillage combined with the deep-furrow drill is also superior to mold-board plowing combined with the narrow-row disk drill for erosion control, but has not gained acceptance in the intermediate rainfall area.

The table below gives yields for the past 3 years on mulch versus mold-board tillage, with and without benomyl in a flat versus a drier slope. In 1973 and again in 1974, the mulch tillage was slightly suppressive to early fall wheat growth, and this favored weeds (mostly cheat grass) to the extent that final yields were less on mulched plots, especially on the drier slope. There was no weed problem in 1975 and yields were as good or better in mulched versus mold-boarded plots. Of special significance is that foot rot (as revealed by the yield response to benomyl) was consistently the worst in mold-boarded plowed plots. In 1975, the wheat in mulched plots yielded equally well with or without benomyl whereas in plowed plots, benomyl was needed to control foot rot and maintain yields. These results suggest that *Cercosporella* foot rot in the Palouse may be favored by the mold-board plow management system. They further suggest, however, that stubble-mulch tillage may suppress wheat growth and hurt yields for some reason other than increased foot rot. Weeds, straw toxicity problems, or other factors must be considered to explain the occasional depressed yield in mulched plots.

This work is continuing by examining fall versus spring plowing, and also by examining an early-late (double) seeding system that plants wheat in 32 or 48-inch row-spacings by deep furrow drill in early September, for erosion control, and then, over-seeds in 7-inch spacings by disk drill in October, for yield. It is too early to report results of these long-term studies.

Table 1. Summary of the influence of method of tillage and Benlate (one lb/A) on yields of Nugaines winter wheat seeded early (Sept. 1-5), by deep-furrow drill at 16 inch spacings on summer fallow at Pullman.

Terrain	Tillage	Yield with Benomyl	Yield without Benomyl
		1973 CROP YEAR	
Slope	Stubble-mulched	61.3	54.2
	Mold-board plowed	73.0	53.6
Flat	Stubble-mulch	54.5	47.6
	Mold-board plowed	60.5	52.6
		1974 CROP YEAR	
Slope	Stubble-mulched	39.0	39.1
	Mold-board plowed	80.3	62.0
Flat	Stubble-mulched	69.1	56.1
	Mold-board plowed	87.0	78.7
		1975 CROP YEAR	
Slope	Stubble-mulched	101.8	97.2
	Mold-board plowed	96.3	82.0
Flat	Stubble-mulched	103.3	100.2
	Mold-board plowed	103.6	89.8

TAKE-ALL IN IRRIGATED WHEAT

R. James Cook and Kevin Moore

Take-all of wheat is a continual problem in the irrigated districts of the Columbia Basin. The problem is greatest on new lands, or following an old stand of alfalfa. Usually, wheat is affected most in the second or third consecutive crop on the same field, but can be severe already in the first year of wheat following an old alfalfa stand that had become badly infested with cheat grass. The best control is rotation with row crops. Control may also be possible, however, by growing continuous wheat; after the second or third crop, the chances of getting the disease are less, or if it occurred in the second or third crop, it commonly declines in the fourth and subsequent crops. This decline in the disease with wheat monoculture is due to certain antagonistic organisms that build up and provide a biological control of take-all. The use of ammonium nitrogen together with N-serve to keep the nitrogen as ammonium helps reduce take-all but is not a complete control.

Research on take-all is underway at Lind and also at Puyallup where high rainfall occurs and favors the disease. We are attempting to determine the influence of alternate crops (e.g., potatoes, beans, alfalfa or grass) on the antagonistic organisms effective against take-all after several years of continuous wheat, and also the influence of no-tillage and certain fertilizer or manurial treatments on take-all.

The work with alternate crops has only just begun and thus no results are available at this time. The work with no-till is preliminary, but indicates that take-all may be favored somewhat by no-till, compared to conventional till. Wheat in no-till plots was more severely affected by the take-all, already in the seedling stage, compared to wheat in conventionally-tilled plots. Where the soil was fumigated to eliminate the take-all fungus, wheat grew uniformly well and vigorously regardless of tillage method. The possibility exists that unidentified soil organisms in addition to the take-all fungus also damage the wheat under no-till. Of special interest is that certain manurial treatments, for example chicken manure mixed into the soil, or even spread on the soil surface, was almost as good as soil fumigation in controlling take-all. Work is now underway to find why manure controls take-all, and whether a similar control can be obtained with sludge.

WATER STRESS STUDIES IN RELATION TO FUSARIUM (DRYLAND) FOOT ROT

R. James Cook and R. I. Papendick

Work is continuing at Harrington on water use and water stress tendencies of various wheats seeded early in *Fusarium*-infested soil. Nugaines, Hyslop, Wanser, Coulee and Burt are among the wheats most susceptible to the *Fusarium*. Moro and Paha are among the moderately-resistant wheats. Luke and Sprague are most resistant to the disease and yield the best of all commercial wheats tested to date in the *Fusarium*-infested soil. Excess nitrogen fertilizer is highly favorable to this foot rot, because it leads to plant water stress. Even Luke and Sprague may show severe *Fusarium* foot rot if over fertilized for the water available.

Future emphasis in this project will be directed more at improving the *Fusarium* resistance of hard red wheats. Since resistance to *Fusarium* and ability to avoid or tolerate water stress are closely related attributes in wheat, we anticipate that wheats with *Fusarium* resistance will also have improved dryland capability. The expanded testing for *Fusarium* resistance in hard wheats will be conducted on a special 4-acre site on the Dryland Research Unit that has been infested with the *Fusarium* by repeated introduction of the fungus over the past two years. Our plan is to screen large numbers of wheats on this site at Lind, and then examine the promising lines in our more detailed water-stress studies presently carried out near Harrington.

SOIL FUMIGATION FOR WHEAT

R. James Cook and Jerry W. Sitton

Soil fumigation studies are underway at Pullman, Walla Walla, and Lind to learn more about the losses caused by harmful soil organisms (e.g., seed-, root-, or foot-rot fungi, or organisms that produce phytotoxins) and also to determine the practicality of soil fumigation for wheat production. The fumigants under test include methyl bromide, chloropicrin, Telone, and Telone C. The Telone treatments are similar to those already in commercial use in the Basin for potatoes. The Walla Walla and Pullman sites are rotated between wheat and peas to determine whether fumigation for control of soil borne diseases of wheat might have the carry-over benefits for peas.

Contrary to common belief, fumigation does not "sterilize" the soil. In fact, even the best fumigants applied under plastic cover destroy no more than 90% of the common soil organisms, and by 2-4 weeks their populations are equal to or even higher than in the non-fumigated check plots. However, there are major micobiological shifts in kinds of organisms present and the net effect is favorable to wheat growth. Tillering is increased by up to 40% with fumigation. Plant vigor and height are also increased. Yields have been increased by 15 bu/A at Pullman and 30 bu/A under irrigation at Lind. However, these may not be fair representations since, with the additional tillering and height, there is more lodging and more grain is probably lost in the harvesting operations of the fumigated than non-fumigated plots. The fumigants also provide good to excellent weed control.

It is not expected that fumigation will work anywhere other than for irrigated wheat. The possibility exists that wheat is already benefiting from fumigation when grown on land fumigated the previous year for potatoes. The benefits to irrigated crops in addition to wheat will continue to be a major consideration of this project.

SOIL FERTILITY MANAGEMENT

A. R. Halvorson
Extension Soil Scientist
Washington State University

Soils fertility varies a great deal throughout a field. A uniform rate of application of fertilizer over the entire field will result in more fertilizer than necessary on those areas in the field which are already high in fertility. If such areas constitute 20% or more of the field, fertilizer costs for that field will be considerably higher than necessary. Also, it is from the overfertilized areas that the greatest potential for nutrient loss to surface and ground waters exists.

The practice of sampling the different areas in a field and then fertilizing each area according to needs, provides one of the best means of making efficient use of our fertilizer resources while at the same time it helps hold potential loss of nutrients (mainly nitrogen) to surface and ground waters to a minimum.

There is a problem in determing what constitutes a uniform area within a field. There are some observable differences in a field that are often associated with differences in soil fertility. An effort is being made to relate visible differences in a field, such as topography, etc., to differences in fertilizer needs, especially nitrogen, so that field sampling guidelines can be drawn up.

BARLEY BREEDING AND TESTING PROGRAMS IN WASHINGTON

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

Barley improvement in the State of Washington consists of 1) an extensive breeding program at Pullman in which five different types of winter and spring, malting and feed barleys are being developed, 2) selection and testing programs at Lind (Dry Land), Davenport (Winterhardiness) and Royal Slope (Irrigated), and 3) testing programs in Eastern Washington at Pullman, Walla Walla, Dayton, and Pomeroy; and in Western Washington at Vancouver, Puyallup, and Mt. Vernon.

Following are brief descriptions of progress toward new varieties in the different types of barley under development.

In the winter barley program, both 6-row and 2-row types are being developed. Winterhardiness is one of the major limiting factors to widespread production. Nevertheless, significant advances have been made in developing more winterhardy, stiffer, and shorter strawed 6-row winter types. Kamiak and Boyer are two new varieties from this program. Boyer, released in 1975, is mid-short and appears well adapted to both non-irrigated and irrigated land. It has been the top yielding selection in the Western Winter Barley Nursery and in Eastern Washington for the years tested. It is more winterhardy than Luther and about as hardy as Kamiak and Hudson. Progress has been made toward incorporating acceptable malting quality and high protein and lysine into our high yield varieties and selections.

Winter 2-row types are being developed primarily for malting. Considerable progress has been made in increasing winterhardiness by using hardy 2-row types introduced from Germany which have good quality. Yield tests of the best new WSU 2-row selections have shown about a 10% increase in yield over Luther. Considerable emphasis is being given to this project because of the significant yield advantage, i.e., 20-25%, winter 2-row strains have over spring-sown 2-row varieties. Selections from new crosses with high quality parents are inhibiting good yield and quality and considerable winterhardiness.

The spring barley breeding program includes the development of superior spring 6-row feed and malting types and 2-row malting types. Recent results from these programs are the very high-yielding 6-row feed variety, Steptoe, and the superior yielding 2-row malting type Vanguard. Steptoe in 1975 occupied 63% of the barley acreage in Washington and much of the spring feed barley acreage in other Northwest states. Vanguard was approved in 1971 as an acceptable malting type, being superior to Piroline in quality and yield. Crosses have been made to add malting quality and increased protein and lysine content to Steptoe and other high yielding spring-type selections.

In 1974, Blazer (Washington 6704-62, Traill x 1038) was released as a potential replacement for the 6-row malting variety Traill. The variety has consistently outyielded Larker and Traill by 10-15% and is significantly more shatter resistant. It is increasing in acreage and rapidly replacing Traill. A number of newer selections having quality comparable to Larker are included in Eastern Washington yield trials for the first time this year.

DRYLAND AND IRRIGATION BARLEY TESTING PROGRAM

A general description of the barley breeding program and progress in producing new varieties of the winter and spring feed and malting types is presented on page .

The Lind Dry Land Research Unit is a valuable selection and testing location for winter and spring barleys being developed at Washington State University.

In the spring barley nursery, Steptoe continues to outyield Unitan by a sizeable margin; Blazer, the new malting barley selection, significantly outyields Larker and Traill; and Vanguard significantly outyields Piroline.

The winter and spring selection and testing program has been extended to irrigated areas. Very high yields with good plump kernels have been obtained at Royal Slope for several varieties and selections. Steptoe has outyielded Unitan by almost three-quarters of a ton. Two-row barley also produced excellent yields. Blazer has produced higher yields than Traill or Larker and did not shatter under irrigation. Quality of the malting types is also quite satisfactory. Thus, it appears that malting barley acreage might be profitably extended to the irrigated areas of Washington. This may be important since the demand for 6-row malting barley is increasing.

PULLMAN (SPILLMAN FARM) BARLEY BREEDING PROGRAM

Visitors at the Field Day at Pullman will have an opportunity to see in demonstration plots early and late seedings of sixteen current varieties and new advanced selections of 2-row and 6-row winter feed and malting barleys and 25 current varieties and new advanced selections of spring 6-row feed, of spring 2-row malting, and spring 6-row malting barleys. The main new varieties and most promising new selections were described in the general information on the barley program on page 42. Numerous other advanced selections will be demonstrated at the Field Day.

Some representative results from tests at Pullman are summarized in Table 1 for some of the more advanced selections and our new current varieties. Steptoe produces about 750 lbs. while Blazer, our potential malting variety, produces about 200 lbs. more yield than Unitan. Karl, the potential new malting variety from Idaho, yields somewhat less than Unitan and Larker. Among the 2-row malting spring types, Vanguard still continues to outyield Piroline and also Klages the new high quality 2-row malting barley from Idaho.

Among the winter feed barleys, the yielding ability of Boyer (Sel. 1094) compared to Kamiak, Luther, and Hudson is shown. High yields, increased winterhardiness and plump kernels are being obtained among our 2-row winter selections bred for malting quality. The yield of Selection 2464 compares favorably with those of the 6-row winter varieties Luther and Kamiak and is much higher than the yield of Vanguard (spring sown).

The selection and testing program under dry land and irrigated conditions is described above.

Table 1

Comparative Yields of Barley Types
Pullman, 1971-75

(Lbs. per Acre)

Winter Type		Spring Type	
6-Row			
Boyer (Feed)	6214	Steptoe (Feed)	4839
Kamiak (Feed)	5863	Blazer (Malting)	4292
Luther (Feed)	5249	Unitan (Feed)	4077
Hudson (Feed)	4673	Larker (Malting)	3726
White Winter (Feed)	4305	Karl (Malting)	3654
2-Row			
Sel. 2464-70 (Ack.989 x R.T.H.) (Potential Malting)	5010	Vanguard (Malting)	3909
Ackerman's 989 (Potential Malting)	4800	Piroline (Malting)	3585
		Klages (Malting)	3264

OATS BREEDING

C. F. Konzak, M. A. Davis, K. J. Morrison, P. Reisenauer

The locally released variety Cayuse continues to dominate oat production in the region, and Cayuse has continued its high yield performance. However, Cayuse has a major fault, in its relatively low test weight compared with Park.

Cayuse was released because of its high yield capability, and barley yellow dwarf virus (BYDV) tolerance. A number of new selections from WSU and the Aberdeen, Idaho station now show promise of yield superiority over Cayuse.

New Selections

WA6013 and WA6014 from the CI2874/Cayuse appear to show some yield advantage over Cayuse, but little improvement in test weight, with possibly some improvement in BYDV tolerance and adaptation. Plant lines of these selections are being increased in 1976 for potential use as Breeders Seed should their 1976 performance merit their consideration for release.

LENTIL IMPROVEMENT

V. E. Wilson and Richard Short

The objectives of the lentil research program are to improve lentil varieties, production practices, and to determine factors affecting lentil production and quality.

Spring-Type Lentils (1975)

Summary of yield trials. Two lentil varieties and 14 selections were grown in comparative yield nurseries located near Colfax, Fairfield, and Pullman, Washington, and Genesee, Idaho. Statistical analysis of seed yield data showed two lentil lines at Fairfield produced seed yields significantly higher than Tekoa, and eight lines were superior to the Chilean check. The experimental lines 554 and 29 yielded 1,444 and 1,395 lb/A, respectively. Tekoa and Chilean yielded 1,255 and 1,001 lb/A, respectively. Seed yields from nurseries located near Colfax, Pullman, and Genesee showed no significant differences between lines.

Pod shatter. To determine the effect of pod shatter on yield the 14 advanced breeding lines and two varieties were tested for shatter losses. The losses were compared with seed yields. Shatter was determined by counting all the mature pods that dehisced or were detached from vines by wind and other natural causes. The number of pods that feel to the ground within a 12-x 12-inch^2 space beneath test plants was used to estimate pod loss differences. Counts showed that line 571 and Chilean had the lowest number of shattered pods in 1975. Counts made during 3 consecutive years showed line 64-18 and Chilean check had the lowest amount of pod shatter. Also, data showed the highest-yielding lines and the highest rates of shatter during the past 3 consecutive years. These data do not support the assumption that shatter has an appreciable effect on seed yield.

Seed yield rankings changed greatly from year to year. For example, line 554 ranked first in 1975, fourth in 1974, and sixth in 1973; line 486 ranked seventh in 1975 and first in 1974. This lack of regularity for yield might indicate plant response to environmental factors.

Heat stress. Heat stress studies were conducted at Prosser and Pullman, Washington, to determine the effect of high temperatures on pod development, seed yield, and seed coat cracking. On May 28, 1975, at Prosser and on June 11, 1975, at Pullman seed of Tekoa and Chilean were sown and repeatedly irrigated throughout the season.

Data collected by Dr. Matt Silbernagel, Prosser, showed that few flowers developed pods and those had few malformed seed. No viable seed was harvested from plants at Prosser.

At Pullman lentil seed sown on June 11 produced plants and seed similar to those produced at Prosser. Three percent of the plants produced pods and less than 1% set seed. The maximum number of seed produced on any one test plant was four malformed seed. Seed failed to mature in the Pullman plots and subsequently they were not harvested.

Twenty-five plants from seed sown on May 1, 1975, produced an average of 264 flowers per plant on July 10 to 13 (experimental line 64-18). At harvest time an average of 48 seed per plant were collected; each pod contained an average of 1.5 seed per pod. From these observations, it was estimated that 32 flowers per plant produced the 48 seed per plant. Therefore, it appeared that 87% of the flowers aborted. During the flowering period, the maximum daily air temperatures for 15 consecutive days (July 1 to July 16) ranged from 75 to 97 F. From July 20 to 29, the maximum daily air temperature ranged from 80 to 97 F. Soil moisture was relatively good during the growing season.

In growth chambers, earlier studies on heat stress showed that lentil plants had more normal growth patterns, produced more flowers per plant, and developed more pods at 65 F than at 75 and 85 F. Also, more viable and active pollen was produced at 65 F than at 75 and 85 F.

Heat stress studies strongly suggested that atmospheric temperatures above 65 to 70 F during flowering periods caused flower abortion and a reduction in seed yields. Also, these studies strongly suggested that current experimental lentil lines have been adversely affected by high temperatures at flowering time. Therefore, the upper yield potentials of lentil lines may not have been realized.

These studies indicate a need to develop lentils that are tolerant to atmospheric temperatures above 70 F during flowering periods.

Winterhardy, Fall-Sown Lentils–1974 to 1975

Summary of yield trials and observations. Seed of three, winterhardy lentil lines were sown in October, 1974, in randomized plots on the Spillman Farm. In the following spring, seed of the same three winterhardy lines were sown in plots adjacent to the fall-sown plots. Summary of the yields showed fall-sown lentils increase yields over spring-sown Chilean lentils by about twofold. Observations made on fall-sown, winterhardy lentils indicated that flower anthesis began about May 1 and continued throughout the month. During this period, the average maximum air temperature was about 65 F.

Breeding

Research was continued to identify and test characters that will increase seed yield potential. Plant introductions were screened and progeny from crosses were tested. Backcrosses were made and tested to transfer advantageous genes into plants that will be harvestable and produce high yields.

Crosses and backcrosses were used to transfer high protein content from small-seeded lines to large-seeded lines.

More than 500 winterhardy lines were grown and evaluated in the field for resistance to cold damage. These lines were planted in October, 1974, and 1975. From previous plantings, acceptable plant types with good seed yield potentials and harvestibility were identified.

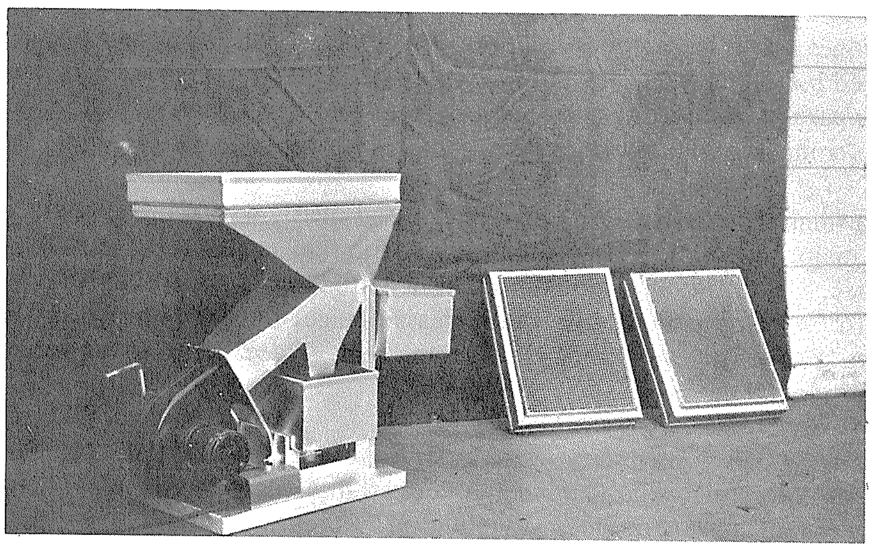
Cultural Studies

In the fall of 1975, winterhardy lentil seed was sown in no-tillage seed beds following barley and in bluegrass sod. The purpose was to determine if the high seed yields of winter-sown lentils could be maintained when sown on no-tillage land.

Plots were sown for testing weed control chemicals on fall-sown lentils.

Diseases

Disease surveys were made in lentil-growing areas of Idaho and Washington when plants were 4 to 6 inches tall and again when plants were in full bloom. In both the early and late surveys, lentil crops were relatively free from foliage diseases. In soil at low elevations in fields, some root damage was observed. *Rhizoctonia, Fusarium,* and *Ascochyta* were the organisms most frequently isolated from lentils. At Prosser, Washington, lentil plants appeared to be infected by several virus diseases.



Vogel cleaner.

BREEDING, DISEASES AND CULTURE OF DRY PEAS

F. J. Muehlbauer and J. L. Coker

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', have been released this year. In yield tests over the past three years, Garfield, a large-seeded selection, has yielded 15% more than common Alaska.

Garfield is resistant to *Fusarium* wilt race 1, is larger seeded, and has a longer vine habit when compared with other Alaska strains. The increase in plant height should improve harvesting ease, especially on ridges where lack of vine has been a problem. Garfield did not differ from Alaska in resistance to seed bleaching, powdery mildew, or mechanical damage. Garfield flowers at the 14th node and has apparent tolerance to pea root rot, two factors which should 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 should improve harvesting ease on the ridges where lack of vine has been a chronic 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.

Both Garfield and Tracer performed well in the root rot nursery conducted at Prosser. The apparent resistance to pea root rot is an attribute of these varieties 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 within a given year. Both Garfield and Tracer were increased at Yuma, Arizona, this past winter to gain time in the initial stages of increase.

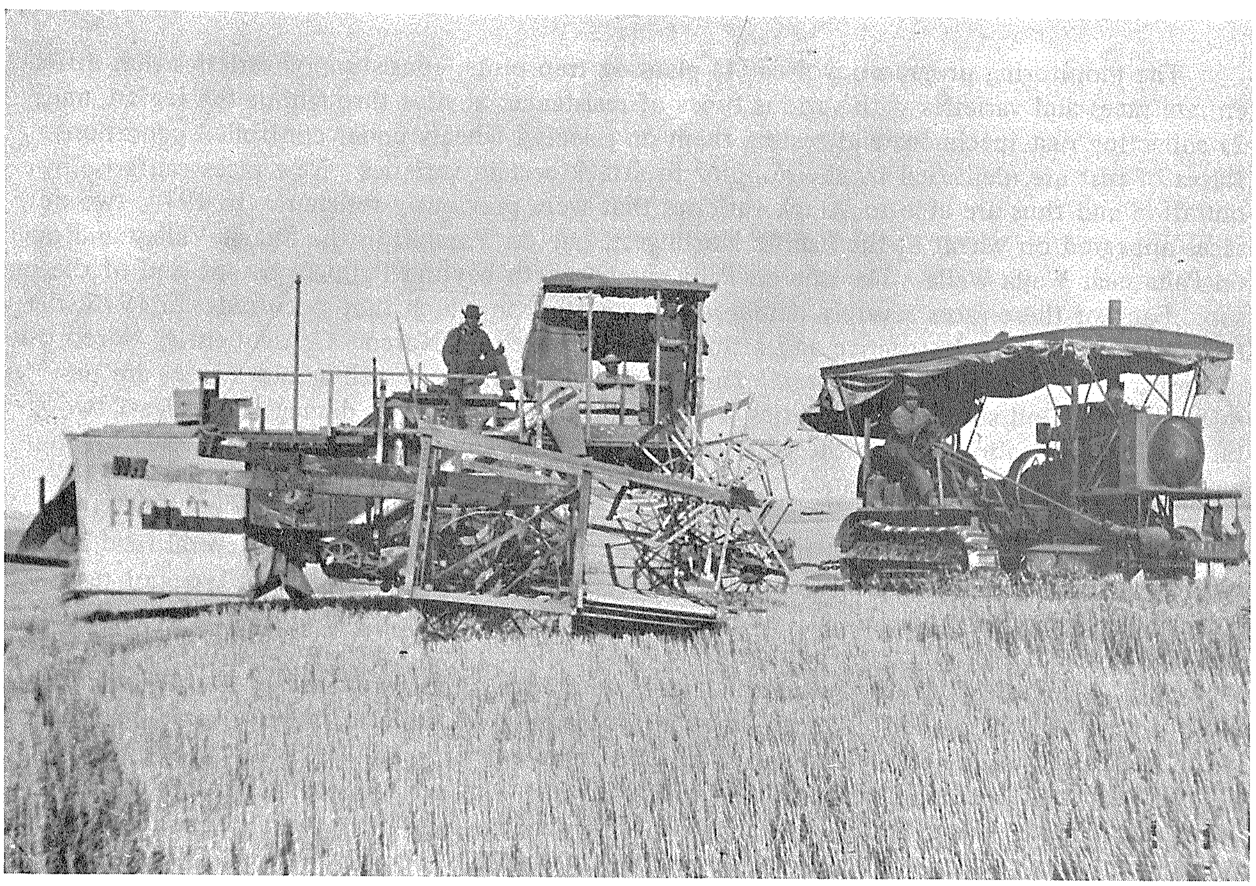
Pea seedborne mosaic virus has caused problems in our breeding program and is a potential serious threat to both dry peas and lentils. Because of the obvious threat this virus poses to the industry, we are incorporating resistance to the virus into 16 pea varieties. These 16 varieties include five dry peas, ten freezer and canner peas, and one Austrian winter pea. We are now in the first backcross and plan to make a total of seven backcrosses. This project should be completed in about three years. Hopefully, the virus-resistant derived lines will be a means of preventing new outbreaks of the virus.

It has been known for some time that the virus will also attack lentils and is seedborne in that crop. Since resistance to the virus was not known, we screened the world collection this past year and were able to identify several sources of immunity. We are now in the process of studying the inheritance of resistance and the feasibility of incorporating resistance into commercial lentils.

Nearly 300 selections were screened for resistance to powdery mildew at Pullman. The natural infection obtained by planting late in June reached epidemic proportions at about bloom the entire nursery was infected. Eight lines showed near immunity and survived to produce seed. These eight lines will be increased and evaluated for agronomic characteristics and for possible use as parents.

About 35 lines with pea seed weevil-resistant parentage that are resistant to *Fusarium* wilt race 1 and have good agronomic qualities will be increased in 1976 and evaluated in 1977 for resistance to the insect. Hopefully, an agronomically acceptable line can be identified and used as a control measure for the insect.

A number of pea lines have been identified by Dr. L. O'Keefe, entomologist at the University of Idaho, and his graduate students as being tolerant to the pea leaf weevil. Tolerance appears to be associated with vigorous plant types with large leaves. Hopefully, we will be able to use this germ plasm to develop pea varieties tolerant to insect feeding and effective in reducing the reproduction and survival of the insect.



Early tractor and combine.

RUST, POWDERY MILDEW, AND SMUT

Roland F. Line

RUST

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; 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 stem. Stripe rust and leaf rust overwinter on wheat plants and increase during the spring. Stripe rust develops during the cool temperature of early spring and 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 and their potential importance in the future; 2) identifying and utilizing various types of resistance and evaluating new lines for resistance; 3) evaluating fungicides at various rates and schedules to determine their ability to control 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 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. The one on Paha spread north beyond Pullman by the end of the season. Each of these races severely damaged the varieties on which they occurred. In 1975, the two races were again destructive and a third race appeared on Norco. Consequently, Norco was not released to be grown in the area. This year, the new races as well as older races are prevalent in Washington and susceptible varieties will probably be significantly damaged. At least two races of leaf rust also occur in the area. Most existing varieties are susceptible to leaf rust, but new lines with improved resistance have been identified.

Research on resistance to stripe rust and leaf rust is being conducted at several field sites where the rusts occur and under controlled environmental conditions. Several types of resistance to stripe rust have been identified. Some types of resistance 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, and 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 sources of resistance have been identified.

As part of the research program we are evaluating fungicides at various rates and schedules at several locations where rust occurs. Some new systemic fungicides have provided good control of both rusts. They are even more effective when the varieties have some resistance. 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.

POWDERY MILDEW

Powdery mildew is prevalent throughout the region and is most prevalent in areas with higher rainfall and in irrigated fields. Accurate measurement of the damage caused by mildew is difficult to obtain. 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; however, there are good sources of resistance that are being incorporated into new varieties.

SMUT

Flag smut has been found in most counties of Washington and in a few counties of Oregon and is most severe in Klickitat County, Washington. It is only important in the Pacific Northwest. Varieties and lines have various degrees of resistance. Wanser is very resistant; Nugaines, Gaines, and Moro have relatively high degrees of resistance; Luke is moderately susceptible and Paha is very susceptible (more susceptible than Omar). A few new, systemic chemicals will control flag smut. Of those that are very 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 the severity of flag smut. The higher temperatures in the early fall increase the disease. The effects of cropping sequence, tillage practices, and other management practices in relationship to flag smut survival and severity and the relationship of flag smut to yield and quality of wheat are being studied. It appears that the most effective control program for flag smut is the combination of several methods of controlling the disease.

Dwarf bunt has become more important in recent years because of restriction on the sale of contaminated grains in certain counties. At present a cooperative study, involving Dr. Duran and Dr. Schafer in Plant Pathology, and several plant breeders, is in progress to obtain information on the factors that contribute to dwarf bunt and the mechanisms of dwarf bunt resistance.

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. Consequently, in cooperation with Dr. Hoffman at Logan, Utah, Jack Waldher is evaluating new sources of resistance, new breeding lines, and new seed treatments for control of common bunt.

FOOT ROT RESEARCH, 1975-1976

G. W. Bruehl and R. Machtmes

Benlate, a fungicide effective against straw breaker (*Cercosporella*) foot rot, received an emergency clearance in Oregon, Washington, and Idaho, permitting farmers to try it. It was recommended for trial only on winter wheat seeded early on land with a known history of foot rot. Symptoms were supposed to be present on some of the plants at the time of spraying. These precautions were listed to prevent spraying healthy wheat. The fungicide costs approximately $9.00 per pound and the label called for one pound per acre. All local experimental data were obtained with ground application, but aerial application would have been necessary in early spring on our heavier, wetter soils. Farmer response was disappointing in that few farmers used the material, even on a limited trial basis.

We strongly feel that, should DuPont receive a permanent label, Benlate can become a useful tool. Farmers in the higher rainfall summer fallow area could seed earlier than they do now on a sustained, every year basis, if they knew that an effective fungicide was available that would prevent serious foot rot losses.

In the summer fallow area, reasonably early seeding should give the highest potential yield, and larger plants would reduce erosion and water run-off substantially.

If the potentially greater yield of wheat from early seedings plus the erosion control benefits are weighted against the cost of the Benlate, the balance should favor early seeding.

Assuming that Benlate becomes a legal material, farmers wishing to move toward earlier seeding should use moderation. Very early seeding exposes wheat to increased danger from virus diseases (yellow dwarf and wheat streak mosaic) and from stripe rust.

Another factor, many farms in the high-production summer fallow region have lighter soils which would permit Benlate application by ground rigs. It is probable that, if applied by ground, smaller amounts of fungicide will give reasonable control.

A great interest in no-till as a means of erosion control exists today. It is conceivable that good use of present methods plus earlier seeding plus Benlate will produce more wheat at lower cost and achieve acceptable erosion levels.

As of this writing, Benlate has not received a permanent label, but we should know prior to planting time.

We established a small foot rot nursery at Puyallup. The disease is progressing well and progress in evaluating parental materials and some breeding material should result. As a bonus, aphids have thoroughly invaded this plot and a natural yellow dwarf attack will enable us to locate the most promising lines for use as parents.

WINTER DISEASES, 1975-1976

G. W. Bruehl, R. Machtmes, and P. Lipps

The most important winter disease, snow mold, developed only on steep slopes where early snow drifted in Douglas County. No mold developed in our nurseries so we will be unable to select resistant wheats this year.

In the 1968-1969 season, the largest winter wheat nursery at Pullman, Washington was destroyed under deep snow. No known snow mold fungus was responsible. Vogel found water running in the drill rows under the snow and believed the wheat had drowned. A water mold fungus filled these plants.

In the present season, Sprague, which is moderately resistant to snow molds, died on significant acreages in the poorly drained areas of the Colville Indian Reservation, Okanogan County. It also died in scattered water ways in Douglas, Stevens, and northern Spokane Counties. In all locations ice and water occurred. Drowning alone did not kill the wheat because it lived in some areas where water stood for longer periods than where it died. In all locations Pat Lipps isolated the water mold fungus from the dead wheat. This trouble is under intensive study. It should not be a widespread problem as it is confined to very wet sites, but it does occur sufficient to require some reseeding, and apparently resistance to regular snow mold does not protect against it.

Another winter disease developed in the region between Kahlotus and Harrington to a limited extent. *Typhula incarnata*, which forms reddish-brown resting bodies about the size of radish seeds on roots and particularly on the leaf sheaths of wheat crowns below the soil surface, killed scattered plants. It developed on plants weakened by some factor. In some cases weak plants from very deep seeding were especially damaged. We plan to investigate this matter also.

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 Mateials 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.

CONTRIBUTORS IN SUPPORT OF RESEARCH
1975-76

Fertilizers and Amendments

Collier Carbon & Chemical Corporation
Cominco American, Inc.
Gardner & Smith
J. R. Simplot
Tennessee Valley Authority
McGregor Company
Ortho Division, Chevron Chemical Company
Northwest Plant Food Association
Wilson & Geo Meyer & Company

Herbicides and Pesticides

Amchem Products, Inc.
Geigy Chemical Corporation
ICI America
McGregor Company
Olin
Rhodia, Chipman Division
Rohm & Haas
Uniroyal
Velsicol

Growth Regulators

Eli Lilly and Company, Greenfield, Indiana
Merck Chemical Division, Rathway, New Jersey
Rohm and Haas Company, Spring House, Pennsylvania

Cash Contribution

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Washington Wheat Commission
Washington Pea and Lentil Commission
Crop Improvement Associations
Pacific NW Crop Improvement Association
Malting Barley Improvement Association

Farmer Cooperators

Variety and Disease Plots

Cliff Adams	Waterville
Orin Anderson	Clyde
Harold Beard	Mansfield
Bud Benedict	Asotin
Elwood Brown	Bickleton
Clarke Farms	Albion
Harry Davis	Lamont
Richard Deffenbaugh	Kennewick
Jack DeWitt	Walla Walla
Diamond Spear Angus Ranch	Lamont
Jim Ferrell	Walla Walla
Paul Harrell	Ellensburg
Heitstuman Farms	Uniontown

Merle Ledgerwood	Pomeroy
Lehn Brothers	Farmington
Carl Meilke	Harrington
Woodrow Mills	St. John
Harold Naught	Bickleton
Arthur Ott	Addy
Kenneth Parks	Fairfield
Elton Polson	Waterville
Bill Schmidtman	Waterville
Ernie Stueckle	Dusty
Harold Stueckle	Colfax
Warren Talbot	Dayton
Bayne Farms	Horse Heaven
Earl Williams	Reardan

Ed Hiller & Son	Pomeroy
Vern Hoffman	Rice
Robert Kramer	Harrington
Quentin Landreth	Espanola
Ed Nichols	Dayton
Bob Kissler	Odessa
Cecil LaRue	Colfax
Don Jensen	Waterville
Harry & Milt Schwisow	Ritzville
Dale Bauermister	Connell
Henry Seusse	Colfax
Don Ogle	Waterville

Fertility, Water, and Tillage Trials

Joe Abbey	Waitsburg
Gary Brash	Spangle
Jack DeWitt	Walla Walla
Dewey Donahue	Dayton
John Dorman	LaCrosse
Maurice Eaton	Dayton
Karl Felgenhauer	Waverly
Larry Gady	Rockford
Gerald Hawks	Dayton
Heer Brothers	Ephrata
Willard Henning	Ritzville
Lamar Homberg	Odessa
Robert Hutchins	Dayton
Tom Hyslop	Spokane
William Jacky	Reardan
Robert Kramer	Harrington
Lawrence Loebsack	Waterville
Conway McDonald	Rockford
McGregor Land & Lvstck.	Hooper
John Moon	Prosser
Dan Plaster	Reardan
Ralph Reifenberger	Fairfield
Jim Scott	Pomeroy
Harold & Ben Stueckle	Colfax
Morton Swanson	Palouse
James Teel	Davenport
Elmo Tanneburg	Coulee City
Don Wellsandt	Ritzville
Jay Wernz	Fairfield
Carlos White	St. John

Weed Plots

Asotin County Road Department	Asotin
Bud Benedict	Asotin
Albert Bruce	Farmington
Roy Eslick	Dayton
Francis Fitzgerald	Clarkston
Kendry Ginlin	Clarkston
Jim Hanger	Dayton
Henry & Juris	Dayton
John Robinson	Pomeroy
Radio Station KCLK	Clarkston
State Highway	Colfax
Stueckle Brothers	Colfax
Don St. John	Palouse
Dean Whitman	Benge
Bob Whitmore	Pullman

POSTHARVEST DORMANCY, GERMINATION, AND EMERGENCE

Donald W. George

Postharvest dormancy was found to be relatively low in freshly-harvested 1975 crop seed. In spite of this, there was little head sprouting reported after the August rains. Wheat piled outside on the ground suffered little damage if properly piled.

These observations tend to emphasize that there is considerable lack of knowledge about the developing wheat crop and its response to the environment as a cause and effect relationship.

Based primarily on European work, we know that a short period (a few days) of above 85° temperatures occurring during the soft dough stage of development of the crop tends to reduce postharvest dormancy to low levels. In contrast, protracted cool weather (experimentally 60° and lower) at that stage results in maximum postharvest dormancy of the crop. The spring and early summer of 1975 in Eastern Washington were regarded as unusually cool, with the weather suddenly turning hot about July 4. Perhaps this hot weather caught most of the crop before completion of the soft dough and resulted in low dormancy. It may be that the August rains were not accompanied by long enough periods of high humidity to complete head sprouting, but this can only be guessed as we are woefully lacking in precise, detailed observations of the micro-climate in a wheat field. This is a handicap which limits all of our developmental studies of the wheat plant. We do have data from Spillman Farm showing little or no reduction in falling numbers following the rains.

The needs of the Japanese Food Agency can only be met by wheat with a low alpha-amylase content (giving a high value in the falling numbers test). A low falling number value is an indicator of high alpha-amylase content which may be caused by head sprouting or even by incipient sprouting of the crop. The quality defects in the flour caused by sprout damage cannot be rectified by blending with sound grain and they are unwilling to accept a cargo which contains sprout damaged grain or gives a low reading in the falling numbers test.

This poses an economic dillema which requires, if not a solution, at least an agreement on a course of action. Breeding can produce red wheats with a high level of postharvest dormancy and white wheats which may approach that level, as we have seen with Brevor. Varieties can also be produced through breeding which have essentially no postharvest dormancy. Most present varieties lie on the intermediate to dormant side. Postharvest dormancy is an important characteristic in preventing head sprouting in Northern Europe but our weather conditions during rare summer rains appear to be capable of breaking the dormancy that we find in wheat grown here.

On the other hand, seeding in the summerfallow area typically is done in a warm or even hot seedbed with sometimes less than adequate moisture. Under these conditions, postharvest dormancy in planting seed often results in poor stands. When partially dormant seed is planted, it requires more available moisture and a longer time for germination and emergence than does non-dormant seed.

The question is: Which is more advantageous to the grower: to maintain at present levels or possibly reduce (but not eliminate) the chances of lost sales which result from head sprouting, or to eliminate the need for holding planting seed over a year in order to avoid the emergence problems of partially-dormant seed? The latter choice offers as an added benefit faster increase of newly-released varieties.

WINTERHARDINESS STUDIES

Donald W. George

Despite a record of generally-successful production, our white wheat varieties lack an adequate level of cold hardiness for present and future needs and there are strong indications that the general level of cold hardiness is declining in the new breeding lines of hard red wheats as represented in the Regional Nursery. There has been a general negative correlation between yield and cold hardiness among improved wheat varieties until recently, when some of the newer lines of white wheat have reversed the trend. The new variety Daws is the most cold hardy semidwarf white variety yet produced and it has also an excellent yield record.

New management systems necessary to improvement of water quality are being proposed and developed and each is likely to present a different environment for winter survival. Earlier planting dates are being recommended and this means that the wheat plants are older and larger, having passed the most hardy stage of growth, before the likely onset of extreme cold. Cold hardiness information gained from later plantings doesn't apply; and the converse, that early-seeded tests (such as our Winterhardiness Nursery) do not always provide reliable information about survival from late seedings, is also true. It appears, however, that a variety which has good hardiness from early planting is also hardy when seeded late. It has been reported informally that, at least under one combination of variety and environment, wheat seeded under a heavy surface residue of stubble is more susceptible to winterkill than when seeded in a conventional seed bed. This is contrary to expectation based on other experience, but, if further experience confirms this behavior, it is another problem which must be faced and solved before "no-till" management can be successful.

Winterhardiness is the sum of a variety's reactions to an everchanging complex of hazards which are or may be encountered during a winter. There is no way to simulate this complex artificially and, consequently, winterhardiness can only be measured in a field environment, and these are seldom the same one year to the next. To be adequately winterhardy for a given area, a wheat variety should only rarely, if ever, be seriously injured by the winter conditions of that area. The cold hardiness component of winterhardiness can be simulated artificially and, when plants and test conditions are properly standardized, a good indication of varietal cold hardiness can be achieved. These laboratory tests must be supplemented by field observations of the same material grown under severe natural conditions, and it is likely that the necessary level of severity can only be assured by planting in some geographic location where normal climatic conditions are more severe than any to be found locally.

LISTING OF COOPERATIVE PERSONNEL AND AREA OF ACTITIVY

Glenn Terrell . . . . President, Washington State University
J. S. Robins . . . . Dean, College of Agriculture
J. Nielson . . . . Director of Research, College of Agriculture
J. O. Young . . . . .Director of Cooperative Extension
J. C. Engibous . . . . Chairman, Department of Agronomy and Soils

Cereal Breeding and Genetics

R. E. Allan and J. A. Pritchett, Cooperative USDA, Pullman . . . . Wheat Genetics
E. Donaldson, Dry Land Research Unit, Lind . . . . .Wheat Breeding
D. W. George, Cooperative USDA, Pullman . . . . Plant Physiology
C. F. Konzak, M. A. Davis, Pullman . . . . .Wheat Breeding & Genetics
R. A. Nilan, A. Lejeune and C. E. Muir, Pullman . . . . .Barley Breeding & Genetics
D. Henderson, Steve Hayward . . . . .Wheat Breeding
C. J. Peterson, Cooperative USDA, Pullman . . . . .Wheat Breeding
R. L. Warner, A. Kleinhofs, R. A. Nilan, K. Jackson . . . . Cereal Evaluation Laboratory

Cooperative Regional Wheat Quality Laboratory

G. L. Rubenthaler . . . . Research Cereal Technician in charge
Wheat Quality Laboratory
S. J. Kitterman . . . . Research Chemist
P. L. Finney . . . . .Research Cereal Technician
H. C. Jeffers . . . . Experimental Miller
P. D. Anderson . . . . Experimental Baker
S. A. Boehme . . . . .Flour Analyst
L. J. Gray . . . . .Early Generation Testing

Cooperative Varietal Testing

S. E. Brauen, Puyallup
P. C. Crandall, Vancouver
S. M. Dietz, Central Ferry
E. Donaldson, Lind
S. Haskey, Puyallup
K. J. Morrison, Pullman
C. E. Muir, Pullman
M. Nagamitsu, Lind
R. A. Nilan, Pullman
P. E. Reisenauer, Pullman
C. J. Peterson, Pullman

Cereal Diseases

G. W. Bruehl, Pullman . . . . Cereal Viruses, Foot Rots and Other Diseases
R. J. Cook, Cooperative USDA, Pullman . . . . .Root Rot Diseases
J. W. Hendrix, Pullman . . . . Leaf Rust on Wheat Septoria
R. F. Line, Cooperative USDA, Pullman . . . . Flag Smut Control

Soil Testing

A. R. Halvorson, Pullman

Seed Testing

J. D. Maguire, Pullman

Cereal Crop Improvement

A. G. Law, Pullman
J. D. Maguire, Pullman
T. D. Wagner, Pullman

Farm Manager

G. F. Varner, Pullman

Fertility & Management

F. E. Koehler, Pullman
Marv Fischer, Pullman
R. I. Papendick, Pullman
V. L. Cochran, Pullman
E. T. Field, Pullman
C. F. Engle, Pullman