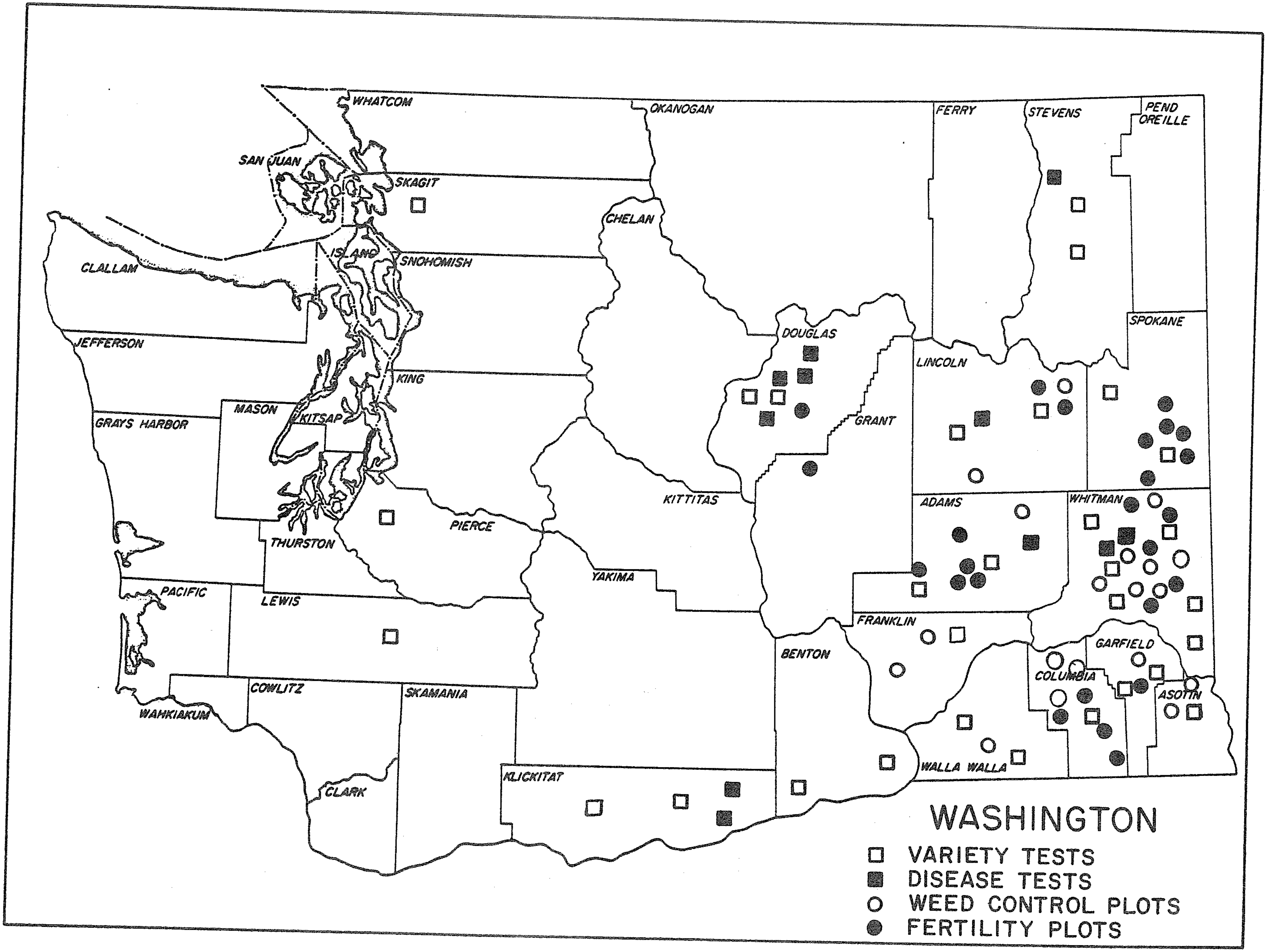
WSU FIELD DAYS

June 26, 1975
Dry Land Research Unit, Lind

July 10, 1975
Spillman Farm, Pullman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WAHKIAKUM
WALLA WALLA
KLICKITAT
CLARK
WASHINGTON
VARIETY TESTS
DISEASE TESTS
WEED CONTROL PLOTS
FERTILITY PLOTS

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 will give you an opportunity to learn about the results of the wheat, barley, oat, pea, lentil 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.

Mr. Norvel Sands, farm foreman retired December 31, 1974 after 25 years of service.

Since 1916 an annual field day has been held to show farmers and interested businessmen the research on the station. This year marks the 58th 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.

Paul Abendroth was the Spillman Agronomy Farm Manager until he retired in 1973. George Varner, who worked with Paul, was promoted to farm manager in the spring of 1974.

CLIMATIC DATA

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

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

Month	Temperature °F. Max.	Temperature °F. Min.	Precipitation 1974	Precipitation 1975	Precipitation 54 yr. av. (in)
January	34	22	1.35	1.70	1.04
February	42	24	.79	1.26	.87
March	53	32	1.14	1.15	.73
April	63	35	.67	.77	.63
May	72	42	.44	.74	.76
June	83	45	.22		.90
July	90	52	1.01		.23
August	90	50	.02		.30
September	79	45	.05		.55
October	65	38	.01		.90
November	47	29	1.57		1.24
December	37	26	1.05		1.29
			9.32		9.44

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

CEREAL CROPS RESEARCH AT THE DRY LAND RESEARCH UNIT

E. Donaldson and M. Nagamitsu

The object of the Dry Land Research Unit's cereal breeding and testing program is to provide adapted cereal varieties to the Big Bend area where annual rainfall is less than 13 inches. In order to achieve this goal, the program includes testing new varieties and selections of wheat developed at other experiment stations throughout the Midwest and Pacific Northwest and foreign breeding programs. The Southern and Northern Regional Hard Red Winter wheat nurseries and the Western Regional White and Hard Red winter wheat nurseries are grown each year. In addition, the Washington advanced Winter Barley nursery, the Washington advanced Spring Barley nursery, and the Regional Dryland Spring Barley nursery are regularly grown. Advanced selections of spring wheats developed in the Midwest and Pacific Northwest are tested in the Regional Hard Red Spring wheat nursery and the Western Regional Spring Wheat nursery.

In addition to the Hard Red Winter Wheat breeding program, the Dry Land Research Unit shares equal responsibility for the Spring Wheat breeding program. Six off-station testing sites are located on the Bill Schmidtman farm and the Don Ogle farm, Waterville; Robert Kramer farm, Harrington; Vollmer and Bayne farm, and the Richard Deffenbaugh farm, Horse Heaven Hills; and the Dale Bauermister farm, Connell, with preliminary nurseries and demonstration plots occasionally located on selected farms. About 100 varieties and new selections from breeding nurseries are tested at these locations. Farmers in these areas are urged to visit the plots on county tours or at any other time. The results of these trials and those at the Dry Land Research Unit will determine the value of any new selection for the Big Bend Area.

Washington State University research personnel from Pullman conduct several nonbreeding wheat studies on the Dry Land Research Unit, including fertilizer management, nitrogen uptake and utilization, residue management, moisture uptake and use, wheat physiology, disease and weed control, and seedling emergence.

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

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

Cooperative studies were made with breeders, geneticists, and plant pathologists in the Western States to determine the milling and flour quality characteristics of 4,936 early generation (F3–F5) wheat selections from the 1973 crop. Milling quality was determined by flour yield using a modified Brabender Quadrumat system on either 150–200 g. samples. The good milling selections were further tested to characterize the flour baking properties using a dye protein, mixograph, AWRC, and modified sedimentation test. Of the 4,936 selections tested 1,435 (29%) were coded as having promising potential.

Micro milling tests were made on 988 selections of F2–F3 single plants using 10 g. of seed. About 10% were scored as having acceptable milling properties.

Complete milling and baking was made on 850 4-5 lb. advanced selections and commercial cultivars of spring and winter wheats. Milling properties were judged on flour yield, percent patent flour, flour ash, bolting character, and rate of milling. Factors used to evaluate baking performance were dough mixing properties, bread crumb grain and texture, oxidation and water requirement, and loaf volume for the hard-endosperm progenies. Soft progenies were evaluated on their performance as pastry wheats by cookie diameter. In addition, the most advanced and agronomically promising lines were tested for Japanese noodle making quality.

In cooperation with the Pacific Northwest Crop Improvement Association, the Laboratory conducted the Third Annual Collaborative Tests by milling nine two-bushel samples of advanced lines on our Miag Multomat and distributed sub-samples of the flour to ten collaborating commercial firms for their evaluation. Two of these collaborators were Korean and one a Japanese milling firm. Information obtained in these studies is most useful.

Nineteen percent of the 850 samples milled and baked were rated as having promising overall quality characteristics, while 10% were rated as particularly promising in overall quality characteristics. Several of these selections are candidates for commercial release in the near future.

SOFT WHITE WINTER WHEAT IMPROVEMENT

Clarence Peterson, Robert Allan, Donald George, John Pritchett, David Henderson and Jeffrey Dearborn

Washington's wheat growers produced 122,110,000 bushels of wheat in 1974 on 3,110,000 acres for a 39.3 bushel per acre average. This is slightly below the ten year average (1964-73) of 42.5 bushels per acre. Grain yields were reduced by leaf rust, stripe rust, snow mold and *Cercosporella* foot rot and by cold spring weather that delayed plant growth. Stripe rust was prevalent on Paha for the first time.

New Release

Norco (C. I. 14482), a soft white common semidwarf, was released 15 August 1974 and foundation seed will be available in the fall of 1975. Norco produced more grain than Nugaines in 12 of 20 trials in 1973-74. It is recommended for late fall (after October 1 in most areas) and early spring seedings. Norco is resistant to most races of stripe and leaf rust. It is susceptible to dwarf bunt, common bunt, flag smut and *Cercosporella* foot rot. The milling and flour qualities of Norco are similar to those of Nugaines except that the flour makes superior noodles.

New Selections

The following three selections are being increased by the Washington Crop Improvement Association for possible release:

1) WA 6099 (C. I. 17419) is a soft white common semidwarf winter wheat that is superior to Nugaines in winterhardiness. It resists stripe rust and common bunt and is susceptible to *Cercosporella* foot rot, flag smut, dwarf bunt and leaf rust. The milling and flour qualities of WA 6099 are similar to those of Nugaines. WA 6099 produced more grain than Nugaines in six out of ten trials in 1973-74. It emerges slower than Nugaines.

2) WA 5988 (C. I. 17418) is a soft white common semidwarf winter wheat that is resistant to flag smut, stripe rust, common bunt and some races of dwarf bunt. Grain yield of WA 5988 exceeded that of Nugaines in seven out of ten trials in 1973-74. Previously, the grain yield of WA 5988 has been slightly lower than that of Nugaines. WA 5988 has satisfactory milling and flour quality characteristics. The emergence and winterhardiness of WA 5988 are similar to that of Nugaines.

3) WA 5826 (C. I. 17417) is a soft white club semidwarf winter wheat that is resistant to stripe rust. It emerges slower than Paha. WA 5826 is resistant to common bunt, flag smut and some races of dwarf bunt. The milling quality of WA 5826 is below that of Paha and similar to the milling quality of Nugaines. Its flour qualities are similar to those of Paha. In 1973-74, WA 5826 produced more grain than Paha in eight out of ten trials.

Cercosporella Foot Rot

We have screened 5247 wheats from the USDA world collection for *Cercosporella* foot rot resistance these past two years at Pullman and Puyallup. Seventy-five of these were saved and are planted at Pullman and Puyallup for further screening.

Line VH 72730 that exhibited resistance to *Cercosporella* foot rot in 1972-73, was also resistant in 1973-74. However, the grain yield of VH 72730 was somewhat disappointing in 1973-74.

Dwarf Bunt

A dwarf bunt screening nursery was seeded in 1973-74 near Rice, Washington. Infection was good. Sixteen percent of the 907 lines in the nursery were resistant in this test. The resistant lines will receive further testing.

Leaf Rust

Leaf rust was prevalent early and although a few of the varieties are resistant (Hyslop, McDermid and Norco), we need to increase our effort on the development of resistant varieties.

Triticale

The spring triticale 6TA476 (Jenkins Foundation) continues to out-perform any other triticale tested to date by about 20 percent. 6TA476 was grown in 23 yield trials during 1971-74. 6TA476 exceeded the grain yield of Marfed by 5 bushels or more in 15 of the 23 tests. Test weight of 6TA476 is about 48 pounds per bushel. When 6TA476 was seeded in the fall, it produced about 20 percent less grain than Nugaines. New triticale lines obtained from CIMMYT in Mexico were included in this year's (1974-75) yield trials.

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.

For the first time in five years, stripe rust was a major disease on the Dry Land Research Unit in 1974, eliminating about three-fourths of the advanced selections, many of which had adequate yield, quality, and emergence superiority to be considered for release. Stripe rust is present on the station this year, but not adequate for good selection. However, the nursery on the Richard Deffenbaugh farm has quite severe damage on the more susceptible lines from the Southern Regional Hard Red winter wheat nursery.

For the second year in a row snow mold was quite severe in parts of Douglas County. Sprague and early seeding reduced the loss considerably this year. None of the advanced lines showed as much resistance on the Don Ogle farm as Sprague, but two soft white selections with stiffer straw and greater yield potentials than Sprague, and two Hard Red selections showed resistance equal to, or greater than Moro.

Last fall had poor conditions of soil moisture and rains for selecting lines with superior seedling emergence capabilities. (Conditions were favorable for good stands of all selections)—however, the two previous falls have provided adequate data to select good emerging lines. These are now in advanced yield trials. One selection, WA7003, is in the final stages of testing, and will be recommended for release pending this year's performance.

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.

Table 2. Yield of selected varieties in low and intermediate rainfall areas in Washington and Oregon, 1964-74.

Variety	Location and Rainfall Lind 9.5"	Moro, OR 11"	Pomeroy 14"	Pendleton, OR 14"	Average
Nugaines	38.6	33.4	65.5	74.8	53.1
Luke*	37.0	36.4	63.3	79.6	54.1
Sprague*	30.2	36.6	58.5	79.3	51.2
Coulee*	33.3	32.5	56.3	72.1	48.6
Moro	38.4	31.8	56.8**	60.5	46.9
Paha	39.2	32.3	62.6	73.1	51.8
Wanser	36.2	32.3	54.4	67.0	47.2
McCall	38.2**	32.6		66.8	45.9
Kharkof	32.1	27.8	48.7	54.1	40.7
Station Average	35.9	32.9	58.1	69.7	48.8

*6 year data, except Luke 4 years at Moro and Pendleton - Sprague 2 year (all locations)
**Not grown in 1972

Table 3. Summary of agronomic characteristics of winter wheat varieties grown at Lind in rod row nurseries. 1952-74.

Variety	Av. plant ht.	Av. tst wt.	1974 yield bu/a	Av. yield bu/a	Yield % Kharkof	No. years grown
Nugaines	25	62.0	51.6	39.1	124	10
Luke	23	60.8	*	34.6	122	6
Sprague	25	61.1	43.3	30.8	113	4
Moro	29	59.2	39.5	37.5	117	11
Paha	26	60.3	47.3	39.0	129	8
Coulee	23	62.2	*	31.3	110	6
Wanser	30	62.2	39.1	36.1	112	11
WA007003	35	61.0	42.2	42.2	116	1
McCall	30	62.4	42.4	37.9	115	10
Kharkof	32	60.6	36.5	30.5	100	20

*Not grown in 1974

Table 4. Summary of agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries, 1952-73. 1974 not harvested.

Variety	Av. plant ht.	Av. test wt.	1973 yield bu/a	Av. yield bu/a	Yield % Kharkof	No. years grown
Nugaines	27	63.0	18.1	44.7	121	7
Luke	28	62.1	22.7	48.1	141	4
Sprague	27	62.9	27.6	36.8	124	2
Moro	34	60.0	23.7	44.2	118	7
Paha	28	61.8	16.7	44.5	126	5
Burt	32	61.6	*	40.2	114	15
Coulee	25	62.9	*	34.0	91	4
Wanser	34	62.8	24.1	41.4	111	8
McCall	34	62.9	30.6	43.6	116	7
Kharkof	38	61.6	26.5	34.5	100	17

*Not grown in 1973

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

	HARRINGTON 1952-74			HORSE HEAVEN 1951-74		
Variety	No. years grown	% Kharkof	Av. yield bu/a	No. years grown	% Kharkof	Av. yield bu/a
Nugaines	9	138	40.3	4	130	21.8
Luke	6	143	39.9	4	123	20.7
Sprague	4	136	42.9	2	120	19.2
Moro	9	132	38.6	6	117	17.9
Paha	7	147	40.6	4	119	20.0
Coulee	6	128	35.9	3	120	19.1
Wanser	8	134	38.3	7	119	19.1
WA007003	---	---	---	1	122	23.7
McCall	8	144	41.0	7	117	18.7
Kharkof	21	100	34.7	14	100	17.9

Table 6. Summary of agronomic data for winter wheat varieties grown at the Dry Land Research Unit in drill strip plots, 1954-74.

Variety	Av. date head	Av. plant ht.	1974 yield bu/a	Av. yield bu/a	Yield % Kharkof	Av. test wt.	No. years grown
Nugaines	5/31	25	46.9	38.5	123	61.4	9
Luke	6/3	25	51.5	38.9	119	60.2	5
Sprague	5/29	26	46.5	34.7	120	60.3	3
Moro	5/30	29	49.5	39.6	126	58.4	9
Paha	6/3	27	67.2	44.2	135	59.8	5
Burt	5/29	29	39.7	35.9	114	60.9	19
Coulee	5/30	25	45.7	37.1	114	60.9	5
Wanser	5/28	30	39.8	36.7	115	61.7	11
McCall	5/29	30	44.5	38.0	120	61.8	10
Kharkof	5/30	31	36.4	31.3	100	57.3	19

HYBRID WHEAT STUDIES

R. E. Allan and J. A. Pritchett

Our emphasis on hybrid wheat research has switched to improving the potency of fertility restoration of the R. lines (males). This year, 137 A line/R line test crosses are under evaluation for their ability to restore self-fertility of hybrids at three test sites in eastern Washington. Preliminary observations show that about 10% of the test crosses exhibit normal self-fertility. Two of the better restorers are club types and represent our first success in transferring fertility restoration to club wheats. Earlier we showed that certain crosses between clubs and common wheats express maximum heterosis for grain yield. Adequate male fertility restoration requires at least three genes under our conditions and some of our best restorers carry both the Primepi gene and two genes from *T. timopheevi*.

We are increasing seven new cyto-sterile A lines (females) this year on Spillman Farm. Only Nugaines and Marfed have proved to be stable A lines among our older types. Both Sel 101 (C. I. 13438) and Sel 1 (WA 4303) have more recently revealed incomplete sterility under some growing conditions in the state which limits their usefulness. The newest A line types represent improvements in foot rot tolerance, stripe rust resistance, quality and yield potential. They include Gaines/Nord sel, Joel, Itana/C.I. 13431, Omar/1834/Gns/P.I. 178383, C. I. 14484, Coulee and Luke.

Yield trials on 59 nucleo-cytoplasmic hybrids are being evaluated at four sites in the state. Last year some of these hybrids yielded 11 to 25% above Luke, Nugaines and their higher yielding parent. We are convinced heterosis for grain yield occurs in our hybrids but improvement is needed in restoration, cytoplasmic sterility and straw strength. Quality evaluations over a 4-year period indicate that hybrid wheats will create no unusual problems. In fact, some R lines have above average protein content which they impart to their hybrids.

POSTHARVEST DORMANCY AND RELATED PROBLEMS

Donald W. George

Postharvest dormancy serves to prevent head sprouting in regions having summer rainfall with high temperatures and high humidity. It is an important characteristic of many wheats bred for northern and central Europe and is considered desirable for our own Middle West.

Head sprouting is further suppressed to some extent by water soluble germination–inhibiting components of the chaff, and there have been suggestions that this inhibitory activity might be strengthened through breeding. Because of our typically cool nights and general cooler weather during infrequent summer rains, postharvest dormancy has not been particularly effective in preventing head sprouting and the elevated alpha amylase levels which accompany it. The Japanese market, in particular, has been very sensitive to this characteristic, since flour with high alpha amylase is quite unsatisfactory for the manufacture of certain kinds of noodles widely consumed in Japan.

On the other hand, seed wheat which retains some of the dormancy characteristic at planting time emerges slowly and produces poor stands. It also requires higher soil moisture levels for germination than does nondormant seed. This is particularly a problem in the summer fallow area where early seeding is necessary and the seedbeds at planting time are often hot.

Chaff-borne germination inhibitors have not been shown to be effective alone in suppressing germination, but "toxins" leached out of residual stubble have been blamed for poor emergence and unsatisfactory growth of wheat planted under minimum tillage management for erosion control. While unproven, it appears very likely that the germination inhibitors in the chaff and the toxins in the straw may be closely related, if not the same compounds. With the growing need for energy conservation, it would appear that new varieties should have less, not more, of the inhibitors to improve the chances of successful minimum tillage planting.

Breeding has been successful for low postharvest dormancy and a few new selections have not been significantly different from nondormant seed the past 2 years. It remains to be seen whether varieties without germination or growth inhibitors can also be produced.

STAND ESTABLISHMENT STUDIES

R. E. Allan, A. Gul and J. A. Pritchett

We developed a "quick-lab-test" for evaluating wheat lines for rate of emergence (ERI) and total emergence at low levels of soil moisture. This method is a modification of a technique used by Dr. M. Lindstrom, formerly of the Lind station. We think this test will give us valuable data needed to improve wheats for the drier areas of the state.

This year we found that our semidwarf types differed markedly in their ability to emerge at low water potentials (-10 to -14 bars). Wheats do not behave similarly when subjected to soil moisture stress and the test readily identified lines with erratic behavior. Several new types developed by recurrent selection emerge superior to Sprague and Moro at the low levels of soil water potential.

Some experimental lines rank high for ERI and total emergence both in field and lab tests. No trait such as seed, root and seedling weight, coleoptile length or seedling height correlated closely with germination under low water potential. Most importantly, the work showed both laboratory and field tests (at several sites) are needed to identify types with superior seedling vigor at low soil water potentials.

Seven of 97 lines have been identified as useful parental material for seedling vigor under deep seeding in the field at low soil water levels. These lines will be released to breeders this fall for crossing purposes.

Over 2,000 F_5 lines were selected from 120 populations of semidwarf types that had been previously screened by bulk testing for ERI and total emergence. We reseeded 1,000 of these lines to determine winter survival, seed type, rust reaction, plant height, straw traits and shatter resistance last fall. The best agronomic types among these lines will be placed in our August seedling vigor tests. Some of these lines have coleoptiles longer than Moro and exceed it for rate of emergence (ERI). These new types will be intercrossed with winterhardy types next spring.

WINTERHARDINESS STUDIES

Donald W. George

Lack of coldhardiness is a very serious deficiency of all of the commercial white wheats grown in eastern Washington. The deficiency only shows up on a large scale during winters having a combination of low temperature and low, poorly timed, precipitation. Normally, a blanket of snow protects even relatively nonhardy varieties from significant winterkill. However, nearly snow-free winters do occur and the consequences can be disastrous, as was shown in 1972-73.

Fortunately, laboratory tests supplementing nursery observations, have made it possible for the breeders to maintain, or actually to improve winterhardiness in new selections now growing in the nursery, and if any of several of these had been in production two years ago, it is probable that little loss would have occurred.

An exciting fact concerning these new selections is that they were developed through the breeding program and reached the advanced testing stage without ever having been exposed to a real "test winter." The parents were either of a known winterhardiness or had been classified for coldhardiness by the crown freezing technique and this, plus careful field observations and measurements, apparently has made it possible to make a substantial improvement over current commercial varieties.

Winterhardiness is the measure of how well a variety survives the winter. Many factors contribute and the timing or sequence of these can be important. Significant winterkill may not be accompanied by or be the result of extreme cold alone, and this fact makes winterhardiness testing an almost impossible task. However, coldhardiness can be successfully identified by laboratory tests and future varieties will be improved in that respect.

GENETIC STUDIES RELATED TO WINTERHARDINESS

R. E. Allan, A. Gul and D. W. George

Very little is known about the inheritance of winterhardiness of wheat under Washington conditions. We know varieties differ in crown depth and the amount of regrowth and recovery that they can make after being subjected to freezing temperatures. Last winter we studied the inheritance of crown depth and regrowth after freezing plants of a cross between Gaines and Nord, a French wheat.

Crown depth behaved as a highly heritable trait. In other words, it should be relatively easy for breeders to select varieties with relatively deep crowns which would give added protection to freezing. The heritability of the ability to regrow and recover after freezing was low, however, and would be more difficult to manipulate by breeding. This means uncontrolled environmental factors affect the degree of recovery achieved which makes selection for the genetic improvement of this trait more difficult. Our results did show good breeding progress could be made for improved winterhardiness using our present crown-freeze technique.

In another study, wheat isolines representing three plant height levels (2-gene semidwarf, 1-gene semidwarf and standard height) of nine genetic backgrounds were compared for crown depth and crown tissue recovery after freezing. The 2-gene semidwarf lines generally had deeper crowns (5 to 31% deeper, or 16%) than their standard height sister lines. The two semidwarf genes gave deeper crowns in the Burt, Nord, Brevor and Marfed backgrounds but had little or no effect on crown depth in Omar, Golden or Itana backgrounds.

The three height levels produced differential regrowth after freezing. After 4 and 8 hrs of freezing, the semidwarf genes reduced the amount of regrowth made in the Nord and Burt backgrounds but they actually enhanced recovery in the Itana background.

This study showed that semidwarf trait of wheat, so important to the Green Revolution, can interact with genetic background of wheat to be an advantage, a disadvantage or neutral for winter survival.

WHEAT ISOLINES THAT MEASURE YIELD AND ADAPTATION

R. E. Allan and J. A. Pritchett

Isolines developed by backcross breeding in 9 populations of 5 genetic backgrounds helped to explain the interaction between genes for height, disease resistance, and beards as they relate to yields under annual crop (AC) or wheat-fallow (WF) conditions. Results have shown:

1) Semidwarf genes give the greatest contribution under WF conditions with one-gene types like Nugaines and Luke yielding the most in 24 of 32 comparisons.

2) The two-gene semidwarfs (Mexican height) out-yielded tall types on 22 of 32 occasions. The short two-gene types exceeded the yield of their one-gene sister lines for 7 of 32 comparisons. This advantage occurred usually when foot rot was a yield reducing factor.

3) Under annual crop management, the short two-gene types yielded less than their tall sisters in 14 of 15 comparisons and ranged from +6% to -30% less (avg. -19%).

4) The medium types were more competitive under AC conditions. They yielded less than their tall sibs in 9 of 15 comparisons (overall about 1% less).

5) Semidwarf types have their most potential under wheat-fallow conditions conducive to foot rot. Under AC conditions, they may actually yield less or fluctuate greater in yield from year to year. These results indicate renewed breeding emphasis is warranted on nonsemidwarf types.

6) The Burt and Nord backgrounds benefitted the least from the semidwarf trait, whereas semidwarfs of the Brevor and Omar backgrounds often showed good yield potential. As a rule, genetic backgrounds with low or mediocre yield potential benefitted more from the presence of semidwarf genes than genetic backgrounds capable of high yield potential.

7) Semidwarf genes can have a reducing effect on test weights. This phenomenon varies with genetic background and management practice. Without exception, the tall and two-gene isolines produced the highest and lowest test weights, respectively, and the one-gene types were intermediate. Under AC managment, the two and one-gene types averaged -3.7 and -1.3 lb/bu less than their tall sibs. Under WF conditions, the differences were -4.1 and -1.1 lb/bu lower for two-gene and one-gene types vs their tall sibs.

8) Wheat-fallow vs AC management gave the greatest test weight losses in the Burt background with reductions of -.6 to -.4 lb/bu followed by the Brevor background (-.3 to -1.0 lb/bu). The Omar background was affected the least but still lost -.1 and -.2 lb/bu under WF management.

9) Semidwarf genes reduced test weights more in the Burt background than in either Omar or Brevor. Weights were about 2.0 to 4.0 lb/bu below tall types of the Burt background vs. 1.0 to 3.0 lbs lower than tall sibs of the other two backgrounds. Hence, almost always semidwarf genes tend to reduce test weight and breeders need to identify the genetic backgrounds most vulnerable to this adverse effect.

FALL-SPRING (FACULTATIVE WHEAT) NURSERIES

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

This special series of trials grown both at Pullman and Lind is required for the evaluation and identification of facultative spring wheats with high levels of cold tolerance and resistance to winter injury. Lines with high levels of winter survival from a late September seeding at Pullman have been identified. To test the vernalization requirements (spring habit) and maturity class of the cold tolerant wheats, a late May to early June seeding is made at Pullman. Some of the more promising cold hardy selections from the WSU breeding research are already in the Western Regional Nursery, and the most cold hardy selections are being used increasingly in breeding. Increased cold tolerance is an important approach for increasing yield potential in spring wheats, because they will be less injured by early spring frosts and may be able to grow faster in the early spring when temperatures are normally cool. Moreover, the hybridization of winter and spring wheats appears to be providing new combinations of high yield factors than has previously been available in strictly spring wheats. The new facultative spring wheats will have adaptation for reseeding or overseeding winter-injured stands of winter wheats, and in some areas with mild winters they will compete well with the semidwarf winter wheats. Because of their wider use potential, the cold hardy facultative spring wheats should increase the availability of seed of suitable spring wheat varieties when they are needed by winter wheat growers. Because of their advantages for our unique needs the facultative spring wheat is the spring wheat of the future for Washington growers and the characteristics required are being bred into virtually all spring wheat populations used in the program.

New induced facultative (spring habit) mutations from Luke winter wheat show unusual promise for yield, retain the good qualities of Luke and appear to carry an exceptional level of winterhardiness. These can be seen in both fall planted and spring planted nurseries. In new crosses our emphasis is being placed on increasing earliness and cold tolerance together in types with suitable quality and desirable agronomic characteristics.

DEVELOPMENT OF FACULTATIVE (COLDHARDY) SPRING WHEATS

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

The winter rainfall climate of eastern Washington is normally ideal for the cultivation of winter wheats, and spring wheat production is often negligible. Consequently, when severe freeze-outs occur (winterkilling) or fall rains come so late that winter wheat stands are variable, there is insufficient seed of spring wheats available and of the quality of the winter wheats for early spring overplanting or replanting. It has long been known that some spring wheats possess considerable cold tolerance, and frequently survived the winter with good stands in those areas having a mild winter climate. One of the Washington soft white spring wheats, Marfed, developed by O. A. Vogel, was frequently fall sown by wheat growers in southeastern Washington until the advent of the higher yielding, more lodging resistant semidwarf winter wheats. The cold tolerance of Marfed is distinctly superior to that of Federation which was formerly grown in that area from fall seedings. Flours milled from grain of Marfed have dual purpose baking properties useful for pastries at low protein, and useful for breads and other products at higher protein. The protein of Marfed is weak compared with the hard red spring wheats but its flour quality is similar to the common soft white winter wheats Gaines, Nugaines, Hyslop, and McDermid.

Because of the unique climatic circumstances and the variable needs for spring wheats in eastern Washington, genetics and breeding research at Washington State University has been directed for more than 17 years toward the development of spring wheats with higher cold tolerance than Marfed. These wheats would have the capacity for high winter survival in most years from fall plantings in the Walla Walla-Dayton area of southeastern Washington and thus compete with winter wheats for acreage, but could also be sown as spring wheats during the normal spring planting period anywhere in the region, or used for overplanting in winter wheat stands as is often needed in more northern areas when winterkilling occurs. Thus, the facultative wheat types must have characteristics intermediate between winter and spring wheats much like some older European "wechsel" wheats. However, all of the wechsel wheats tried and used as parents with local cultivars have failed to yield progeny with appreciably greater winterhardiness than Marfed without being also appreciably later in maturity from spring planting, and in addition all of them have had other weaknesses. Some of the better selections from the wechsel wheat crosses have been used as parents in further crosses. In our breeding work, a wide variety of winter/spring wheat crosses has been evaluated, and many lines with winterhardiness levels superior to Marfed have been isolated. Some of these are now in advanced trials. In the common soft wheats, the generally poor milling properties have been a further obstacle until recently, but we now have a broad base of soft wheats with good to excellent milling quality, some giving superior flour yields even when compared with the hard endosperm wheats. One of the new lines Urquie has distinctly improved milling properties. It was isolated by screening thousands of selections from the cross Gaines/Marfed (both parents of which have poor milling properties). Urquie was identified about eight years ago using the 3-5 gram micromill developed by Pell, Seaborg and Barmore at the ARS-USDA Western Wheat Quality Laboratory at Pullman. Urquie was isolated from a bulk F_6 population grown for several years under low rainfall stress and screened to remove grain of low test weight at the Dry Land Experiment Station, Lind, Washington. Its better milling properties and improved cold tolerance were identified from tests at Pullman. A few lines with like milling properties also were isolated later from Marfed crosses, but only Urquie has proved to combine the dual purpose of flour quality of its parents with semidwarf plant height, good yielding capacity and cold tolerance (or facultative properties) significantly superior to Marfed. Urquie is about 1-2 days later in anthesis than Marfed, but produces grain superior in test weight to Marfed and Twin under Washington conditions. Urquie has proved superior in yield to Marfed and competitive with Twin and other soft white spring wheats (which have little cold tolerance) especially in the low rainfall areas of Washington, but not under irrigated conditions. Urquie outyielded Nugaines from a normal (September 28) fall planting at Pullman in 1974 (Table 1), indicating that it has the yield capacity to compete with standard winter wheats in areas where it can be expected to survive well. Because of the several improvements over other soft white spring wheats, Breeder's Seed of Urquie is being produced in 1975 for fall 1975 and spring 1976 release.

Several spring wheat lines selected from other spring/winter wheat crosses, including Norco (CI14482, Norin 10, Brevor 11/P14/CI13438) have proved to carry winterhardiness distinctly superior to Urquie (Table 2). Although the recent selections have had less testing than Urquie, and many are unfortunately several days later in maturity (which affects their yield potential in some years), all have spring habit and true facultative characteristics, thus they will head normally from a mid to late May planting at Pullman when all winter wheats fail to head. Several of the Norco lines have been tested in spring trials for two to three years. The best of these lines may be considered for a 1976 release. Recent crosses using Urquie and related lines, as well as Twin and other Idaho selections as parents with the Norco selections and with local soft white winter wheats have produced progeny with good milling properties, disease resistance (leaf and stripe rust), and good agronomic properties. Their promise for yield potential and winterhardiness appears to be good to exceptional from preliminary tests, indicating that we may now have fixed the required gene complexes for our new facultative types of wheat. On the strength of these results, we have initiated new fall and spring sown facultative spring wheat trials at five locations in Washington (4) and Oregon (1). Facultative types with the most cold-hardiness are probably day length sensitive. Virtually all CIMMYT wheats have winterkilled severely in our tests, and (moderately cold-tolerant) lines from crosses with day sensitive wheats have proved to head too early from fall plantings and too late from spring plantings indicating that they may be day insensitive, but have some vernalization response.

Mutagen Induced Facultative (spring habit) Lines from Luke Reselections

Several years ago we tried induced mutation methods as a means to produce spring habit forms of useful winter wheats. We were successful with the cultivar 'Omar,' a soft white club wheat, but the spring habit mutants were too late in maturity from spring planting and seemed to have reduced winterhardiness. We made another attempt recently, using several leaf rust resistant reselections from the common soft white winter wheat, Luke, which is late maturing from fall planting, similar to Omar. An M_2 population was late spring planted (about 2 acres), and from this a small number of spring habit selections was made. These selections were spring sown in 1972 and then planted again that fall. All lines had the general morphological characteristics of Luke. Several lines did winterkill, and were discarded. The remaining 41 lines were fall sown in single 4 row plots, at Pullman and spring sown at Lind (low rainfall) and Royal Slope (irrigated) in 1973-74. Both the spring habit and high cold tolerance of the lines was confirmed. Yields at Pullman ranged from 85 to 134 bu/A, (Luke check 119 bu/A), at Lind from 17 to 35 bu/A (Marfed checks from 21 to 34 bu/A) and at Royal Slope 72 to 159 bu/A (Twin check 91 bu/A, and Luke check did not head). The 159 bu/A is the highest plot yield ever obtained for a spring wheat in Washington (Table 3). Test weights were normal at all locations. Quality tests indicate that all 41 Luke mutants are almost exactly like the winter wheat Luke considering the differences in test weight from fall versus spring sowing. All of the Luke mutant selections appear to be earlier maturing from spring plantings than were the Omar mutants, but they also may be later maturing than is desirable, especially for late spring sowing in the low rainfall areas of Washington. However, the results indicate that we may have a very useful complementary method for breeding facultative spring wheats, and that the selections obtained also may be useful parents for breeding.

A new study to further test the mutation method has been initiated using several Pacific Northwest soft white winter wheats.

Table 1

Performance and Agronomic Data on Coldhardy Spring Wheats Sown September 28, 1973 (Pullman, 1974)

Variety	Acc. No.	Height (In.)	Winter Survival	Qual. Type	Yield (Bu/Ac)
Nugaines (W. W. Check)	CI013968	27	99	SW	86.5
Marfed (Sp. W. Check)	CI011919	35	50	SW	70.4
Urquie	CI17413	33	95	SW	92.4
Marf/57-344//Burt/ Itana 5160 69-10	K6900410	30	80	SW	95.9
NB 3880-277/CI13438/3/ Henry/Karn 90	WA005937	42	70	HR	84.5
"Norco" Sel. 111	K7105095	29	80	SW	110.0
"Norco" Sel. 125	K7105106	29	80	SW	103.1
"Norco" Sel. 131	K7105109	30	75	SW	105.4
"Norco" Sel. 156	K7105129	30	75	SW	102.5

Table 2

Winter Survival Data on Spring (Facultative) Wheats

Variety	Pullman 1971	Pullman 1972	Pullman 1973	Pullman 1974	Pomeroy (Houser) 1971	Lind 1973
Nugaines (W. Check)	99	99-99	85-95	99	95	95
Marfed (Spr. Check)	12	01-10	10-30	50	0	20
CI13736 (Burt/KF Sel 2025)	98	20-60	70-80	80	35	50
Thatcher (Spr. Check)	70	-	35-70	-	02	-
Urquie	99	30-60	70-85	95	02	85
WA4685 (E. B. Sel)	99	99-99	80-90	95	40	95
Kaschitzer (WA5035)	99	99-99	85-98	98	80	95
Burt/KF 70136 Sel	99	60	50-70	90	40	-
K7105095 (Norco Sel)	99	99	85-90	80	75	90
K7105109 (Norco Sel)	99	99	85-95	75	95	90

Table 3

Performance of 41 Facultative Luke Mutants

1974

Variety	Yield Range	Yield Ave	Test Weight Range	Test Weight Ave
	LIND (Seeded March 20)			
Luke M.	16.6-34.8	30	58-60	59.4
Marfed	21 -33.5	28	59-59.7	59.4
	PULLMAN (Seeded September 28)			
Luke M.	85 -124	107	61.6-63	62.5
Luke		119		62
Nugaines		114		62
	ROYAL SLOPE (Seeded March 7)			
Luke M.	71.7-159	117	59.5-62	61
Twin		93.3		60

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 1975 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.

Soft white spring wheats include Marfed, the long time standard widely adapted variety with standard tall plant height and dual purpose baking properties but only acceptable milling characteristics. Idaed 59 is similar to Marfed with the exception that Idaed 59 matures earlier, has somewhat better milling properties, and more disease resistance. Twin is a semidwarf, high-yielding variety; its test weight is usually lower than either Marfed or Idaed 59 when all are grown under similar conditions. Urquie is a new semidwarf derivative of Marfed and Gaines scheduled for release in the fall of 1975 and spring 1976. It has the desirable dual purpose baking properties of Marfed and Nugaines but milling characteristics superior to both, representing a breakthrough in the quest for a better milling, common soft white wheat. Urquie is also more cold tolerant, generally higher yielding than Marfed, and produces grain of higher test weight than Twin. Urquie is especially well adapted to the lower rainfall areas of the state. Fielder is a high yielding, semidwarf soft white wheat which produces grain having a higher test weight than Twin. Both Fielder and Twin have only pastry type quality intermediate between that of the club and common soft white winter wheats. Comparative performance records for these soft white spring wheat varieties in eastern Washington are shown in Tables 1, 2, 3, and 4.

Promising new soft white spring wheat selections include WA6100, WA6101, and WA6102, three cold tolerant fully spring habit facultative selections from Norco (Table 5). The best of these will likely be considered for a potential 1976 fall release. All have acceptable quality, good leaf disease resistance and good agronomic characteristics. Among the promising new hard red spring wheats are WA6105, WA6018, and ID47 (Table 6). Selections of the former two bred at Washington State University will be made for potential Breeder's Seed increase in 1976.

Table 1

Summary of agronomic characteristics of spring wheat grown at Lind in rod row nurseries, 1950-74

Variety	Av. date head	Av. plant ht.	1974 yield bu/a	Av. yield bu/a	Yield % Marfed	Av. test wt.	No. years grown
Marfed	6/15	25	26.8	23.5	100	58.9	24
Twin	6/14	22	27.7	22.1	101	57.8	7
Fielder	6/13	22	22.9	18.7	86	60.1	4
Urquie	6/18	23	26.8	23.3	102	60.4	5
Peak 72	6/10	21	*	17.2	83	61.2	4
Wared	6/15	22	22.6	19.3	87	60.2	6
Norana	6/14	20	*	15.4	103	60.2	2
Borah	6/12	20	21.9	17.2	85	59.0	4

*Not grown in 1974

Table 2

Summary of agronomic characteristics of spring wheat grown at Lind in drill strip plots, 1970-74

Variety	Av. date head	Av. plant ht.	1974 yield bu/a	Av. yield bu/a	Yield % Marfed	Av. test wt.	No. years grown
Marfed	6/17	26	29.4	25.7	100	58.8	5
Twin	6/12	20	34.4	24.1	112	57.8	3
Fielder	6/14	---	28.7	28.7	98	59.2	1
Wared	6/13	21	27.9	21.9	102	59.5	3
Urquie	6/16	21	33.9	23.0	107	60.5	3
Fortuna	6/12	28	21.4	20.3	79	59.6	5

Table 3

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

	HARRINGTON			WATERVILLE			HORSE HEAVEN		
Variety	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	24	100	30.1	23	100	30.0	21	100	18.0
Twin	6	99	29.6	6	106	30.9	6	94	12.2
Fielder	4	108	29.7	4	100	30.6	4	101	16.1
Urquie	5	99	27.8	3	95	30.3	4	106	17.3
Peak 72*	3	88	27.3	3	86	28.2	4	72	13.0
Wared	4	105	28.0	4	100	29.6	5	95	13.2
Norana	2	104	26.2	2	87	25.5	3	121	13.9
Borah	3	117	29.4	3	103	30.2	2	87	11.7

*Not grown in 1973 (all locations)

Table 4

Performance of spring wheats at four locations in Eastern Washington

Ave. Rainfall*		(20.5)		(19.6)		(20.0)		(16.6)	
		Pullman		Dayton		Walla Walla		Pomeroy	
Variety	No. years grown	Ave. yield bu/a	% Marfed	Ave. yield bu/a	% Marfed	Ave. yield bu/a	% Marfed	Ave. yield bu/a	% Marfed
Marfed	6	45.6	100	44.0	100	44.0	100	37.3	100
Twin	6	52.2	114	46.0	105	45.2	103	41.8	112
Urquie	5	51.5	110	44.6	97	44.0	101	46.1	118
Fielder	4	56.7	119	54.7	113	48.4	105	52.9	123

*Crop year - October 1 to August 30

Table 5

Performance of Soft White Spring Wheats
(1974 Regional Nurseries)

	Plt Ht		% Type		Test Wt		Yield Performance		
			Stripe Rust	Leaf Rust			High Rnfl (Av 4 loc)	Low Rnfl (Av 3 loc)	
Variety	Plmn	Lind	Pullman		Plmn	Walla Walla	H	L	Irrig. (R.S.)
Fielder	26	22	10/6	01/3	62.8	60.2	41.2	26.4	81.3
Twin	25	21	01/3	60/6	52.5	58.7	41.4	32.0	68.8
Marfed	35	26	01/3	80/7	60.9	58.4	35.2	26.1	46.6
ID7250-75	34	24	01/3	60/6	59.0	57.0	36.8	28.4	61.8
Urquie	29	24	01/3	70/7	62.3	61.0	36.7	28.7	76.5
WA6035	32	26	10/6	01/3	59.6	58.2	37.9	29.9	63.8
WA6100	28	22	01/3	01/3	61.3	59.2	38.5	26.8	80.4
WA6101	29	24	01/3	01/3	62.0	60.7	43.0	26.3	74.6
WA6102	31	24	01/3	01/3	60.5	58.5	40.9	29.2	71.0
WA6103	29	23	01/3	01/3	61.9	60.2	40.8	23.1	78.6

Table 6

Performance of Hard Spring Wheats
(1974 Regional Nursery)

	Plt Ht		% Type		Test Wt		Yield Performance		
			Stripe Rust	Leaf Rust			High Rnfl (Av 4 loc)	Low Rnfl (Av 3 loc)	
Variety	Plmn	Lind	Pullman		Plmn	Walla Walla	H	L	Irrig. (R.S.)
Borah	25	21	01/3	20/6	62.5	58.9	41.2	23.9	67.8
Wared	27	23	10/4	01/3	62.9	60.0	41.8	23.4	71.4
Prospur	29	24	01/3	01/3	63.8	60.2	42.6	22.2	91.6
WA6019*	30	26	01/3	50/7	63.1	61.1	42.2	26.9	92.0
ID47	27	23	01/3	10/6	62.4	60.7	40.8	28.1	73.4
WA6105	30	26	01/3	01/3	62.3	60.1	42.5	27.6	69.0
WA6106	30	24	01/3	01/3	62.6	59.9	39.5	25.3	77.8
WA6018	31	25	01/3	01/3	60.8	61.6	39.1	25.7	70.1

SPRING WHEAT VARIETY ADAPTATION AND RATE AND DATE OF SEEDING TRIAL

(Palouse Conservation Station, Pullman, Washington)

M. R. Khajehpour, C. F. Konzak, R. I. Papendick, R. E. Witters and T. S. Russell

As part of a Master's Degree research project, seven soft white facultative and spring wheat varieties have been planted at three rates of seeding and at four dates. The varieties include:

Variety	Maturity Characteristics	Plant Type
Twin - Midseason	Heads about same time as Marfed	Awnless semi-dwarf
Fielder - Early Mid-season	1-2 days earlier than Twin	Awned semidwarf
Idaed 59 - Early	3-5 days earlier than Twin	Awnless semi-tall standard
Norco - Late	Mixture of winter and spring types 4-5 days later than Twin	Awned semidwarf
Urquie - Midseason	2 days later than Twin	Awned semidwarf
WA6100 - Mid-late to late	Coldhardy, spring selections from Norco, 3 days later than Twin	Awned semidwarf
WA6101 "	"	"

The objective of the project is to investigate interactions between varieties and seeding rates over the range of seeding dates and obtain data on the comparative ability of varieties to maintain high productivity from a wide range in seeding dates. The different rates of seeding were used to determine the extent to which variety performance can be maintained in later plantings by increased seeding rates. The plots were fertilized with 50 lb/acre of N as Ammonium Nitrate Sulfate mixture, all broadcast before the earliest date of seeding and harrowed in. No further tillage was done before the later plantings. Herbicides used have been Avadex applied before planting for wild oats control and by Bromoxynil (Buctril) applied post-emergence for broadleaf weed control. Some differences in emergence from the various plantings are apparent. Also, some of the effects observed have resulted because the planter used is inadequate to provide uniform seeding rates. No or poor stands were obtained with some varieties. The chemical used for wild oats control seems to have an adverse effect on some varieties. The tillage factor also seems to be a problem at the third and fourth dates. The soil is compacted and stand establishment more difficult. This is compounded with the drill failure as well.

The various data being recorded on each variety include: date of planting; date of 50% emergence; dates at each of a sequence of growth stages including tillering, jointing, booting, flowering, and kernel development and maturation stages; disease reactions; lodging; plant height; tiller number at booting and fertile tillers at maturity; spikes/plot; kernels/spike; 1000 kernel weight; volume weight; kernel sizes (% large, medium, small).

From these data we hope to identify differences in developmental characteristics among the varieties which may relate to their relative adaptations over the range of test conditions and experimental variables introduced. The data obtained will be especially useful for developing variety and management recommendations. Date of planting studies similar to this have been conducted previously only with winter wheats, and recently have been conducted also with spring wheats at the Dry Land Experimental Unit at Lind. These studies should be conducted every year at a range of locations across the state to provide adaptation data on new and prospective new varieties.

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 wide-spread production. Nevertheless, significant advances have been made in developing more winterhardy, stiffer, and shorter strawed 6-row winter types. Luther and Kamiak are two new varieties from this program. Selection 1094-67 (Luther x 1255-60), a 6-row feed barley, has been named Boyer and appropriate seed increases are being made for release in 1975. It 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. Crosses have been made in an attempt to incorporate acceptable malting quality and high protein and lysine into this and other high yielding 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 also appear to 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 a high-quality parent are under test for the first time this year.

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. It is anticipated that Steptoe will take over much of the spring feed barley acreage in the Northwest. 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 varieties Traill and Larker. The variety has consistently outyielded Larker and Traill by 10-15% and is significantly more shatter resistant. A number of newer selections having quality comparable to Larker are included in Eastern Washington yield trials for the first time this year.

DRY LAND 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 27.

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 sizable margin; Blazer, the new malting barley selection, significantly outyields Larker; and Vanguard significantly outyields Piroline. Bulk early generation lines and rows from single plants selected at Lind in 1974 are being grown in order to select desirable and adapted lines under dry land conditions.

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 27. Numerous other advanced selections will be demonstrated at the Field Day.

Some representative results from tests at Pullman are summarized in Table 7 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 Traill. 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 7

Comparative Yields of Barley Types

Pullman, 1971-74

(Lbs. per Acre)

Winter Type		Spring Type	
	6-Row		
Boyer (Sel. 1094, Feed)	5947	Steptoe (Feed)	4896
Kamiak (Feed)	5914	Blazer (Potential Malting)	4315
Luther (Feed)	4824	Unitan (Feed)	4127
Hudson (Feed)	4632	Traill (Malting)	3893
White Winter (Feed)	4282	Karl (Malting-Idaho)	3697
	2-Row		
Sel. 2464-70 (Ack. 989 x R T.H.) (Potential Malting)	4992	Vanguard (Malting)	4112
Ackerman's 989 (Potential Malting)	4759	Piroline (Malting)	3955
		Klages (Malting)	3173

WHEAT, OATS AND BARLEY

Kenneth J. Morrison
Extension Agronomist

Winter Wheat

Paha

Paha is a short standard height, white club wheat variety with brown chaff developed by USDA, ARS and Washington State University. The resistance to stripe rust was inherited from Suwon 92 but it is susceptible to a new race that developed in 1974. It has moderate resistance to *cercosporella* foot rot. The variety is resistant to lodging and shattering, but it is susceptible to powdery mildew and flag smut. Good germination and emergence characteristics of Paha are typical of the club wheats. Paha is adapted to the areas which consistantly 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, Moro will establish a stand easier and mature earlier.

The high susceptibility of Paha to dwarf and flag smut limits its use. It has widespread use in the intermediate rainfall area.

Moro

Moro is a white club wheat with brown chaff developed at the Pendleton Branch Experiment Station, Pendleton, Oregon. The chief advantage of Moro is its resistance to stripe rust and emergence. Moro is resistant to dwarf bunt and common bunt. It emerges faster than Paha when moisture stress is a factor in germination and emergence. The yields are less than Paha when stripe rust is not a factor.

Moro is a good pastry flour, however, it has a higher flour viscosity than older club varieties. Moro is a medium tall variety. It does not have the high yield potential of Nugaines in the higher rainfall area. In the low rainfall areas of Washington, where it is difficult to obtain stands with semidwarf varieties, Moro will germinate and emerge much better from deep seedings.

Nugaines

Nugaines is a semidwarf white winter wheat developed by USDA, ARS and Washington State University. Nugaines has a high test weight and good milling properties. The variety has a bearded common type head with white chaff. The kernels are classed as soft white. Nugaines is not as winterhardy as the hard red winter wheats, but it is slightly hardier than the club wheats.

Nugaines has good mature plant resistance to stripe rust, but it has a different strip rust resistance than that of Moro. It is susceptible to stripe rust in the seedling stage. Nugaines is resistant to all known races of common smut and some races of dwarf smut. However, some races of dwarf smut attack Nugaines and cause severe losses.

Luke

Luke is a soft white semidwarf wheat developed by USDA, ARS and Washington State University to counteract the recent widespread appearance of new races of dwarf smut. Luke is resistant to all known races of common smut, but some races of dwarf smut will attack the variety. It is well adapted to areas where dwarf smut is a problem on Nugaines. Luke is superior in resistance to *cercosporella* foot rot, snow mold and stripe rust.

Growth habit and general appearance are similar to Nugaines, but it is less winterhardy. Its resistance to lodging and shattering are slightly less than Nugaines.

The milling quality is unusual for soft white wheat and the baking qualities are similar to Nugaines.

This variety is susceptible to flag smut.

Sprague

Sprague is a soft white common wheat developed by Washington State University and USDA, ARS and released for snow mold areas. The chaff varies from white to grey-brown. The heads are small and awned. The variety is 3 to 6 inches shorter than Wanser and McCall and about 3 inches taller than Luke. Sprague has high tillering capacity from early seedings, but the straw is weak. Test weight of Sprague has been about 60 lbs/bu.

Sprague has good resistance to snow mold and stripe rust, but is susceptible to common and dwarf smut and *cercosporella* foot rot. It has excellent emergence and adequate winterhardiness. The variety has survived all snow mold trials in Washington. In the most severe test sites in Douglas County, commercial controls were not harvested while Sprague yielded 70 bu/A. Tests indicate that Sprague has sufficient yield to compete in severe snow mold regions in Washington. Its inferior plant type should limit its use in other areas. The variety should be grown in areas where snow mold is a major problem.

Hyslop

Hyslop is a soft white semidwarf winter wheat that yields well in high rainfall areas or with irrigation. Hyslop was developed at Oregon State University. Hyslop has a slightly better yield record than Nugaines where winter killing is not a factor. Insufficient winterhardiness limits the use of Hyslop in eastern Washington. Coldhardiness tests showed that Hyslop lacks the winterhardiness of varieties such as Paha, Luke and Nugaines. Hyslop has more common smut resistance than Nugaines. It is resistant to stripe rust, moderately resistant to mildew, but is susceptible to flag smut. Milling and baking qualities of Hyslop are similar to Nugaines.

McDermid

McDermid is a semidwarf white common winter wheat with awned heads, developed at Oregon State University. It has weaker straw than Hyslop. McDermid is adapted to the dry land winter wheat growing areas of Washington. McDermid has more winterhardiness than Hyslop, but not as much as Nugaines. McDermid is similar to Nugaines in common smut reaction, but it is susceptible to some races of dwarf smut. The variety is resistant to stripe rust and intermediate in reaction to mildew, Septoria and leaf rust. McDermid has shown a slightly lower yield than Nugaines in Washington.

Wanser-McCall

Wanser-McCall are hard red winter wheats developed for low rainfall areas of Washington. Both varieties yield as well as Nugaines in the areas that have less than 11 inches of annual rainfall. The two varieties are distinguished by chaff color; Wanser has a brown chaffed head, McCall a white chaffed head. Both have bearded common type heads and medium type straw that resists lodging. 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 wheat producing area. McCall is susceptible to strip rust.

McCall is well adapted to the north 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 seeding. Wanser and McCall are more winterhardy than Nugaines or the club wheats. Wanser mills somewhat better than McCall, but McCall has slightly better bread baking qualities than Wanser. Wanser and McCall were developed at the Washington State University Dryland Research Unit.

Norco

Norco is a semidwarf soft white facultative wheat developed by USDA, ARS and Washington State University. Norco has a lax head with long awns and with a white head. Norco has about the same winterhardiness as Nugaines when seeded about the middle of October at Pullman. The variety requires very little vernalization and can be seeded early in the spring. It is less sensitive to day length than varieties currently grown in the state. Norco is resistant to local races of stripe and leaf rust. It is susceptible to common, dwarf and flag smut and is very susceptible to foot rot. The milling characteristics of Norco are similar to Nugaines. The flour has acceptable pastry qualities and is superior to all commercial varieties grown in Washington for noodle making properties.

The average grain yield of Norco is about equal to other winter varieties from late fall seedings. Yields of Norco from *early* spring seeding equal those from other spring wheats.

Norco is intended for production from late fall, winter and early spring seedings in Washington.

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.

Gem

Gem is a six-row, smooth awned variety of spring barley developed by the University of Idaho. It is high yielding and has stiff straw that resists lodging. It has white kernels, but is not acceptable to the malting industry. Gem is adapted to nearly all areas of eastern Washington and for irrigated areas in central Washington. It is not recommended in the Goldendale area or in the glaciated valleys of Pend Oreille, Stevens, Okanogan, Chelan and Ferry counties.

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.

Traill

Traill is a medium tall, six-row, spring malting barley developed by North Dakota State University. It matures a few days later than Gem. It has a rough, long beard and moderately stiff straw. The kernel size is small to medium. Traill may shatter if left standing after it is ripe. Traill is used for malting barley production in the high rainfall areas of southeastern Washington.

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.

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 Norco (late seeding only)	Marfed Idaed-59 Twin Fielder Urquie	Cayuse Park	Steptoe Gem Unitan Traill–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 Coulee	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 Norco	Norco Marfed Wandell (Durum) Twin Fielder	Cayuse Park	Steptoe Gem Belford–for hay only	Luther
Douglas County (snow mold area)	Sprague				

SOIL SAMPLING AND VARIABILITY

A. R. Halvorson

If you sent two people into a field to take soil samples for nitrate testing, each going out independent of the other, would the test report on those two sets of samples show the same nitrate level? It is possible that the two sets of results could be in close agreement. It is also possible that differences could be quite large. Why should there be a difference and if differences can be expected, which results can be counted on as being the right ones for making a fertilizer recommendation?

The differences in test results can come about as a result of soil variability—variability in the amount of nitrate nitrogen that occurs from area to area across a field. These areas vary in size and shape. If the two samplers were unaware of this variability or were unaware of the visual physical features which can help delineate one variable area from another, it would be expected that there would be about a fifty-fifty chance of a difference in test results on the two sets of samples.

Differences in nitrate levels across the field are to be expected. First most of our nitrogen fertilizer is applied in bands about eighteen inches apart. This is an example of man caused variability—a patterned variability—but one which we can correct for when sampling. We need to know the pattern of natural variability so we can correct for it also.

The natural source of nitrate nitrogen comes from the bacterial decomposition of soil humus and crop residues. Eroded areas have less humus and less crop residues, so less nitrate nitrogen would be expected in those locations. This natural and random type of variability is more difficult to correct for when sampling. There is even a variability in depth at which the nitrate will occur—even if a uniform broadcast application had been made over the field. Slight differences in texture, compaction, slope, etc. can cause a difference in the rate of downward movement of the soluble nutrients. This results in shallow to deep locations of the nitrate concentration. One location may hold the nitrate at two feet while a short distance away it may be three or four feet deep.

The big question is, what is the pattern of this variation? Is there a way we can judge from the appearance of the landscape or other features, where the differences might occur so when we sample we can be reasonably sure we won't mix samples from areas of highly variable nitrate levels?

To properly determine what amount of fertilizer a field needs we must know what *each of the different parts need* and we need also to know the boundaries of each of the different areas. Then each area can be fertilized according to its need—or at least, if fertilizer must be applied at one rate over the entire field, we will have a much better basis for deciding what that one rate should be.

But when we go out to sample a field, how are we to know where those different areas are and where they grade into another soil fertility level? We are carrying out studies to find the best possible way to sample a field. Proper sampling is the key to obtaining the correct information about nitrogen needs of a field.

NITRATE MOVEMENT UNDER WINTER WHEAT

V. L. Cochran, R. I. Papendick, and F. E. Koehler

A study to evaluate the movement of nitrate under an alternate wheat-fallow system was initiated at Pullman and Lind in 1971. Anhydrous ammonia was applied in mid-June at rates of 0, 60, 120, and 240 lb N/acre at Pullman. At Lind, ammonium nitrate was applied at rates of 0, 40, 80, 160, and 240 lb N/acre prior to seeding in early September. Both sites were planted to Nugaines wheat.

The results of 3 years of monitoring nitrate movement indicate that during seasons with average precipitation, little movement of nitrate out of the root zone occurs during the cropping season even at the high N rates. However, the excess or residual nitrate in the soil may be subject to deep movement during the subsequent fallow season. During the 1973-74 season, which had abnormally high precipitation, approximately 60 lb of nitrogen moved below the root zone of the high N plots at Pullman. At Lind, nitrate moved to the lower portion of the root zone, but there was little movement below the root zone.

Potassium chloride bands applied on the contour near the Pullman plots (25 to 30 percent slope) showed very little lateral (downhill) movement in 3 years but did move to below the 16-ft depth. Most of the movement occurred during the fallow seasons.

RESEARCH ON PLANT TOXINS PRODUCED BY MICROBIAL DECOMPOSITION OF CROP RESIDUES

V. L. Cochran and D. F. Bezdicek

Reduced yields resulting from substantial amounts of crop residue left on the soil surface have generally been attributed to weed control problems. However, preliminary studies at Pullman using soil sterilents to control weeds have shown that overwinter survival of winter wheat stands have been markedly reduced in the presence of substantial amounts of surface straw. In another experiment, tillering was reduced by the late fall addition of straw on established winter wheat on previously fallowed ground where weeds were not a problem.

Certain soil-inhabiting *Penicillium* species of fungi are known to produce patulin, an antibiotic that is toxic to plants at very low concentrations. Growth of the *Penicillium* species that produce patulin are favored by cool, moist conditions and by leaving crop residues on the soil surface. Patulin is rapidly degraded in soil and can be detected only short distances from the source of its production. Therefore, surface residues may not only favor the production of patulin but often the source of its production is in very close contact to the wheat seedlings.

A greenhouse pot experiment with winter wheat showed stunting and marked chlorosis of plants with surface-applied straw, but not where straw was mixed in the soil or banded as with plowing. Plant analysis showed that nitrate reductase (needed to convert nitrate to ammonium in the plant) in the chlorotic leaves was half that of the healthy leaves, but both nitrogen and sulfur contents were similar. Not all pots with surface straw had chlorotic plants. However, those with chlorotic plants had higher populations of *Penicillium* species than those with healthy plants. A bioassay of filtrate from cultures of *Penicillium* isolates taken from these pots with unhealthy plants showed acute toxicity to corn.

Results from a field study indicate that *Penicillium* populations are greatest throughout the spring where crop residues are left on the surface. Mixing of the straw with the soil was intermediate to that of complete removal. Barley straw supported both a greater population of total spore-forming fungi and *Penicillium* species than did wheat straw, which indicated a higher potential for production of plant toxins. Poor emergence resulted from problems in getting good seed placement through the straw, but plants that did emerge showed reduced growth and some chlorosis.

WATER CONSERVATION AS AFFECTED BY TILLAGE PRACTICES IN THE PACIFIC NORTHWEST

R. I. Papendick and G. S. Campbell

Successful farmers have long recognized the need to match tillage practices to soil type and weather. The matching process was through trial and error with astute observation over several years of success and failure, finally resulting in what the farmer considered to be the best combination. Recent emphasis on improved water quality may require major changes in tillage methods to achieve established goals. Under this project, mathematical equations are being applied to describe water movement, evaporation and water use patterns to determine possible alternate tillage systems for a given area as to effects on water storage and loss Field data are being collected to compare with the predictions of the equations. Results show thus far that for a low rainfall area such as Lind, Washington, about half of the precipitation received on an untilled, coarse-textured soil without residue cover would be stored for crop use while for a fine-textured soil such as in the Palouse with no residue cover and no tillage, only about 10 percent would be stored. Residues on an untilled, sandy soil would have little effect on water storage but a good straw cover could increase storage on a silt loam soil by 20 or 30 percent. This research information will be useful in the development of tillage practices for different areas of the Pacific Northwest dryland grain region with particular emphasis being given to the development of minimum tillage and no-tillage systems.

EROSION PREDICTION AND CONTROL

D. K. McCool and R. I. Papendick

A major effort of the Research Unit is to adapt the Universal Soil Loss Equation (USLE) to the region to use as a farm planning tool and to predict the effect of changes in crop management on soil erosion and environmental quality. The USLE uses factors for climate, soil type, slope length and steepness, crop management and erosion control practice in computing soil loss in tons per acre.

An erosion survey across Whitman and Latah counties and a more localized study to determine the effect of slope length and steepness are part of the USLE effort. Soil loss is measured with the rill meter, a 6-foot wide device that photographically records soil loss. The erosion survey has been conducted for two seasons and the slope length and steepness study for three seasons. Analysis of two years of data indicates that slope steepness has much less effect than in the midwest.

Runoff plots have been installed on or near the Palouse Conservation Field Station and near Rockford on cooperator's land. These will compare the effect of land treatment on soil loss and water quality. The Rockford study is at the request of the Intermountain Grass Growers Association and the Washington Department of Ecology to help assess the effects of alternatives to the grass seed field burning practice.

The 27.1 square mile Missouri Flat Creek watershed is the site of a sediment transport study to determine the total amount of sediment transported from the watershed, the daily and seasonal variation in water quality, and the delivery ratio, or the proportion of soil eroded from the slopes and channels that actually reaches the South Fork of the Palouse River.

THE SOIL FUMIGATION RESPONSE IN WHEAT

R. James Cook

Field experiments are in progress at Walla Walla, Lind, and Pullman to assess the full yield potential of wheat using soil fumigated to destroy weed seeds and harmful soil microorganisms. Early plant growth responses are striking in soil fumigated last fall with either methyl bromide or chloropicrin. In the past, however, such lush wheat has run out of soil water and yields have not been exceptional. The trials this year are irrigated at Walla Walla and Lind and located in a low flat at Pullman. The purpose of this work is not necessarily to find a commercial use for fumigants in wheat production, but rather to use fumigants as a tool to determine soil microbiological limitations to yields of existing wheats. The results indicate that there are unknown pathogenic agents to wheat in Northwest soils.

SNOW MOLD RESEARCH, 1974-75

G. W. Bruehl, E. Donaldson and C. Peterson

Erratic mold development because of drifting reduced the value of two mold nurseries, but a drift covered a third nursery seeded by Ed Donaldson and Dick Nagamitsu on a slope. In that nursery three advanced selections more resistant than Moro and Luke but less resistant than Sprague were identified. These wheats should be resistant to dwarf smut and could prove useful, either as parents or as "back-ups," should dwarf bunt become a problem. Efforts by breeders in Washington and Idaho to increase mold resistance in general, all-round good wheats is continuing.

Typhula incarnata, a snow mold fungus with reddish-brown, radish seed-like sclerotia, developed below ground in a few localities in Lincoln County to kill well-developed wheat plants. After the cold injury of 1973 this fungus was abundant on damaged wheat. We assumed that it thrived only when the wheat was at least "half dead." The wheat of this year was protected by snow so that cold did not weaken it. We now know that, when conditions are favorable, *Typhula incarnata* can damage and even kill otherwise sound wheat.

Young wheat sometimes dies in heavy soils that are cold and very wet for prolonged periods during winter and early spring. A water mold fungus, a *Pythium* spp., is responsible for most of this damage. We intend to investigate this problem this coming winter.

Richard Kiyomoto completed his studies and proved a close relationship between carbohydrate utilization and resistance to snow mold. Resistant wheats use food more sparingly under the snow, conserving their energy. He also proved that the virulence of the black speckled mold fungus, *Typhula idahoensis*, is governed by many recessive genes.

Rollin Machtmes and I toured part of Oregon and much of Idaho collecting mold fungi to compare with our own.

No new control measures of practical use were discovered.

MANAGEMENT/FUNGICIDE COMBINATIONS TO REDUCE STRAWBREAKER FOOT ROT

R. James Cook and J. T. Waldher

Work has been underway on the Palouse Conservation Field Station at Pullman to determine whether trashy-fallow (maximum stubble left on the soil surface) favors more strawbreaker foot rot than mold board plowing (clean tillage). Seven years' results leave little doubt that although yields were hurt by the trashy-fallow system in the Palouse, the effect is not due to increased strawbreaker foot rot. In general, foot rot has been most severe where wheat has grown the best.

Our project at Pullman is now directed at the influence of fall versus spring plowing on strawbreaker foot rot to determine whether stubble left on the soil surface over winter helps dissipate inoculum of *Cercosporella* harmlessly onto the uncropped soil surface. Stubble buried immediately after harvest may "preserve" the fungus and thus contribute to greater disease in a future wheat crop.

This project is also examining the possibility of *double seeding* to reduce strawbreaker foot rot in the Palouse; that is, we seed on the contour by deep furrow drill at 32 inch centers in early September for erosion control, then seed again with a double disk drill 7 inch centers in October for greater yield potential. This method is an attempt to capitalize on the advantages of both early seeding for erosion control and late seeding for foot rot control. The work is still inconclusive.

Work is also now underway in the Horse Heaven Hills and in southern Lincoln County to investigate whether Benlate applied in the dryland areas will protect wheat against foot rot in fields skew-treaded in the spring for cheat grass control, or disturbed by spring applications of ammonia. Skew-treading wheat fields in the spring, or spring application of nitrogen by ground machine both are desirable management practices but are presently avoided because they increase strawbreaker foot rot.

WATER STRESS AND DRYLAND FOOT ROT IN WHEAT

R. James Cook and R. I. Papendick

Work continues near Harrington, Washington on the relationship between water stress in wheat and severity of dryland foot rot caused by *Fusarium*. Virtually any management system that promotes vigorous early growth of winter wheat in the 9-14 inch rainfall area is also conducive to eventual water stress in the plants—and severe dryland foot rot. The fungus attacks those plants already in trouble from stress, but which could yield well in spite of the stress, except for the disease.

Paha and Moro stress less than Nugaines—and they have less dryland foot rot. Indications are that they conserve their limited soil water supplies better than Nugaines. Luke stresses like Nugaines but still resists the foot rot, unless excessive nitrogen is used. There has been a direct relationship between high nitrogen rates and high amounts of the foot rot.

We are now attempting to develop better methods for identifying the best dryland wheats at an early stage in the breeding program. The evidence is clear that a *Fusarium* resistant wheat is also a good dryland wheat, and vice versa. We plan to eventually use the disease to pick wheats with better dryland capability.

BIOLOGICAL CONTROL OF THE TAKE-ALL ROOT DISEASE

R. James Cook and Jerry W. Sitton

Take-all of wheat caused by *Gaeumannomyces graminis* var. *tritici* ranks among the three most serious root diseases of wheat in the world. The disease can be severe in Washington on new (virgin) lands, on old lands not previously cropped to intensive wheat, or on lands where wheat is grown in rotation with grass/legume pastures. It is thus important east of the Cascades in the Columbia Basin and Snake River plains irrigation districts, and west of the Cascades in the Willamette Valley and extending into western Washington.

With major problems from take-all in some parts of the region, it is significant that the disease is rare or nonexistent in long-established wheat growing areas of eastern Washington and adjacent Oregon and Idaho. The pathogen is present in the soil but produces no disease. Moreover, once a field develops severe take-all, if it is recropped again to wheat, the soil becomes "immune" to subsequent take-all. This is a natural form of biological control that, if identified, could perhaps be extended to other areas. Work is underway at Lind and Puyallup, Washington with the control agent(s) to learn more about how to generate and maintain high levels of this disease control. Indications are that certain bacteria are involved which multiply on diseased roots and antagonize the pathogenic fungus. Work at Lind is investigating the influence of crops such as potatoes, beans, alfalfa and grasses on persistence of the antagonists, if these crops are used in rotation with wheat. Indications are that alfalfa causes the antagonists to disappear.

FIELD BINDWEED CONTROL

D. G. Swan and T. L. Nagle

Field bindweed (morning glory) continues to be a major perennial weed control problem in the wheat producing area.

Field bindweed spreads vegetatively and by seed. Most vertical roots penetrate to about 8 feet but can go to 25 feet deep. Horizontal roots (all in the top 2 feet of soil) send up new shoots from buds, thus forming dense colonies. Field bindweed spreads rapidly. The root system can grow up to 10 feet in one direction in a season. Thus, one plant can grow and cover an area 20 feet across in one summer.

Root density—one researcher found 3-1/2 tons per acre of fresh weight roots. Seventy percent were in the top 2 feet of soil. Food reserves, however, are more concentrated in the deeper roots allowing the plant to persist for long periods even under adverse conditions.

Bindweed can be controlled by smothering or shading. Reducing the light intensity to 650 foot candles or less for three years has caused the weed to exhaust its food reserves. However, cultivation every two weeks for three years has not always eradicated the weed.

Research

Several herbicides were applied to field bindweed in a summer fallow field. The liquid treatments were applied when the weed was in the early bloom stage of growth on August 2, 1973. Paraquat was applied to the check as a "chemical hoe" to stop growth. The dicamba granules were applied on September 21, 1973 and wheat was seeded that fall. The plots were evaluated and harvested in 1974.

Plots treated with 2,4-D amine at 3 lb/A yielded significantly higher than other treatments (Table 1). Dicamba at 4 and 6 lb/A caused a yield reduction. The "check," due to field bindweed competition, was the lowest yielding treatment.

Table 1. Wheat injury, field bindweed control and wheat yield from herbicide trial. Cooperator: Stueckle Bros.. Colfax, 1974.

Treatment	Rate[a] lb/A	Wheat injury (%)	Field bindweed control (%)	Wheat yield[b] bu/A
Dicamba + 2,4-D amine	1 2	0	60	51.3 b
Dicamba + 2,4-D amine	2 4	0	80	50.3 b
Dicamba granules	4	10	70	42.0 c
Dicamba granules	6	20	90	41.6 c
2,4-D amine	3	0	60	61.1 a
Paraquat check	1	0	0	18.9 d

[a]Acid equivalent

[b]Means sharing the same letter are not significantly different at the 5% level.

MOVEMENT OF SELECTED HERBICIDES IN THE SOIL

H. H. Cheng and F. O. Farrow

The control of phenoxy-tolerant weeds in small grains and other crops is a continuing problem. In field trials DOWCO 290 herbicide in combination with phenoxy herbicides such as 2,4-D has provided excellent control of a broad spectrum of broadleaf weeds. The objective of our study is to determine the environmental significance of the use of DOWCO 290 in terms of runoff from the plot area, leaching into the profile, and microbial breakdown of the material. The DOWCO 290 content of the runoff is measured chemically in the laboratory and by bio-assay in the field. Movement of the material in the soil profile is studied by periodical soil sampling and analysis by gas chromatography. Microbial breakdown is studied in the laboratory by incubating radioactively tagged DOWCO 290 and relating the results to our findings in the field. Evaluation is made with the aid of benchmarks. Some of the plots are treated with herbicides that have already been studied extensively such as 2,4-D, Tordon and Banvel. The fate of DOWCO 290 in the environment can then be compared with these more familiar herbi-cides. By better understanding the movement of herbicides in the soil, we will be able to make more efficient and environmentally compatible use of them.

DRY PEA IMPROVEMENT

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. Significant progress has been made, and several candidate breeding lines are now being considered for release as varieties. Improved resistance to pea root rot, resulting in yield increases of 30 to 40%, combined with improved vine growth are the main attributes.

Improved standing ability of pea varieties through the use of three morphological genes (af, st, tl) is being attempted and may be a means of improving harvesting ease while resisting invasion by foliar diseases. Such a development may also improve light penetration to the lower canopy and thus improve the photosynthetic capacity of pea varieties and thereby improve yields.

Fusarium wilt (race 1) reappeared in the Palouse region three years ago causing economic loss in at least two pea fields. It was subsequently shown that the varieties being grown in these fields and several varieties of small-sieve Alaska peas were wilt susceptible. This disease was a major problem in this area during the early 1930s but was successfully controlled through the use of resistant varieties. It is necessary, therefore, that varieties intended for use in the Palouse region be resistant to race 1 of *Fusarium* wilt. We are also aware of the other races of wilt that may become important in the future. For example, race 5 wilt has been responsible for taking nearly 30,000 acres out of pea production in western Washington. In the event race 5 becomes a problem in the Palouse area, we have begun incorporating race 5 resistance into our early generation breeding lines.

Hazards from the pea seed weevil may also be significantly reduced or eliminated if promising genes for resistance to this pest can be transferred to acceptable varieties. Germ plasm tolerant to the pea leaf weevil may also be available, but further work needs to be done on evaluation of resistance. Preliminary observations indicate resistance to be associated with certain floral types. If this proves to be true, the early stages of breeding for resistance will be greatly simplified. Resistant varieties would be an ideal means of controlling infestations without the use of chemicals.

CONTRIBUTORS IN SUPPORT OF RESEARCH 1973-74

Fertilizers and Amendments

Cominco American, Inc.
Gardner & Smith
J. R. Simplot
McGregor Company
Ortho Division, Chevron Chemical Company
Northwest Plant Food Association

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

Heitstuman Farms, Uniontown, Washington
Washington Wheat Commission
Washington Pea and Lentil Commission
Crop Improvement Associations

Farmer Cooperators

Variety and Disease Plots

Orin Anderson	Clyde
Harold Beard	Mansfield
Bud Benedict	Asotin
Elwood Brown	Bickleton
Clarke Farms	Albion
Richard Deffenbaugh	Kennewick
Jack DeWitt	Walla Walla
Diamond Spear Angus Ranch	Lamont
Jim Ferrell	Walla Walla
Paul Harrell	Ellensburg
Heitstuman Farms	Uniontown
Ed Hiller & Son	Ellensburg
Vern Hoffman	Rice
Robert Kramer	Harrington
Quentin Landreth	Espanola
Ed Nichols	Dayton
Merle Ledgerwood	Pomeroy
Lehn Brothers	Farmington
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