WSU FIELD DAYS

June 28, 1973
Dry Land Research Unit, Lind

July 12, 1973
Spillman Farm, Pullman

WELCOME TO THE FIELD DAY

The Field Day Brochure has been changed this year to include 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, and lentil fertility research programs being conducted in all areas of eastern Washington. It is hoped that 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 carried on cooperatively by the 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 Association and County 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. The brochure is divided into three colors for the field days–Both, Gold; Lind, Bamboo; Pullman, Green.

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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WHEAT, OATS, BARLEY

Kenneth J. Morrison

Winter Wheat

Paha

Paha is a short, standard height, Omar-type white club wheat selection made at Pullman, Washington. The selection is shorter but in other characteristics is similar to Omar in appearance and in reaction to common and dwarf bunt. The high resistance to stripe rust was inherited from Suwon 92. It has moderate resistance to *Cercosporella* foot rot. The variety is superior to Omar in resistance to lodging, shattering, but is notably more susceptible to powdery mildew and flag smut. Good germination and emergence characteristics of the selection are similar to Omar.

Compared to Moro the new selection appears better adapted to the areas which most consistently produce the quality of club wheat desired by domestic and foreign markets. Under conditions of relatively low rainfall and critical soil moisture conditions at seeding time, Moro is expected to maintain its favorable competitive position principally because of ease of stand establishment and early maturity.

The high susceptibility of Paha to dwarf and flag smut are expected to retard its widespread adoption in the intermediate rainfall area. This selection would fill the need for a low protein, high quality Omar-type club wheat highly desired in the domestic and Japanese market.

Moro

Moro, a white club wheat with brown chaff was released by Oregon and Washington experiment stations and the U.S. Department of Agriculture. It was developed at the Pendleton Branch Experiment Station, Pendleton, Oregon.

Its chief advantage over Omar is that it is resistant to stripe rust. Moro is more resistant to dwarf bunt and common bunt also.

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

Moro is a good pastry flour; however, it has a higher flour viscosity than older club varieties that may make it less suitable for some uses.

Moro is a medium tall club variety, about two days earlier maturing than Omar. Its kernels are white and it has brown chaff. Moro does not have the high yield potential of Nugaines in the higher rainfall areas. The same fertilizer program is recommended for Moro as for Omar.

In the lower rainfall areas of Washington where it is difficult to obtain stands with Nugaines, Moro will germinate and emerge much better than Nugaines from deep seedings in dry dusty seedbeds.

Sprague

Sprague is a soft white common wheat released for snow mold areas. The chaff varies from white to gray-brown; the heads are small and awnletted. The variety is 3 to 6 inches shorter than Wanser and McCall, and about 3 inches taller than Luke. The variety heads about the same time as Wanser and McCall. It has high tillering capacity from early seedings, but the straw is weaker than Luke. The test weight of Sprague is below Nugaines but it has been above 60 pounds per bushel.

Sprague has good resistance to snow mold, stripe rust, and common bunt, but is susceptible to dwarf bunt and *Cercosporella* foot rot. Reaction to flag smut is not known.

It has excellent emergence and adequate winterhardiness.

The variety has survived in all snow mold trials in Washington. In the most severe test site in Douglas County in 1971, no commercial control was harvested while Sprague yielded 70 bushels per acre. Tests indicate that Sprague has sufficient yield to compete in severe snow mold regions in Washington. Its inferior plant type should preclude its use in other areas. The variety should be grown in areas where snow mold is a major problem. Because of its weak straw and lower yield, it should not be grown in more productive areas where snow mold is not a problem. The original crosses were made by Dick Nagamitsu and Walt Nelson at the Dry Land Research Unit at Lind in 1962. Final selection was made in 1968 by Mr. Nelson, Mr. Nagamitsu, and Dr. Bruehl, Washington State University.

Coulee

Coulee is a semidwarf Burt-type hard white wheat selection made at Pullman. It is very similar to Burt in general appearance, winter and spring growth habits, winterhardiness, kernel type, and milling and baking qualities. The selection has shorter straw than Burt. It is slightly more tolerant to *Cercosporella* foot rot than Burt. The germination and emergence characteristics are very similar to Burt, representing an improvement over Nugaines and other relatively slow-emerging, semidwarf varieties. It is superior to Burt in resistance to stripe rust, lodging, and shattering.

The selection appears to be worthy of release in Washington for the production of strong gluten Burt-type hard white wheat desirable in the domestic and foreign markets. Tests indicate it is best adapted to good management in areas receiving between 10 and 14 inches of annual precipitation. When grown under relatively severe conditions of drought and severe freezing temperatures, it has shown no advantage in potential yield over Wanser or Burt.

Burt

Burt is a hard white bread-type wheat. It has a common-type, bearded head with white chaff. Burt is highly resistant to all races of common smut and to most races of dwarf smut. It is less resistant to stripe rust than Nugaines. It has short, stiff, lodging resistant straw. Burt is recommended in the drier areas where the rainfall is 14 inches a year or less.

Luke

Luke is a soft white semidwarf wheat selection for use in counteracting the recent wide-spread appearance of new races of dwarf bunt. Parents of this variety include PI-178383 x Burt.

178383 was one of the parents of Moro. The result of this cross was then crossed with Selection 101, one of the high yielding semidwarf selections. Luke is resistant to all known races of common and dwarf bunt and is well adapted to areas where new races of dwarf bunt are found on Gaines and Nugaines. This variety is notably superior to these two varieties in resistance to *Cercosporella* foot rot, snow mold caused by *Fusarium nivale*, and to stripe rust.

The winterhardiness, growth habits, and general appearance are similar to Nugaines. The milling quality is unusually good for soft white wheat, and the baking quality is similar to Nugaines. Its resistance to lodging, shattering, and leaf rust are slightly less than Nugaines. This selection is also susceptible to flag smut.

Nugaines

Nugaines is a semidwarf white winter wheat released for use in Washington and other parts of the Pacific Northwest where Gaines, which it closely resembles, has proved to be well adapted. Outstanding superior characteristics of Nugaines are improved test weight per bushel and milling properties. The variety has a bearded, common-type head with white chaff. The kernels are classed as soft white. The head grows slightly more erect than Gaines.

Nugaines is not as winterhardy as McCall or Wanser hard red winter wheats, but is slightly hardier than the club wheats. Nugaines is similar to Gaines in hardiness.

Nugaines has good mature plant resistance to stripe rust. It also has more stripe rust resistance than Gaines, but less than Moro. Nugaines, like Gaines, is susceptible to stripe rust in the seedling stage.

Nugaines is similar to Gaines in resistance to all known races of common smut and most races of dwarf smut. Nugaines has moderate resistance to flag smut and stinking smut.

Hyslop

Hyslop is a soft white semidwarf winter wheat that yields well on dry land in high rainfall areas or with irrigation. Hyslop was developed by Dr. Warren Kronstad, Wheat Breeder, Oregon State University and has been tested in Washington. 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. Cold hardiness tests showed that Hyslop lacks the winterhardiness of such varieties as Paha, Luke and Nugaines.

Hyslop has more common smut resistance than Nugaines; it also is resistant to stripe rust, moderately resistant to mildew, but is susceptible to flag smut.

Milling and baking quality of Hyslop is similar to Nugaines.

Wanser and McCall

Wanser and McCall are hard red winter wheats developed for low rainfall areas of Washington. Both varieties yield as well as Gaines in areas that have less than 11 inches of annual rainfall.

The two varieties can be distinguished by chaff color. Wanser has a brown-chaffed head; McCall, a white-chaffed head. Both have bearded, common-type heads and medium height 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. Its superiority over McCall in stripe rust tolerance and winterhardiness is important for maximum production.

McCall is well adapted to the northern section of the Big Bend area including Douglas, Grant, and Lincoln counties. McCall is superior to Wanser in both snow mold tolerance and emergence from deep seedings—two qualities important to production in this area. McCall recovers rapidly in the spring which is another advantage for the northern area.

Wanser is as winterhardy as Itana. McCall has good winterhardiness, though less than Wanser. Both Wanser and McCall are more winterhardy than Burt, Gaines, or the club wheats.

Wanser and McCall are more shatter resistant than Burt. They will shatter more than Itana, but are easier to combine and thresh clean.

Both varieties compare favorably with Itana in milling and baking characteristics. Wanser mills somewhat better than McCall. McCall has slightly better bread-baking quality than Wanser or Itana. Neither is suitable for production of soft white wheat products.

Wanser and McCall have higher yield potential than Itana, Columbia, or Cheyenne. Their potential is equal to that of Burt in the recommended areas.

Spring Wheat

Marfed

Marfed is an early to mid-season common soft white variety with medium tall, stiff, white straw. It has a beardless, white-chaffed head. Marfed is more resistant to common smut than Federation. It tillers more than Federation, but otherwise is quite similar. When spring seeded, there is no lodging difference between Marfed and Federation. However, when fall seeded, Marfed has lodged somewhat more than Federation. Marfed resists shattering. It has fair seedling resistance to stripe rust and some mature plant tolerance. Marfed is recommended in the areas of eastern Washington with 10 or more inches of rainfall and for spring seeding in the irrigated areas of central Washington.

Idaed-59

Idaed-59 is a common soft white wheat that is very similar in appearance and growth habits to Idaed. 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 common 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 harvest time, 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.

Twin

Twin is a soft white spring wheat named and released by Washington, Idaho, and Oregon agricultural experiment stations and the Crops Research Division, U.S. Department of Agriculture. Twin has a higher yield record under dry land conditions than Marfed. Twin did better under irrigation at Ellensburg but did not do as well as Marfed at Othello. Twin has a lower test weight than Marfed, it has shorter straw, and is more lodging resistant. The variety is resistant to prevalent races of stripe rust but is susceptible to leaf rust and mildew. Twin is an awnless wheat of medium maturity, has white chaff, and moderately stiff straw. The variety was developed at the Idaho Branch Experiment Station at Aberdeen, Idaho.

Wared

Wared is a new hard red spring wheat released by Washington State University. The variety was evaluated in Washington by Drs. C. F. Konzak, E. Donaldson, and K. J. Morrison. The original crosses and selections were made in Minnesota as part of the U.S. Department of Agriculture–Agricultural Research Service, Minnesota State Wheat research program. 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 either dry land or with irrigation.

Seed for commercial production will be available in 1975. Registered seed will be available in 1974.

Durum–Wandell

Wandell is a durum wheat released 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 by Dr. Konzak at Washington State University.

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

Spring Barley

Steptoe

Steptoe is a six-row spring feed barley with a higher yielding 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. Steptoe has a higher yield record at most locations.

The variety was developed by Dr. Robert Nilan and Mr. Carl Muir, Washington State University plant breeders. The selection was made from an experimental selection crossed with Unitan.

Gem

Gem is a six-row, semi-rough-awned variety of spring barley. 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 recommended for 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. 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 recommended as a feed barley only in both the high and low rainfall areas of eastern Washington.

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.

Piroline is 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 barley recommended to replace Piroline. The variety has a 250 pound per acre higher yield 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 by Dr. Robert Nilan and Mr. Carl Muir. The variety is a selection from a cross of (Betzes x Haisa) x Piroline.

Klages

Klages is a high yielding 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 by the University of Idaho and the Western Region Agricultural Research Service, U. S. Department of Agriculture.

Traill

Traill is a medium tall, six-row, spring malting barley. 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 recommended 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. 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

White Winter

White Winter (Idaho Club) is a six-row winter barley. It is moderately winterhardy and resistant to mildew. White Winter has rough awns and compact head. In fall seedings, it matures early; in spring seedings it is late maturing. When spring planted, its earlier growth is sprawling, and at maturity it is medium tall. Its stiff straw makes it more resistant to lodging than other varieties. White Winter can be used for malting. Spring-sown White Winter generally out-yields spring varieties. White Winter is recommended for fall seeding in areas with 18 or more inches of rainfall in eastern Washington.

It is not recommended for spring planting.

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 and is not acceptable to the malting industry.

Kamiak

Kamiak is a winter barley similar to Hudson in appearance. The selection has been tested at Pullman, Pomeroy, and Dayton, where 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 should perform well in eastern Washington where Hudson is being grown.

Oats

Cayuse

Cayuse is a high yielding, moderately early spring oat recommended in Washington and northern Idaho. 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 per cent more than Park in test plantings.

The main weakness of Cayuse is its test weight, which is relatively lower than 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 some tolerance to the most serious oat disease in Washington—yellow dwarf or "red leaf of oats." The yellow dwarf tolerance of Cayuse can be seen mainly in its high yielding ability. Discoloration results after severe attack by aphids carrying the virus.

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

Although Cayuse is susceptible to node blackening and stem break, these diseases do not affect oat yield 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.

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	Marfed Idaed-59 Twin	Cayuse Park	Steptoe Gem Unitan Traill–malting barley Belford–for hay only Piroline–malting barley Vanguard	White Winter–18 inches or more rainfall Luther Kamiak
EASTERN WASHINGTON					
Less than 14 inches rainfall	Wanser McCall Moro Burt Paha Nugaines Coulee	Wared–8-12 inches rainfall Baart–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	
CENTRAL WASHINGTON					
Under Irrigation	Nugaines	Marfed Idaed-59 Wandell (Durum)	Cayuse Park	Gem Belford–for hay only	Luther
Douglas County (snow mold area)	Sprague				

WINTERHARDINESS STUDIES

Donald W. George

An estimated 30% of the winter wheat in Washington was reseeded this spring. Below 0° minimum temperatures during the second week of December caused injury where there was no snow cover. The last two weeks of December turned mild and wheat began to grow. Three consecutive sub-zero nights in early January with little snow resulted in severe and widespread injury. Fifty to sixty percent of the wheat acreage was damaged and the yield potential on a statewide basis probably was reduced by 20%. Subsequently, drought has slowed the recovery of injured wheat and limited the growth of spring wheat, further reducing the potential yield.

Winterkill is an ever-present threat in many areas of wheat production. Most winter wheat breeders have some method by which they routinely attempt to maintain a level of winterhardiness in their breeding program adequate to the area in which they work. The needs vary considerably. During the development of the first high yielding semidwarfs in Washington, and coincident with the realization of the need for greatly improved disease resistance, it was recognized that increased use of exotic germplasm, often of poor or unknown winterhardiness would necessitate more active testing and selection in order that the general level of winterhardiness in new selections from the breeding program might not decline. Eight years ago the USDA-ARS project on winterhardiness techniques and testing was transferred to WSU where facilities are available to carry on an effective program of screening advanced breeding lines. The project has been well supported by Washington Wheat Commission grants, but suffers from a lack of sub-professional help.

In order to breed winterhardy wheat varieties suitable to all of the needs of the grower and the marketplace, it is first necessary to identify winterhardiness among the otherwise suitable parental lines. A breeding program cannot depend only on the occurrence of "test winters" such as last winter. Winters severe enough to provide the needed information are relatively rare. Laboratory-type freeze tests must be combined with field observations of every aspect of winter plant development in seeking clues to the identification of winterhardy lines. When the "test winter" does occur, it serves as a check on the reliability of the tests which have been applied.

Examination of Table 1 makes it clear that progress has been made. Of the selections listed as significantly better than the mean of the nursery, nearly one-half appeared in the Advanced Yield Nursery for the first time this year. While no commercial white wheat and only one white check selection (CI 13438) appears in this group, several of the new entries approach the survival score of the commercially-grown hard red wheats, indicating that substantial improvement has been made.

Other tests of the Advanced Yield Nursery will determine whether any of these lines have the necessary high levels of yield, quality, and disease resistance required of a successful variety.

Table 1. Selections and varieties with excellent survival and quick recovery as rated 3/14/73 in the 1972-73 Winterhardiness Nursery consisting of 176 entries grown at Central Ferry*

	Variety	ID No.	Rating (survival x vigor)	Class
(Part of the group of 44 selections which were significantly better than mean of nursery.)				
1	Yogo (check)	CI8033	900	HR
2	Kharkof MC 22 (check)	CI6938	900	HR
3	Blackhull Sel. (check)	CI11737	800	HR
4	Ranger	CI15316	800	HR
5	Ark	CI15286	800	HR
6	Bezostaja-1	WA4785	800	HR
7	Kharkof (check)	CI1442	750	HR
8	Franklin	CI15317	750	HR
9	WA 4992/WA 4979	VH72634	700	W
10	Wanser	CI13844	700	HR
11	CI 14106/WA 4765	VH72355	650	W
12	WA 4996/Gns/101/Gns/101	VH72636	650	W
13	Bezostaja 2/Sel. B	WA4836	650	HR
14	WA 4877/VH 66344	WA5987	640	W
15	WA 4994/VH 66457	VB72277	615	W
16	WA 4992//CI 13645/Gaines	VH72520	615	W
17	CI 14482//CI 13645/Gaines	VH72550	615	W
18	CI 14106/Requa//WA 4767	VB72283	600	W
19	Nugaines/CI 13438//172582	VH 72297	600	W
20	CI 14482/Requa//Nugaines	VH72575	585	W
21	14/53, 101 (check)	CI13438	585	W
22	C59287/WA 3969//Moro	VH 71255	585	W
23	WA 4877/VB 66336	VH71349	585	W
24	It//KO/PI 178383	ID37	585	HR
25	Delmar/PI 178383//CLM	UT755204	585	HR
26	Bez-1/(CI 13438/Burt, S4)	WA5838	570	HR
27	WA 4877//Itana/CI 13431-66344	VH71396	555	W
28	DM/PI 173438//CLM/3/DM	UT80702	555	HR
29	101/Odin//CI 13645/101	VB71221	550	W
30	CI 14482//C59287/WA 3969	VB72276	550	W
31	178383/0//101/3/Gns/101	VB72292	550	W
32	CI 14482/WA 3969	VH72394	540	W
33	WA 4994/1826-3/285/178383	VH72503	540	W
34	M65-2509//WA 4765	VH72521	540	W
35	WA 4877//PI 94540	VH72734	540	W
36	WA 4877/VH 66344	VH71662	540	W
37	Bez-1/(CI 13483/Burt, S4)	WA5836	540	HR

Table 1. (Continued)

	Variety	ID No.	Rating (survival x vigor)	Class
(The 54 selections in this group are not different from the nursery mean.)				
38	Coulee	CI14483	515	
39	Sprague	CI15376	450	
40	Burt	CI12696	425	
41	Brevor	CI12385	410	
42	Nugaines	CI13968	400	
43	Gaines (check)	CI13448	310	
44	Elgin (check)	CI11755	290	
45	Moro	CI13740	290	
46	Luke	CI14586	200	
(The 78 selections in this group are significantly poorer than nursery mean.)				
47	Paha	CI14485	130	
48	Orfed (check)	CI12686	80	
49	Hyslop	CI14564	1	

*This nursery includes the Advanced Yield Nursery (100 entries) plus the Regional Hard Red Winter Nursery (30 entries) and 46 other lines of interest.

WHEAT BREEDING AND PRODUCTION
AGRICULTURAL RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE

The Agricultural Research Service has undergone an extensive reorganization during the past year. The changes were primarily administrative and have not materially affected the research goals of the ARS, USDA wheat research group stationed at Pullman, which still includes the Regional Cereal Disease Research Laboratory, the Western Wheat Quality Laboratory, and the Breeding and Genetics Laboratory. All three have regional responsibilities. Administratively, we are now one group called Wheat Breeding and Production, R. E. Allan, Research Leader. Dr. Stanley N. Brooks is now stationed at Pullman as Area Director for all ARS work in Washington and Oregon; Dr. Boyd W. George is Assistant Area Director and Location Leader at Pullman. They will soon be housed in the Ag Phase II Building.

Some personnel changes have occurred in the laboratories during the past year. J. A. Hoffmann and the dwarf bunt program were transferred to Logan, Utah. R. J. Cook and R. F. Line and their three technicians are concentrating their efforts on soilborne and foliar diseases, with special emphasis on dry land foot rot, take-all, stripe rust, and flag smut. In the future more emphasis will be placed on biological control of diseases in the region.

The Wheat Quality Laboratory continues to serve the testing needs of the breeders in the region. G. L. Rubenthaler, W. F. Sollars, H. C. Jeffers, and J. S. Kitterman and their three assistants have this responsibility. They are redirecting some of their effort from problems exclusively related to the domestic quality needs to include the quality needs of our important foreign customers as well.

Dr. Orville A. Vogel retired in January after 41 years with ARS as wheat breeder and Senior Agronomist. His record of research accomplishments and contributions to national and international wheat improvement speaks for itself. C. J. Peterson has taken over as wheat breeder and D. W. George continues his responsibility for winterhardiness, seed physiology studies, and plant growth habits. R. E. Allan and his technician conduct genetic studies on disease response, yield, plant growth and quality. The primary goal of the breeding unit is to develop disease resistant, highly productive, adapted cultivars with desired quality. More recently emphasis is being placed on wheat cultivars that lend themselves to culture for maximum erosion control.

HYBRID WHEAT STUDIES

R. E. Allan, C. J. Peterson, and J. A. Pritchett

We have studied the grain yields and other agronomic traits on 116 hybrids and their parents the past three years. This year 48 new hybrids are in tests. Trials have been conducted at 4 to 7 locations each year and the hybrids have been compared to their high yielding parents and to conventional wheats such as Nugaines or Sel. 101. Hybrids equaled the yield of Nugaines or Sel. 101 in 382 of 1,208 possible comparisons. They definitely surpassed the yield of these two varieties in 143 of 1,208 comparisons. Increases above 23 and 27% over the high yielding parents and Nugaines have occurred.

The tests have conclusively shown that we can get useful hybrid vigor in wheat using the cytoplasmic sterile system. Yet a number of problems still exist. Few if any hybrids appear to be generally adapted to the region and their yield performance has often been erratic. We have also found that restoration of male fertility has not always been complete. In fact, reduced yields in several instances can be related to incomplete restoration of fertility. Excess straw is another problem. Combinations of semidwarf parents have been more productive than hybrids that contain standard height parents.

There are some added advantages to the hybrids. Several hybrids showed excellent winter survival and came through the winter better than their parents. Our seedling vigor tests show certain hybrids emerge faster than either of their parents. Overall our results establish that hybrid wheat has potential but several bottlenecks still exist before we can make hybrid wheat a practical reality for Pacific Northwest growers.

CHEMICAL INDUCTION OF MALE STERILITY IN WHEAT

D. G. Miller and J. L. Dickey

Two chemicals, RH-531 and N-10656, from Rohm and Haas Company and FMC Corporation, respectively, were discarded as useful gametocides in wheat last year. Our efforts are now being concentrated upon Ethephon in combination with gibberellic acid to develop a formulation for use as a gametocide under field conditions. Semidwarf (Nugaines), short standard (Burt), and tall standard (Cheyenne) wheats are being foliar sprayed in the field to observe varietal reactions to combinations of gibberellic acid and Ethephon. Certain chemical combinations show favorable response.

Two new chemicals from Rohm and Haas Company (RH-532 and RH-2956) and Ethephon are being tested on spring wheat in a one-acre crossing block on the Harold Stueckle farm, northwest of Pullman. Reports from California on barley show 90% male sterility and 80% seed set following applications of RH-2956, but results in wheat are not known as yet.

STAND ESTABLISHMENT STUDIES

R. E. Allan, C. J. Peterson, and D. W. George

Improved seedling vigor continues to receive major emphasis in our breeding program. Lack of adequate seedling vigor is most serious among semidwarf lines. The new semidwarf varieties of Luke, Coulee, Paha, and Sprague have improved seedling vigor over Gaines and Nugaines. Breeding progress for further improvement has been slow, but by intercrossing the best emerging semidwarf selections for the past seven years and by screening these intercross lines in high soil temperature, deep sown, field emergence tests, types with improved vigor have been obtained. Some of these semidwarf lines appear to be notably superior to Luke for total emerged seedlings (total stand) and for rate of emergence (ERI) based on two years of tests. Most of the lines are shorter than Luke. The germplasm which imparts improved seedling vigor includes PI178383, Suwon 92/3*Burt 2, Spinkcota, and Nigger. Ten of these lines that show promise as parents are:

Pedigree	Sel. No.	% Total Stand	ERI	Plt. Ht. (in)
Spinkcota/B1/Gns/Sw92/3*Burt 2	69T1	68	245	25
Spinkcota/B1/Gns/14/53/Burt 5	69T36	62	244	27
Spinkcota/B1/Gns/CI13749	69T72	60	232	27
Sw92/3*Burt/Sw92/3*Burt 2	69T133	60	236	30
SD25/PI178383-62//CI13749	69T186	60	257	22
SD25/PI178383-62//CI13749	69T208	64	232	24
SD25/PI178383-62//14/53/Burt 5	69T246	60	250	32
Nigger/Sel. 101/Gns/14/53/Burt 5	69T369	62	233	29
Nigger/Sel. 101/Gns/Sw92/3*Burt 2	69T375	64	261	28
Nigger/Sel. 101/Gns/Sw92/3*Burt 2	69T389	62	263	25
Luke	-- -- --	59	223	31
Moro	-- -- --	68	297	38

SIMULATED HAIL DAMAGE IN WHEAT

J. W. Burns, D. G. Miller, and J. L. Dickey

Stem breakage injury was inflicted upon Paha and Nugaines wheats at Lind and Pullman. Hail injury intensities involved 33%, 66%, and 100% of the stems broken at five plant growth stages: boot, anthesis, milk, soft dough, and hard dough. Breaks were made below and above the flag leaf.

The higher breakage intensities in the boot treatment stage reduced grain yield by more than 40% in Paha at both locations and in Nugaines at the Lind location. Yield of Nugaines at Pullman was reduced most in the milk treatment stage. Generally, yield reductions increased as the intensity of breakage increased from 33 to 100%; however, height of breakage had no significant effect on yield reductions.

Kernels per spike were reduced most by treatments in the boot and anthesis stages while 1000 kernel weight was reduced most by injury in the milk stage. It appeared that a decrease in kernels per spike was accompanied by an increase in kernel weight for both varieties at both locations.

Test weight and percentage protein were affected little by simulated hail injuries and appeared to be influenced more by seasonal and market class variations, respectively.

PLANT WATER STRESS AND DRYLAND FOOT ROT

R. J. Cook and R. I. Papendick

Recent breakthroughs in instrumentation are making it possible for the first time to measure water stress in wheat plants under field conditions at several different sites concurrently. This project was initiated in the fall of 1969, following observations that a relationship exists between increased water stress in wheat, and increased severity of dry land foot rot caused by the soilborne fungus, *Fusarium culmorum*. Excessive N fertility (relative to available soil moisture), narrow row spacing (or other means to increase plant density), and early seeding all were subsequently shown to (1) hasten early spring use of the limited soil water supplies, (2) cause greatest water stress in wheat, and (3) cause earliest and greatest onset of severe foot rot. *Fusarium* infects in the fall shortly after seeding and remains a slow-decay (and generally harmless) pathogen in the wheat crowns until water stress conditions develop within the plant itself, at which time the fungus kills its host by rapid and aggressive attack, generally right after heading. Laboratory studies have now confirmed that this fungus grows optionally and even appears to be addicted to water stress. Moreover, as the temperature rises (up to 95-100^{o}F), the level of water stress most favorable for fungus growth also rises.

Spreading rows apart to 24 inches, reducing N fertility from excessive rates, and seeding later all help reduce the disease significantly, with no reduction in yield; often yields increase. A more desirable disease control, however, is resistant varieties that can be planted early for erosion control, in denser stands for weed control, and with adequate N for maximum yields. Our tests indicate that most wheats actually have good resistance to this disease (adequate to keep the fungus in the slow-decay stage) but that this resistance ceases to function adequately in plants stressed for water. The objective thus becomes one of breeding wheats for better dry land capability and drought tolerance; resistance to *Fusarium* will then be obtained simultaneously. Thus, whereas this study was started in an effort to reduce losses from dry land foot rot, it is now contributing fundamental information on means for wheat improvement for the dry land area with or without the presence of foot rot. In a sense, this fungus serves as an early indicator of stress susceptibility in wheat.

Plant water stress studies are underway this year employing 7-10 test varieties at Pomeroy, Pullman, Dayton, Walla Walla, Kennewick, Lind, and Harrington. The pattern emerging is that wheats adapted to the low rainfall-high fertility conditions may be either of two types: stress avoiders and stress tolerators. A stress tolerant variety is defined as one capable of functioning with minimum strain, even when water within its tissues is under very high tension. A variety that avoids stress has the means to keep its internal water status at a favorable level (under less tension), presumably by shutting down transpiration more quickly. Luke may be an example of a stress tolerant wheat; Moro is apparently a stress avoider. Both display good resistance to dry land foot rot. Unfortunately most wheats fall in the third category; they neither avoid nor tolerate stress and are highly susceptible to dry land foot rot. Nugaines is of this third category. More work is thus needed to develop stress tolerant wheats with their attendant greater yield potential and ability to respond to N, but which will be resistant to the *Fusarium*.

BIOLOGICAL CONTROL OF TAKE-ALL

R. J. Cook

The wheat foot rot known as take-all is a problem primarily in newly-developed lands in the Columbia Basin recently reclaimed from the sagebruch/bunchgrass vegetation. Of interest is that this disease increases in importance with wheat recropping only for three-four years; thereafter it declines to an insignificant level. A biological factor (fungus, bacterium, or collection of organisms) multiplies in the soil in response to the take-all fungus and/or root rot disease and finally brings about a natural biological control. Some fields in the Columbia Basin are now in their 12th-15th year of continuous wheat or barley and show no take-all, in spite of favorable moisture and temperature. Soil from one of these fields was used as "starter" soil in a non-antagonistic site that thereafter was cropped annually to wheat; severe take-all occurred in the first crop, but virtually complete disease suppression occurred the second year in each of the plots amended with the suppressive starter soil. Experiments are now in progress to identify the factor(s) for more expedient introduction into fields where take-all still occurs. Indications are that soils of the Palouse and even wheat-fallow soils of the low to intermediate rainfall area contain a measure of this suppressive factor. Growers in eastern Washington are thus unbeknowingly enjoying the benefits of a fairly effective biological control of this otherwise very serious disease.

CERCOSPORELLA FOOT ROT

G. W. Bruehl and C. J. Peterson

The fungicide Benlate was sprayed on wheat in Columbia, Whitman, and Spokane Counties on ranches with early-seeded Nugaines. Yields on the three ranches averaged 87 bu/acre with 5 pounds Benlate per acre, 73 bu/acre with 1/2 pound, and 61 bushels with no Benlate. No inoculum was added, so this level of disease resulted from natural infection.

Experiments on Spillman Farm, Pullman, showed that the breeding program is making real progress. Sel. 101, Nugaines, Luke, and Sel. 70774 were seeded September 9 and inoculated with the fungus. Without fungicide, Sel. 101 produced 37 bu/acre, Nugaines 46, Luke 62, and Sel. 70774, 99 bushels/acre. Selection 70774 was so resistant that in this test, its yields were not increased with 2 pounds Benlate/acre, and it was the only wheat with normal test weight. What is most impressive, the potentially higher yielding wheats (Sel. 101, Nugaines, Luke) did not yield as well as Sel. 70774, even when sprayed with 2 pounds of Benlate/acre. The estimated cost of Benlate, if available, would be about $9 per pound. The resistance of 70774 would thus have a dollar value of about $20 per acre! Sel. 70774 was developed by Peterson.

These very encouraging results argue for sustained effort to obtain commercial wheats as resistant as Sel. 70774 so that wheat can be safely seeded early to aid in erosion control.

The foot rot research is expanding in that some of it will be conducted at Puyallup in a wetter, more humid climate where very severe disease may aid in detecting the best sources of resistance.

STRIPE RUST GENETIC STUDIES

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

Genetic tests over the past eight years have allowed for differentiation between the genes for resistance among 34 sources used in our program. Although all phases of this research are not completed, at least 15 genes for specific resistance have been categorized. The following sources carry different genes and are receiving special attention in the breeding program:

Source	No. of Genes	Source	No. of Genes
PI178383	1	Spaldings Pro.	2
Suwon 92	1	Druchamp	1-3?
PI94349	1	Hybrid 46	1
Soissonias	1	Peko	1
Ottawa/Rcm	2	Sel. 2629-14	1-2?
Pnc/MM/Ex/Rm	1	Heines Kolben	2

This information indicates that we can make use of wide germplasm base for specific resistance to stripe rust. A wide base of resistance has proven to be the most effective way to combat new races of airborne diseases. In addition there is a parallel breeding program in which sources of non-specific resistance are identified. This type of resistance remains effective to different races of the disease, but may allow for some moderate disease damage. Genetic tests in the field have shown that different sources of non-specific resistance occur in Gaines, Ridit, Iowin, Spinkcota, Dickson 114, and PI178383. Our goal is to utilize both the specific and non-specific forms of resistance in regionally adapted high yielding varieties.

FLAG SMUT GENETIC STUDIES

R. E. Allan, C. J. Peterson, and R. F. Line

Studies of segregating material in field plots at Bickleton the past three years have given very useful information on the inheritance of resistance to flag smut. We have tested 14 crosses in detail. Nine of the crosses involved crosses of resistant x resistant parents and the others involve resistant x susceptible parents. Reaction to the disease was controlled by two to four genes. The results are summarized as follows:

1. Norin 10/Brevor 14 has a single gene for high resistance that differs from a resistant gene of Itana.
2. Although Omar and Brevor are susceptible varieties, they have genes for low level resistance that becomes effective when crossed to other varieties.
3. Ridit has one single recessive gene for moderate resistance unlike genes found in Dickson 114, Spinkcota, and Gaines.
4. Iowin carries a high level of resistance that is conditioned by two or more genes. Its resistance differs from Gaines, Dickson 114, and Spinkcota.
5. Dickson 114 carries a high level of resistance due to two or more genes. This resistance differs from that of Golden and Norin 10/Brevor 14, Iowin, Burt, and Ridit.
6. Reaction to flag smut was not associated with chaff color, awn expression, spike type, maturity, plant height or stripe rust reaction in seven crosses. Disease reaction did relate to chaff color, plant height, and awn expression in 2, 2, and 1 crosses, respectively.

These results will help guide the methods used in our breeding program. We now know the germplasm base for resistance to flag smut is wide and that several of the sources we are using are uniquely different. There are at least two types of resistance. One type affords a high level of protection and the other represents a combination of genes that by themselves give only partial resistance but when they are placed together give excellent protection. Resistance to flag smut is primarily inherited, independently of the important plant and agronomic traits which breeders work with. This means very few barriers to selection progress should occur.

RUST, POWDERY MILDEW, AND FLAG SMUT

R. F. Line

Rust

Three rusts occur on wheat in the Pacific Northwest (stripe rust, leaf rust, and stem rust). So far in 1973, stripe rust has only been found at a few locations. It appears that it will not be important this year. The unusually dry weather this spring is unfavorable for rust development. Moro is resistant to all stripe rust races except PNW-5, which was first found near Bonners Ferry, Idaho in 1968. Race PNW-5 has since spread to the Palouse area. Paha is resistant to all races of stripe rust except race PNW-2. Race PNW-2 was found in 1963 in the area but has not been found since then. Nugaines, Gaines, Wanser, McCall, and Luke are susceptible to stripe rust in the seedling stage but are more resistant later in the season, especially when the temperatures are high.

Most varieties of wheat grown in the region are very susceptible to leaf rust. This disease could be potentially dangerous, especially in the areas with higher rainfall and in irrigated fields. Leaf rust usually appears later than stripe rust but can tolerate higher temperatures than stripe rust and can therefore increase to epidemic levels during the summer. There are sources of resistance to leaf rust and resistance is being incorporated into new varieties. Also there is a possibility that a chemical fungicide may be available for use in the future. Leaf rust needs free moisture on the leaves in order to infect the plants; consequently, it may not be severe in commercial fields this year because of the dry weather.

In recent years stem rust has appeared late in the season when the wheat and barley crop was almost mature. Consequently, it has caused only slight damage to the crop.

Powdery Mildew

Powdery mildew is prevalent throughout the region and is most prevalent in areas with higher rainfall and in irrigated fields. Accurate measurements of the damage caused by mildew are difficult to obtain. Mildew does not cause as much damage as the rusts even when it completely covers the plant. Most varieties grown in the region are very susceptible to mildew; however, there are good sources of resistance to mildew. Resistance is being incorporated into new varieties.

Flag Smut

Flag smut has been found in most of the eastern counties of Washington and in a few counties of Oregon and is most severe in Klickitat County, Washington. Varieties and lines show various degrees of resistance. Wanser is very resistant and Nugaines, Gaines, and Moro have a relatively high degree of resistance. Luke is moderately susceptible and Paha is very susceptible (as susceptible as Omar). A few chemicals will control flag smut. Vitavax will control both seed-borne and soil-borne flag smut. Planting early and planting deep (2 to 3") increases the severity of flag smut.

WEED CONTROL IN WINTER WHEAT

T. J. Muzik and T. L. Nagle

Weed control practices in winter wheat have been undergoing rapid changes in the past few years. Washington State University now recommends eight herbicides for broadleaf control in winter wheat. These are:

Diuron (Karmex)	2,4-D
Linuron (Lorox)	MCPA
Terbutryn (Igran)	Bromoxynil + MCPA (Bronate, Brominal+)
Bromoxynil (Brominal, Buctril)	Dicamba (Banvel) + 2,4-D

These materials have various restrictions concerning proper usage. Before a grower makes a decision concerning a new herbicide, he should read Extension Bulletin 599, *Annual Weed Control in Winter Wheat in Eastern Washington.* Each product is discussed in the bulletin. Age, stage of growth, and climate are important factors which should be considered before applying an herbicide.

In the 10 to 12 inch rainfall area, 2,4-D is still generally the best choice of herbicide to use. The weed problem should be analyzed for weed species, population, soil type, and size of weed before a herbicide program is chosen. One of the newer materials might be the best choice. Although somewhat more expensive, they have the advantage of being more effective against certain weed species or less toxic to the wheat.

Experiments with these herbicides have been conducted for several years at many locations. Results from these experiments show that growers, by choosing the right selective herbicide and with appropriate timing, can control virtually all problem broadleaf weeds in the winter wheat-producing areas in Eastern Washington. Varietal differences to herbicides in wheat are under investigation and it appears that there are some differences, which can be important, especially under stress conditions.

NOTE

Indiscriminate application of these herbicides is not recommended. Damage to wheat may occur when the wheat is under stress. Selectivity is decreased and crop damage might occur following winter injury, heaving, frost damage, or drought.

Downy brome (cheatgrass) continues to be a major problem in the winter wheat-growing areas. Research continues to be conducted in attempting to find a selective herbicide for the control of downy brome in wheat. To date these attempts have been unsuccessful but promising new herbicides appear each year and the possibility of finding a selective material is good. Many compounds have been tested over the past 20 years. This list includes more than 60 herbicides tested singly at varying rates and more than twenty tested in combination with other herbicides. Several of these herbicides were only tested one year. Most of these either did not control downy brome, caused crop injury, or both. Other materials were tested for several years and then dropped because of lack of consistent performance or crop injury. Cultivation and directed-shielded spray exploratory research is under way.

SPRING WHEAT RESEARCH PROGRAM

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

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, with each entry being evaluated at all 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.

At Pullman the 1973 Replicated Preliminary Spring and the Single Plot Preliminary Nurseries were planted on March 29. The Replicated Preliminary Nursery consists of 210 red and white seeded lines having satisfactory agronomic and quality characteristics in 1972 trials. Being tested in the single plot preliminary nursery are 320 lines selected in 1972 from approximately 3000 F_4 and F_5 progeny rows. The Single Row Screening Nursery consists of approximately 5000 F_4 and F_5 plant rows to be evaluated for stripe rust resistance, maturity, yield potential, test weight, and quality. Half of the F_4 and F_5 lines are planted at the Knott Dairy Center three miles west of Spillman Farm, and half are planted at Spillman Farm. In March and April 40,000 F_3 rows were planted at Royal Slope and Pullman to be plant selected for disease resistance, maturity, and yield potential. Nurseries with F_2 populations from crosses are at the Spillman Farm and at the Palouse Conservation Farm on the Albion road. In 1972 nearly 800 crosses involving both winter and spring lines were made to provide materials with a wide genetic base for plant selection and further crossing in 1973.

An important objective in the 1973 crossing program will be to combine new selections obtained from Nebraska or introductions from India, Pakistan, and Argentina having high protein and better lysine with hard red spring lines adapted to the Pacific Northwest.

SPRING WHEAT IMPROVEMENT
VARIETY TRIALS

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

The 1973 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. In addition to the varieties from the Western states, the nursery contains one entry from the CIMMYT program in Mexico and several from commercial breeders. Identical trials are being grown at the Lind and Royal Slope Research Units and in the vicinities of Walla Walla, Pomeroy, Dayton, Harrington, and Waterville on land provided by the cooperating local wheat growers. In addition to these larger replicated trials, released varieties are evaluated in replicated nurseries throughout Eastern Washington. Several soft white, hard white, hard red wheat varieties, and new lines of interest to growers are described below and in Table 1.

Soft white spring lines include Marfed, a widely adapted variety with standard height and satisfactory milling characteristics. Idaed-59 is similar to Marfed with the exception that Idaed-59 matures earlier. 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. WA5876 is a semidwarf derivative of Marfed and Gaines. It has dual purpose baking properties and superior milling characteristics. It represents a breakthrough in the quest for a better milling, common soft white wheat. It is also more cold tolerant than Marfed. ID000044 is a high yielding, semidwarf wheat which produces grain having a higher test weight than Twin.

Hard red spring selections listed in Table 1 are Peak 72, a semidwarf, good-yielding variety, which has somewhat stronger than desirable gluten quality characteristics for a bread wheat. Wared (Era Sib 2), a selection originally from the Minnesota program, is a semidwarf that has shown good yielding ability and wide adaptation in Central and Eastern Washington over a four-year test period. Breeder's seed of Wared was produced in 1972 and has been approved for release in 1973. ID000043 is a semidwarf selection from the Idaho program. This line also has good yield potential in Washington and may be released in 1974 by Idaho. Both Wared and ID000043 possess desirable gluten quality characteristics for bread baking. Norana was milling tested in the Western Regional for the first time in 1972.

Of the hard white spring wheats, CI13736 has been extensively tested in Eastern and Central Washington and appears to lack the ability to produce sufficient grain at some locations in the state. OR006713 is a standard height selection from the Oregon program. WA5936 was placed in the Regional tests in 1972. It has good quality characteristics and wider adaptation and yield potential than CI13736.

Table 1. Performance of Spring Wheats at 4 Locations in Eastern Washington

Ave. Rainfall*	Pullman (20.5)		Dayton (19.6)		Walla Walla (20.0)		Pomeroy (16.6)		Pullman 1972 TW
Market Class & Variety	1972 yld	% MFD (yrs)	1972 yld	% MFD (yrs)	1972 yld	% MFD (yrs)	1972 yld	% MFD (yrs)	lbs/bu
Soft White									
Marfed	50.2	100(5)	50.4	100(5)	49.3	100(5)	52.8	100(5)	58.8
Idaed-59	45.9	84(4)	46.5	91(4)	48.0	93(4)	36.8	84(4)	60.4
Twin	54.4	123(5)	45.8	118(4)	48.2	119(4)	38.5	105(4)	57.6
WA005876	50.8	118(3)	53.2	97(3)	59.5	122(3)	51.2	113(3)	59.2
ID000044	63.9	149(2)	48.7	130(2)	57.2	134(2)	52.8	114(2)	60.5
Hard Red									
Peak 72	49.9	119(3)	51.0	112(3)	49.4	111(3)	45.1	100(3)	60.2
Wared	57.2	116(4)	51.2	112(4)	53.3	112(4)	50.3	124(4)	60.5
ID000043	55.1	139(2)	50.4	128(2)	54.4	126(2)	48.5	114(2)	59.9
Norana	57.2	114(1)	55.9	111(1)	56.0	114(1)	51.5	98(1)	60.2
Hard White									
CI013736	49.5	100(5)	49.9	98(5)	51.5	108(5)	46.1	98(5)	58.0
OR006713	51.2	101(3)	50.8	111(3)	52.6	127(2)	49.8	108(2)	61.5
WA005936	49.9	99(1)	50.0	99(1)	55.6	113(1)	57.6	109(1)	59.5

*Crop Year – October 1 - August 30.

FALL-SPRING NURSERIES

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

This special series of trials is required for the evaluation and identification of spring wheats with high levels of cold tolerance and resistance to winter injury. Lines with higher levels of winter survival from a late September seeding have been identified through use of this nursery grown also at Lind (Table 1). To test the vernalization requirement (spring habit) and maturity class of the cold tolerant wheats, a late May to early June seeding is also made at Pullman. Some of the more promising cold hardy selections are already in the Western Regional Nursery, and the most cold hardy selections are being used increasingly in breeding. Increased cold tolerance is one important approach for increasing yield potential in spring wheats, because they will grow faster in the early spring when temperatures are normally cool. In addition, these spring wheats will have adaptation for reseeding or overseeding winter-injured stands of winter wheats, and in some areas with mild winters may serve as regular winter wheats. The wider use potential of the cold hardy spring wheats should increase the regular availability of seed of suitable spring wheat varieties when they are needed by winter wheat growers.

New plant introductions of common wheats and durums from Turkey and Afghanistan are among the materials included in the 1972-73 trials. Evidence already obtained indicates that some new sources of cold resistance are present among the various materials. Many of these accessions will be tested further and used in many new crosses. Accessions with cold tolerance about equal to Nugaines (at Pullman and Lind) have been identified, but many of these are late maturing. Emphasis is being placed on increasing earliness and cold tolerance together in types with suitable quality and desirable agronomic characteristics.

Table 1

PERCENT WINTERKILL OF EARLY FALL PLANTED SPRING

WHEAT LINES AT LIND AND PULLMAN

	VARIETY	LOCATION LIND	PULLMAN 9/18/72
		% KILL	
white	Nugaines (Winter Wheat check)	10	4
	Marfed (Spring Wheat check)	90	80
	Gaines/Marfed 68-3 (WA005876)	15	15-30
	Nor10B11/P14//101,6539(K7105095)	10	10
	Brons/CI13438(KN700247)	20	15
	Marfed/57-344//Burt-Itana(N6900410)	10	06
red	NS 3880-277/101/Burt-Onas	10	04

PERCENT WINTERKILL OF LATE-FALL PLANTED SPRING

WHEAT LINES AT PULLMAN

white	Nugaines (Winter Wheat check)	01-05
	Marfed	90-95
	Twin	100
	CI13438/Marfed-13-191(K7205232)	05
	Burt/Onas 52, 5507//Koelz 7941 S70-2	70
	Idaed 59	100
red	NS3880-227/101//CI13735(WA005937)	20-30
	Era Sib 2 (CI15926)	80-100
	Protor (NK710001)	100
	Prospor (NK710002)	100
	Henry/Burt S65-2 (WA005652)	30-40
	Peak 72 (ID000035)	100
	N58/TC//TC/KF/3/FTN/3*TC(ID000043)	100
	Norana (CI15927)	98
	NRN10/Bur//CNN/3/2*CNT(ID000034)	40
	NS 3880-227//Burt/Itana, 160 S70-25	50
hard	Idaed/Burt/Idd 59, S74 (OR006713)	99
white	B/KF, 70136-M165 (K6478872)	40

WHEAT QUALITY RESEARCH

Gordon L. Rubenthaler

The research on wheat quality in our Laboratory is an integral part of the wheat breeding programs working toward improved wheat varieties. The Laboratory is cooperative between the U.S.D.A., Agricultural Research Service, and the Regional State Experiment Stations, and serves the wheat breeders of the eleven Western states.

Flour milling and baking quality is determined by many factors which are important in the economic production of attractive and satisfactory products for the consumer, both domestic and foreign. Unfortunately, none of these quality factors are associated with field performance or visible grain characteristics, and thus, must be measured by specific milling and baking tests in the Laboratory. All new crosses and selections with agronomic potential for commercial varieties must be tested for milling and baking quality to insure that the selection will meet traditional properties of wheats in the established market classes. Tests are conducted at as early a stage of development as possible. Early generation material (F_2 & F_3) is tested by micro techniques to screen the material of obviously poor milling quality selections and to estimate its baking properties. More extensive milling and baking tests are run on the promising advanced selections.

MIAG MILLING AND COLLABORATIVE FLOUR TESTS

Since the installation of a Miag semi-pilot mill in 1971, a group of collaborators have been organized with the cooperation of the Pacific Northwest Crop Improvement Association to assist in the evaluation of promising advanced selections. Included among these twelve collaborators, which are made up of flour milling and baking companies, are a committee of four of the major flour milling firms in Japan and two flour mills in Korea. The following is a summary of their evaluation and rating of the promising elections from the 1972 crop submitted by the breeders for testing:

SUMMARY FLOUR BAKING PROPERTIES

No.	Variety or Selection	Location Grown	Class & Color	% of Coll. Rating Poor	Equal	Better
1	Luke CI 14586	Waterville	SWW	Check Sample		
2	Sprague CI 15376	Waterville	SWW	16	68	16
3	Moro CI 13740	Waterville	Club	16	68	16
4	Hyslop CI 14564	Pendleton	SWW	Check Sample		
5	ND/2*Sel.101 (OR 631305) CI 14565	Pendleton	SWW	16	84	
6	Of/Eg//Emr/3/Hns.VII/4/Of/Eg//Emr/3/Sel.101 OR 6933	Pendleton	SWW	16	68	16
7	Marfed CI 11919	Pullman	SWS	Check Sample		
8	Twin CI 14588	Pullman	SWS		60	40
9	Gaines/Marfed S68-3 WA 5876	Pullman	SWS		80	20
10	Wanser CI 13844	Lind	HRW	Check Sample		
11	CI 9342/Itana 236-7 WA 5911	Lind	HRW	20	60	20
12	Henry/Burt S.65-2 WA 5652	Lind	HRW		40	60
13	Peak 72 CI 15319	Pullman	HRS	80	20	
14	Shortana CI 15233	Pullman	HRS		20	80
15	Era Sib II MN 206264	Pullman	HRS		20	80

ORIENTAL NOODLE-TESTING PROGRAM INAUGURATED

Floyd W. Sollars

About 40% of the wheat that Japan imports is made into noodles. For several years, a goal of the Pullman Wheat Quality Laboratory has been a testing program for evaluating the noodle-making quality of Pacific Northwest wheats. Because most noodles are machine-made in factories, a really effective program requires a noodle-making machine. In early 1972, the Pullman laboratory acquired an Ohtake noodle-making machine, and the testing program became possible. This first year, the standard varieties and advanced selections grown at Pullman and Lind were tested by a method furnished by the large Japanese flour mill that scaled down the factory machinery to the Ohtake model. Each flour sample was made into noodles, and subjected to the boiling test. Yield and volume of boiled noodles was determined. Turbidity of the boiling water was measured, and eating quality of the boiled noodles was evaluated. The yield and volume measurements had a good range in values, appeared to correlate well with the Japanese results, and were judged satisfactory. Turbidity measurements were not satisfactory, and efforts are being made to acquire a better instrument. The real limitation of the testing program was in the subjective estimation of eating quality; this is considered by the Japanese, the ultimate consumers, as the most important characteristic of all, and it is the most difficult for us to determine. On the basis of the yield and volume results, the club wheat flours rated very good for noodle-making, and many of the PNW soft wheats rated good. In summary, the noodle-testing program appears to be off to a good start with some limitations and will be expanded this year to test more wheats.

A STUDY OF THE WET GLUTEN TEST FOR EVALUATING FLOUR QUALITY

Floyd W. Sollars

Recently there has been an interest in reviving the wet gluten test for flour evaluation. The standard wheat varieties grown at Pullman yielded flours with lower loaf volume than expected on the basis of their flour protein content, and the Japanese are reported to be using wet gluten as a flour quality index. This is an old test that was displaced in the 1920's by the more precise, more rapid Kjeldahl protein test. The wet gluten test is based on a simple principle; flour and water are made into a dough ball and kneaded under water until all starch is removed. The remaining gluten mass is then weighed. There has been no study of this test in recent years.

The 1971 standard commercial varieties and advanced selections grown at Pullman and Lind were tested by the official hand-washing method. Wet gluten had the same correlation with loaf volume as flour protein, and wet gluten had a very high correlation with flour protein. This showed that the amount of wet gluten depended almost entirely on the amount of flour protein, and there was no "quality" factor in wet gluten. Wet gluten had fair correlations with AWRC and cookie diameter and a poor correlation with yield of boiled noodles. In summary, the hand-washing method for gluten determination, although as good as the flour protein test, does not appear to offer any advantages in flour evaluation and is less efficient. Machine-washing methods for wet gluten might make this test more feasible and further studies will be made.

SOIL FERTILITY MANAGEMENT THROUGH SOIL TESTING

A. R. Halvorson

Wheat producers in the dry land area of Eastern Washington can, with proper soil fertility management, count on obtaining approximately one bushel of wheat for each 2.7 lbs of nitrogen (N in fertilizer form) he applies to his wheat. He knows he can't get top yields without adding nitrogen fertilizer—the question is, how much should he apply? Experience is a good guide in answering this question, but it's the soil moisture supply and the nitrate nitrogen the soil can supply that greatly influence the nitrogen fertilizer need. A soil test at the proper time to evaluate these two factors can do a better job of providing answers to this than does experience, because there is little or no visible evidence on which to make a reasonably accurate judgment about these two factors. *A SOIL TEST ELIMINATES THE GUESS.*

BARLEY BREEDING AND TESTING PROGRAMS OF THE STATE OF 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 and 2) a testing program in Eastern Washington at Pullman, Walla Walla, Dayton, and Pomeroy; in Central Washington at Lind, Davenport, and Royal Slope (irrigated); and in Western Washington at Vancouver, Puyallup, and Mt. Vernon.

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

In the winter barley program, both 6-row and 2-row types are being developed. Winterhardiness is one of the major limiting factors to widespread production. Despite this problem, significant advances have been made in developing hardier, stiffer, and shorter-strawed 6-row winter types. Luther and Kamiak are two new varieties from this program. Two new 6-row selections are being increased with a view to release. They have shorter and stiffer straw than Luther and Kamiak and have consistently outyielded these two varieties. Selection 1094-67 (Luther x 1255-60) is mid-short and will probably be best adapted to non-irrigated land while Selection 2196-68 (Luther x Hudson), which is a very stiff, short-strawed type, should be well adapted to irrigation in the Columbia Basin. Both are somewhat more winterhardy than Luther and Selection 2196-68 is about as hardy as Kamiak and Hudson. Crosses have been made in an attempt to incorporate acceptable malting quality into the best winter 6-row types now available.

Winter 2-row types are being developed specifically for malting purposes. The most serious deficiency in a winter 2-row is winterhardiness. Considerable progress has been made in this area by using hardy 2-row types introduced from Germany which also appear to have very promising quality. Preliminary yield tests of the first W.S.U. 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 winter 2-row malting types would have over spring-sown types. It appears that spring 2-rows may be reaching the upper limit in yield potential.

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 type, Steptoe, and the improved 2-row malting type, Vanguard. Vanguard was approved in 1971 as an acceptable malting type, being superior to Piroline in quality and yield.

A replacement for Traill and Larker appears close at hand. Washington 6704-62 (Traill x 1038), a 6-rowed malting type, was increased in 1972 for plant scale malting and brewing tests on the West Coast. Preliminary reports indicate favorable processing performance, both in the malt house and brewery. If these results continue to be promising in the 1973 crop, consideration will be given to releasing this selection as a new 6-row spring malting type for the Pacific Northwest. This selection has consistently outyielded Larker and Traill by 10 to 15%.

DRY LAND RESEARCH UNIT BARLEY TESTING PROGRAM

The Lind Dry Land Research Unit is a valuable testing location for winter and spring barleys. being developed at Washington State University. Unfortunately, due to adverse weather conditions in the fall of 1972, the winter barley yield test did not emerge and establish a stand. Included in the yield trial were the recommended varieties, Kamiak, Luther, and Hudson, along with 15 promising 6-row and 2-row selections, including Selections 1094-67 and 2196-68.

In the spring barley nursery (Table 1), Steptoe continues to outyield Unitan by a sizable margin. The new malting barley selection 6704-62 also significantly outyields Larker. In 1972, Piroline outyielded Vanguard although in most years the reverse has been true.

Table 1

Spring 6-Row and 2-Row Barley

Lind, Washington, 1972

	Plant Hts. (ins.)	Test Wt. (lbs.)	Yield lbs./ac
Steptoe	18	49.4	1258
Piroline	19	50.9	1142
Unitan	19	49.8	1046
Vanguard	19	49.4	1042
WA6704-62 (Traill x -1038)	22	47.6	1042
Larker	19	50.9	941

The 1972 barley testing program extended to the W.S.U. branch station at Royal Slope where current spring varieties and new selections were tested under irrigation. Very high yields with good plump kernels were obtained for several varieties and selections (Table 2). Steptoe outyielded Unitan by almost three-quarters of a ton. Two-row barley also produced excellent yields. The selection 6704-62, which may be the next 6-row spring malting barley to replace Traill and Larker, also performed well under irrigation. Quality of the malting types was 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.

This year the spring tests were repeated and last fall a winter barley test was also included. The winterhardiness of most selections was satisfactory in that they all came through the winter in a fairly satisfactory manner.

Table 2

Spring Barley

Royal Slope (irrigated), 1972

	Lodg. %	Kernel Size Plump %	Thin %	Test Wt. (lbs.)	Yield lbs./ac
WA7652- 67 (Hann. x H.H.^{2} x Piroline)	3	96	1	55.7	6480
Steptoe	3	98	0	51.8	6456
Vanguard	0	95	1	55.5	5822
6704-62 (Traill x -1038)	10	87	3	52.2	4877
Unitan	20	95	1	51.1	4867

SPILLMAN FARM BARLEY BREEDING PROGRAM

Visitors at the Field Day at Pullman will have an opportunity to see in special planted demonstration plots early and late seedings of sixteen current varieties and new selections of 2-row and 6-row winter feed and malting barleys and 24 current varieties and new advance selections of spring 6-row feed barleys, of spring 2-row malting barleys, and spring 6-row malting barleys. The main types that are under consideration were described in the general information given at the beginning of this report. Numerous other advanced selections will be demonstrated at the Field Day.

The testing results in Eastern Washington from Pullman and Walla Walla for some of the more advanced selections and our new current varieties are presented in the attached tables. Steptoe, our new 6-row feed barley, continues to outyield Unitan (Tables 1 and 3). This variety will be ready for more general production next spring. Among the 2-row malting spring types, Vanguard still continues to outyield Piroline and Klages, the new high quality 2-row malting barley from Idaho (Table 1).

A very important need at the present time is a replacement for Traill and Larker to overcome the deficiencies in these varieties in terms of shatter resistance and lower yields. The selection 6704-62 (Tables 1 and 3) appears to be a very adequate substitute in that it outyields Traill and Larker by 10-15%.

Among the winter feed barleys, the high yielding ability of selections 1094 and 2196 is shown in Tables 2 and 3. Because of its short, stiff straw, Selection 2196 should be suitable for irrigation.

High yields, increased winterhardiness and plump kernels are also being obtained among our 2-row winter selections bred for malting quality (Table 2).

Table 1

Pullman Barley Tests, 1970-72

	Plant Ht. (ins.)	Lodg. %	Kernel Size Plump %	Kernel Size Thin %	Yield lbs./ac
Spring 6-Row Barley					
Steptoe	36	26	93	2	4608
WA5704-62 (Traill x -1038)	38	24	60	13	3888
Unitan	41	43	85	4	3682
Traill	41	33	66	8	3514
Larker	39	37	85	8	3379
Spring 2-Row Barley					
Vanguard	35	17	86	4	3730
Piroline	35	24	88	3	3634
Klages	34	18	88	4	3293
WA6752 (Hann. x H. H.^{2} x Piroline)	35	15	88	4	3874

Table 2

Pullman Barley Tests

	Plant Ht. (ins.)	Lodg. %	Winter Surv. %	Kernel Size* Plump %	Kernel Size* Thin %	Test Wt. (lbs.)	Yield lbs./ac
Winter 6-Row, 1970-72							
WA2196-68 (Luther x Hudson)	36	6	100	40	18	47.9	6346
WA1094-67 (Luther x 1255-60)	40	10	100	60	12	48.6	6298
Kamiak	44	39	100	62	11	51.4	5405
Luther	42	30	97	42	26	48.5	5088
Hudson	47	38	100	61	9	53.2	4896
Winter 2-Row, 1972							
WA3308-70 (Ack. 989 x R. T. H.)	41	0	100	99	0	54.4	6302
WA2464-70 (Ack. 989 x R. T. H.)	40	0	95	99	0	53.7	6269
Ackerman's 989	41	0	92	99	0	54.0	5794
Luther	40	0	90	42	26	49.6	5726

*1972 only

Table 3

Walla Walla Barley Tests

	Plant Ht. (ins.)	Lodg. %	Test Wt. (lbs.)	Yield lbs./ac
	Spring 6-Row, 1970-72			
Steptoe	27	28	48.7	4181
WA6704-62 (Traill x -1038)	30	19	48.9	3643
Unitan	28	44	48.6	3288
Larker	29	36	51.6	2808
Traill	31	46	51.2	2683
	Winter 6-Row, 1971-72			
WA1094-67 (Luther x 1255-60)	32	9	50.4	5400
Kamiak	35	39	52.0	5336
WA2196-68 (Luther x Hudson)	28	9	49.8	4798
Hudson	35	54	52.2	4493
Luther	34	13	49.1	4384

CONTRIBUTORS IN SUPPORT OF RESEARCH
1972–73

Fertilizers and Amendments

Cominco American, Inc.
Ortho Division, Chevron Chemical Company
Phillips Petroleum Company
J. R. Simplot Company

Herbicides and Pesticides

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Velsicol Company

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Farmer Cooperators

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Orin Anderson	Clyde
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Elwood Brown	Bickleton
Clarke Farms	Albion
Jack DeWitt	Walla Walla
Diamond Spear Angus Ranch	Lamont
Jim Ferrell	Walla Walla
Leonard Fuhrmon	Kettle Falls
Paul Harrell	Ellensburg
Heitstuman Farms	Uniontown
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Jack Jensen	Bickleton
Robert Kramer	Harrington
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Clayton Walker	Coulee City
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H. J. Clauson & Sons	Spokane
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Norman Kagele	Ritzville
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Charles Mead	Dayton
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Bill Anderson	Reardan

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Harold Stueckle	Colfax
Orlund Ostheller	Fairfield
Cedric Hall	Steptoe
Sanford Evans	Genesee, Idaho
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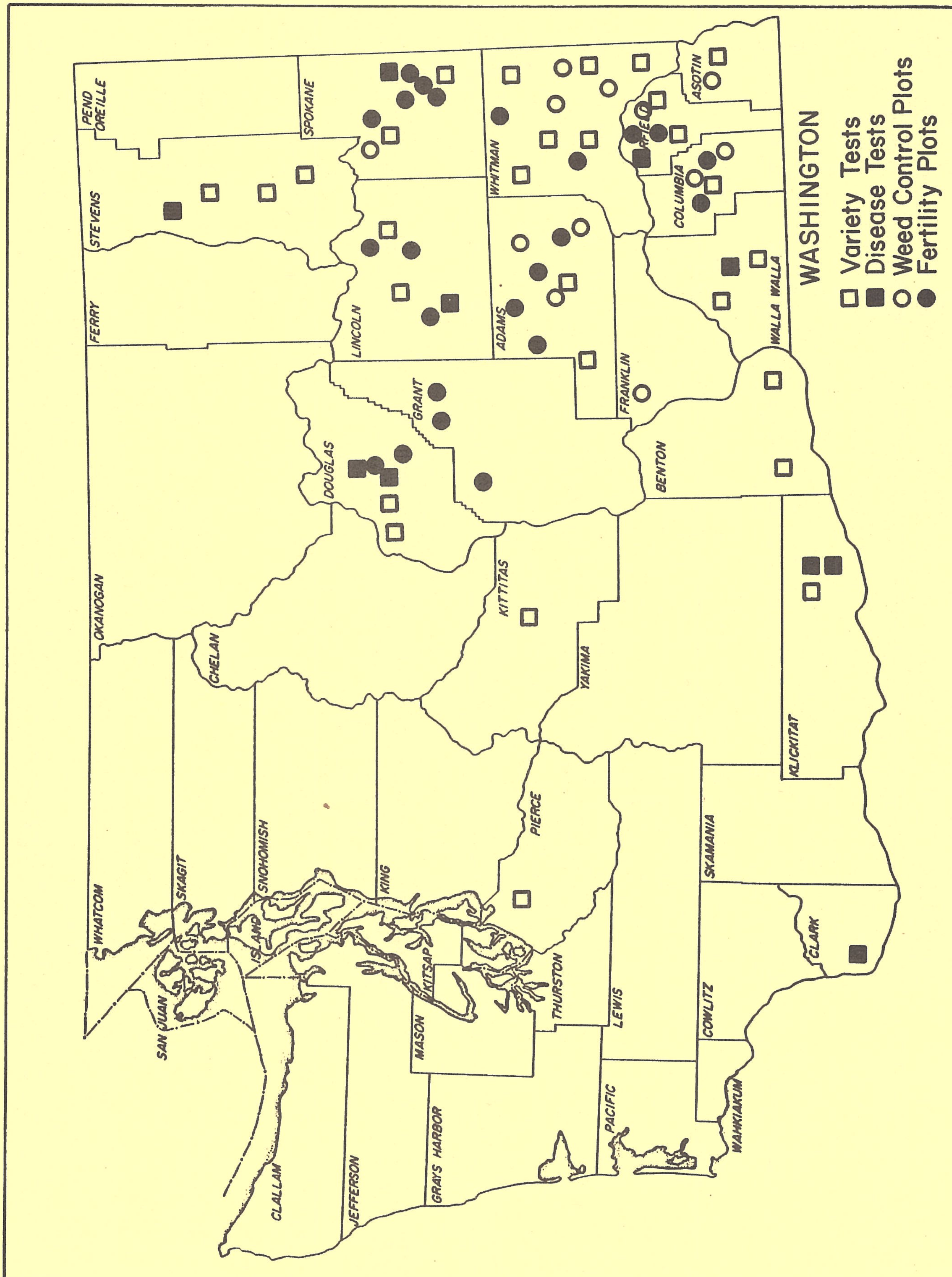
WASHINGTON
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HISTORY OF DRY LAND RESEARCH UNIT

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 the land was deeded to Washington State University for as long as it is used for experimental purposes.

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 existency 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 of this year. 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 adaption, wheat production management including weed and disease control, and wheat breeding are the major programs of research in recent years. Although many varieties of wheat have been recommended from variety trials by the station, Wanser and McCall were the first varieties developed on the station by plant breeding.

Since 1916 an annual field day has been held to show farmers and interested businessmen the research on the station. This year marks the 56th field day. Visitors are welcome at any time. Their suggestions are appreciated.

CLIMATIC DATA

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

Table 1

Average temperature and precipitation at Dry Land Research Unit, Lind

Month	Temperature ^{O}F.		Precipitation		Precipitation
	Max.	Min.	1972	1973	52 yr. av. (in)
January	34	22	.37	1.00	1.03
February	42	24	.42	.23	.89
March	53	32	1.00	.34	.73
April	63	35	.47	.23	.64
May	72	42	1.02		.77
June	83	45	.96		.93
July	90	52	.37		.22
August	90	50	.60		.31
September	79	45	.36		.55
October	65	38	.07		.90
November	47	29	.79		1.20
December	37	26	1.80		1.24
			8.23		9.41

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. The program includes testing new varieties and selections developed at other experiment stations throughout the Midwest and Pacific Northwest and foreign breeding programs. Within the total wheat breeding program in Washington State, the Dry Land Research Unit has primary responsibility for the breeding and development of spring wheats. Virtually all of the breeding and development of white winter wheats is carried out by USDA personnel at Pullman, with the Dry Land Research Unit cooperating in yield testing. Yield testing of spring and winter barley and spring triticales is also conducted on the station.

Final testing is at selected locations in the Big Bend. These sites are now located on the Bill Schmidtman farm, Waterville; Robert Kramer farm, Harrington; and Vollmer and Bayne farm, Horse Heaven Hills, with preliminary nurseries and demonstration plots occasionally located on selected farms.

All experimental work at the outlying locations is conducted by the same methods as the work at the Station. About sixty 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.

HARD RED WINTER WHEAT BREEDING AND TESTING AT THE DRY LAND RESEARCH UNIT

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 germplasm 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 selections that do well under our conditions. The breeding program, then, is a continuous cycle of attempting to get the desirable traits of the parents into adapted varieties of high quality and disease resistance for the low rainfall area.

Although the Dry Land Research Unit has the leadership responsibilities for hard red winter wheat development, many researchers and many projects within the State's overall wheat improvement program contribute to a greater, or lesser, degree in the breeding and testing program. The USDA Western Wheat Quality Laboratory at Pullman is the essential part of the quality testing program. Dr. George W. Bruehl, who is largely responsible for the development of the snow mold resistant soft white winter wheat, Sprague, will continue to cooperate in the program by making crosses and testing segregating populations and selections for snow mold resistance and *Cercosporella* foot rot resistance. *Fusarium* foot rot resistance is sought with the aid of Dr. James R. Cook. This year he inoculated two acres for testing of plant lines and selection. Working with stripe rust, Drs. J. Walter Hendrix and Roland F. Line test advanced selections for seedling and mature plant resistance, and for the degree of damage done to the plant by the organism. Dr. Clarence J. Peterson, Jr. and the USDA wheat team at Pullman cooperate in disease and agronomic testing of selections at many locations. Dr. Calvin F. Konzak aids in the care of our nursery at Pullman and Royal Slope and makes crosses at Pullman where anthesis is extended for a longer time and a greater chance of nicking occurs.

Future plans include the establishment of several new nurseries, including the one already mentioned to screen for *Fusarium* foot rot resistance and a yield nursery under sprinkler irrigation. Mike Lindstrom's data of seeding management trials will be reduced to plantings between August 1 and October 1 and expanded to include more varieties and advanced selections in an attempt to learn something about culture-germplasm interactions. With the loss of Mike Lindstrom's position. the cultural trials conducted by station personnel will be oriented toward studying the response of selections to changes in cultural practices.

The yields of recommended varieties for low and intermediate rainfall areas of Washington and Oregon are given in Table 1. In Tables 2, 3, and 4 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 5 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. Morrison.

Table 1

Yield of selected varieties in low and intermediate rainfall areas in Washington and Oregon, 1964–72

	Location and Rainfall				
Variety	Lind 9.5"	Moro, Ore.* 11"	Pomeroy 14"	Pendleton 14"	Average
Nugaines	40.3	35.2	67.2	73.7	54.1
Luke**	37.9	41.2	63.3	79.8	55.6
Sprague**	23.4	54.2	67.8	87.6	58.3
Coulee**	34.9	34.3	56.2	70.5	49.0
Moro*	38.3	33.9	59.1***	61.1	48.1
Paha	38.1	34.4	61.9	74.1	52.1
Wanser	37.3	35.0	54.7	66.2	48.3
McCall	39.2***	35.3	55.6***	65.6	48.9
Kharkof	32.3	29.3	50.5	53.3	41.4
Station Av.	35.7	37.0	59.6	70.2	50.6

*Moro location 8 years—1965 missing
**5 year data, except Luke, 3 yr at Moro and Pendleton—Sprague 1 yr (all locations)
***Not grown in 1972

Table 2

Summary of agronomic characteristics of winter wheat grown at Lind in rod row nurseries, 1952–72

Variety	Av. plant ht.	Av. Tst. wt.	1972 yield bu/a	Av. yield bu/a	Yield % Kharkof	No. years grown
Nugaines	25	62.3	29.7	40.3	124	8
Luke	24	61.0	26.7	37.9	125	5
Sprague	23	62.1	23.4	29.6	108	2
Moro	29	59.4	27.7	38.3	116	9
Paha	25	60.7	28.8	41.4	132	6
Coulee	23	62.3	26.8	34.9	115	5
Wanser	30	62.4	25.8	37.3	113	9
Kharkof	32	60.7	22.5	30.8	100	18

Table 3

Summary of agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries, 1952–72

Variety	Av. plant ht.	Av. tst. wt.	1972 yield bu/a	Av. yield bu/a	Yield % Kharkof	No. years grown
Nugaines	27	63.0	44.7	49.2	125	6
Luke	29	61.7	82.5	56.5	154	3
Sprague	30	63.0	*	45.9	140	1
Moro	35	60.0	62.1	47.7	121	6
Paha	29	61.8	78.5	51.5	138	4
Burt	32	61.6	40.6	40.2	114	15
Coulee	25	62.9	29.0	34.0	91	4
Wanser	35	62.7	42.8	43.7	113	7
McCall	35	62.8	55.8	45.7	116	6
Kharkof	39	61.6	55.0	35.1	100	16

*Not grown in 1972

Table 4

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

Variety	HARRINGTON 1952–72 No. years grown	% Kharkof	Av. yield bu/a	HORSE HEAVEN 1951–72 No. years grown	% Kharkof	Av. yield bu/a
Nugaines	7	154	44.0	3	127	20.2
Luke	4	170	45.1	3	121	19.2
Sprague	2	164	52.6	---	---	---
Moro	7	146	41.9	5	115	16.8
Paha	5	178	46.9	3	114	18.2
Coulee	5	140	39.3	3	120	19.1
Wanser	6	144	40.0	6	121	18.7
McCall	6	155	42.8	6	120	18.6
Cheyenne	---	---	---	11	115	19.7
Kharkof	19	100	35.1	13	100	17.8

Table 5

Summary of agronomic data for winter wheat varieties grown at the Dry Land Research Unit in drill strip plots, 1954–72

Variety	Av. date head	Av. plant ht.	1972 yield bu/a	Av. yield bu/a	Yield % Kharkof	Av. tst. wt.	No. years grown
Nugaines	5/31	24	48.0	40.6	122	61.4	7
Luke	6/4	24	41.1	43.4	114	60.1	3
Sprague	5/31	22	43.5	43.5	116	60.2	1
Moro	5/31	29	42.1	41.7	125	58.6	7
Paha	6/4	25	39.1	46.6	123	39.1	3
Burt	5/30	29	45.2	36.9	114	61.0	17
Coulee	6/1	24	45.2	42.4	112	61.0	3
Wanser	5/29	29	42.4	38.7	115	61.9	9
McCall	5/30	29	47.3	39.5	119	61.9	8
Kharkof	5/30	33	37.6	32.1	100	60.5	17

Spring Wheat

The leadership responsibilities and main breeding and testing program are located and operated from Pullman. Yet, every phase of spring wheat improvement, including breeding, selection, increase, and testing, are conducted at the Dry Land Research Unit.

The spring wheat breeding program at the Dry Land Research Unit is a cooperative effort with the spring wheat breeding program at Pullman. This approach provides a wider climatic base for selection and early generation testing and should yield selections adapted to a wider range of environments. Both red and white spring wheats are included in this program.

In the area served by the Dry Land Research Unit, spring wheat is seeded if winter wheat cannot be seeded because of lack of moisture, reseeded into winter killed wheat, and used for rotation to clean up weed-infested fields that have been continuously cropped to winter wheat. Since spring wheat is used more as an emergency crop, yield is even more important than in winter wheat.

Tables 1 and 2 show the agronomic characteristics of standard spring wheat varieties grown in the dry land region.

Marfed has the highest long time yield average at all locations.

Presently released varieties include Wared (Era Sib II), which is a semidwarf hard red spring wheat with acceptable quality and fair stripe rust resistance. Wared is particularly suited to irrigated and supplemental irrigated culture, but will yield fairly well on dry land. Montana released Norana, a hard red spring wheat which looks good for dry land culture from one year's data. Idaho released selection ID000044, a soft white spring wheat with pastry flour characteristics, as a replacement for Twin and Springfield. ID000044 has a better yield record and much better test weight than Twin or Springfield.

Table 1

Summary of agronomic characteristics of spring wheat grown at Lind in rod row nurseries, 1950–72

Variety	Av. date head	Av. plant ht.	1972 yield bu/a	Av. yield bu/a	Yield % Marfed	Av. test wt.	No. years grown
Marfed	6/15	25	15.4	23.7	100	58.8	22
Twin	6/14	22	15.2	22.8	103	57.3	5
Idaed (Idaed 59)	6/9	25	12.9	20.5	86	59.1	22
ID000044	6/15	22	12.8	20.1	87	59.9	2
CI13448/Marfed S 68-3	6/19	23	16.6	22.9	100	59.9	3
Adams	6/13	26	*	23.1	96	59.3	7
Baart	6/11	28	*	21.3	88	60.2	21
Peak 72	6/11	22	13.5	19.6	86	61.1	3
Wared	6/15	22	13.8	20.3	89	60.1	4
Norana	6/17	20	17.1	17.1	111	59.8	1

* not grown

Table 2

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

Variety	Harrington No. years grown	Harrington % Marfed	Harrington Av. yield bu/a	Waterville No. years grown	Waterville % Marfed	Waterville Av. yield bu/a	Horse Heaven No. years grown	Horse Heaven % Marfed	Horse Heaven Av. yield bu/a
Marfed	22	100	30.8	21	100	30.5	19	100	18.6
Twin	4	99	31.4	4	103	30.4	4	93	13.1
Idaed (Idaed 59)	21	97	29.5	20	90	27.4	18	110	18.2
ID000044	2	112	37.6	2	108	36.4	2	96	19.1
CI13448/Marfed S 68-3	3	102	31.6	1	98	36.7	2	99	19.9
Peak 72	3	88	27.3	3	86	28.2	3	72	11.7
Wared	2	104	35.0	2	103	34.8	3	90	14.4
Norana	1	117	32.6	1	98	36.6	1	99	13.4

TILLAGE PRACTICES FOR MOISTURE CONSERVATION AND EARLY STAND ESTABLISHMENT

F. E. Koehler and M. J. Lindstrom

Information reported in this section of the field day brochure has been made possible by Washington Wheat Commission's support of Project 1857 entitled "Factors affecting water conservation for plant growth in the low rainfall area of eastern Washington." A summary and conclusions of significant results found in this study will be presented.

Tillage Implements

Various stubble mulch tillage implements were studied to determine what soil structural and physical conditions as influenced by tillage would provide the maximum moisture for the wheat crop with special emphasis on moisture in the seed zone. Similar results were obtained with the various tillage implements provided: adequate weed control was obtained, an adequate dust mulch was maintained and that runoff did not occur. A highly significant difference was observed in over-winter moisture storage during years in which frozen soil and rapidly melting snow or heavy rainfall (or combination of both) set up runoff conditions. In this case, fall chiseling or a tillage treatment that produced open channels, which provided surface storage of water and also allowed a faster rate of soil thawing around the channels allowing water infiltration into the soil profile, was more effective than no fall tillage (standing stubble) or fall disking. No fall tillage allowed rapid runoff of water during these conditions and a disked or similar type tillage treatment only provided limited surface water storage which was rapidly exceeded.

Moisture retention in the soil profile during the summer fallow season was not affected by type of tillage implement used. Moisture loss after initial spring tillage was slight with approximately only 5 percent of the moisture in the soil below the tillage layer at the time of initial spring tillage lost during the summer months. In fact, chemical fallow treatment (no tillage throughout the fallow season) did not lose signficantly more moisture than did the tilled plots during the summer season.

Depth of mulch was found to influence the retention of moisture in the seed zone. A deep mulch (approximately 4½ inches) was found to be most effective in all cases in soil types present in the low rainfall areas of eastern Washington, but other factors such as temperature and total moisture in the profile were found to be important determining the depth of mulch needed to insure adequate seed zone moisture for early fall seeding. It was determined that as the temperature decreased the depth of mulch could be decreased and also as total soil moisture increased the depth of mulch could be decreased. For example, at Lind when the soil profile was wetted down to 6 feet with sprinkler irrigation in February of the fallow year, adequate seed zone moisture was maintained with chemical fallow, but when the profile was only wetted down to 3 or 4 feet by winter precipitation adequate seed zone moisture was only maintained during very cool summer seasons.

Timing of Tillage

Timing of initial spring tillage was found to have an influence on total moisture in the soil profile during some years and not have an influence in other years. The precipitation pattern during the spring period was the major factor influencing the results from these studies. In years that spring rains were substantial in amounts, the timing of spring tillage had no effect, whereas, in years in which spring rains where highly scattered and of low intensities, the early spring tillages (mid-February to April) had slightly higher moisture in the soil profile and also in the seed zone.

Moisture loss from the soil profile during early spring can be substantial while soil pores are continuous to the surface and the soil surface is wet. Early spring tillage will break the continuity of the soil pores allowing a more rapid drying of the soil surface, reducing moisture loss. Only in years of higher than normal rainfall during the spring season will rainfall replace the increased water lost from delayed initial spring tillage.

It is important to note that during these experiments that weed growth was controlled on all plots with chemicals. Increased moisture would have undoubtedly been lost with the delayed tillage treatment due to weed and volunteer growth.

Timing of secondary tillage had no effect on moisture loss provided weed growth was controlled. Excessive weed growth at anytime during the fallow season will cause moisture loss and must be controlled.

Surface Structure

The effect of surface structure was slight except at the two extremes (very coarse or very fine). A very fine surface, single grain structure, increases the soil surface temperature and heat transmittance into the soil profile causing accelerated moisture loss from the seed zone. A very coarse structured soil surface (large clods) in which the soil clods penetrate throughout the dust mulch and increase air exchange between the atmosphere and the seed zone will also increase the rate of moisture loss.

The ideal surface would be one in which small clods were present on the surface reducing soil surface temperature underlain by a fine dust mulch which would reduce air exchange. A fine structured mulch is more susceptible to wind erosion; therefore, caution should be observed when establishing the mulch.

Temperature and Moisture Effects on Rate of Emergence

Seed zone water content and temperature were found to have an important effect on the rate of emergence of deep seeded winter wheat. Seed zone temperature was found to have a direct effect on the rate of emergence. As temperature increased up to a point, the rate of emergence increased in direct proportion to temperature. Seed zone water content (measured as water potential in bars) became more important on the rate of emergence as the water content decreased. That is, the rate of emergence decreased at an increasing rate with decline in moisture. Seed zone water content began to limit stand establishment under deep seeding conditions at approximately 7 percent moisture by weight (-7 bars) for the Ritzville silt loam soil on the Lind station.

Seed zone temperatures greater than 86 F were found to have detrimental effects on emergence rate (non-dormant seed was used in these trials). The mean seed zone temperature at Lind only exceeded 80 F on extremely hot days; therefore, high seed zone temperature was not found to be a problem, but temperature of the soil surface could have caused damage by scorching the wheat seedling as it was emerging on hot days.

TILLAGE PRACTICES

Tillage Practices for Dry Land Wheat Production

In the dry land wheat production areas of Eastern Washington, water is generally the limiting factor for maximum wheat production. Since water is limited, the management of our soils during the fallow period becomes extremely important. Practices which allow maximum intake of precipitation and tend to limit evaporation or loss during the summer fallow year are essential. Date of seeding, proper fertilization, and use of adapted varieties are also important factors in reaching maximum yields with a limited water supply. The subject of this discussion will be primarily concerned with tillage practices related to moisture conservation.

Eastern Washington has a winter rainfall pattern. Approximately 70% of the precipitation occurs from October through April. During this period, temperatures are low and evaporation is at a minimum. Stubble fields should be in a condition to absorb all precipitation that occurs during this period.

Conservation of moisture should start as soon as the crop is harvested. The stubble should be worked immediately in areas where active weed growth occurs. These weeds are removing deep soil moisture that could be used by the next crop. In the low rainfall areas, sweeping at a depth of 4 to 5 inches will usually kill these weeds, provided there is enough overlap in the sweeps. This leaves the soil somewhat pulverized, and a fall chiseling after rain will put the soil in a rough condition which will help increase moisture penetration.

In areas where the soils are frozen during some period of the winter months, the soils should be chiseled. Depth of chiseling in the southern areas, where snow accumulation is low, should be 8 to 10 inches. In the northern areas where more snow is expected to accumulate and the soils freeze deeper, the soils should be chiseled to a depth of 10 to 15 inches. In areas of high snow accumulation, subsoiling to a depth of 24 inches will increase water penetration of the soil. These operations should follow the contour of the land to be most effective. Chiseling also helps prevent the formation of implement hard pans caused by the weight of implements operated at the same depth over a period of years. When implement hard pans have formed, crop root penetration is retarded and the rate of downward water movement is reduced. Fall chiseling of stubble will probably be of less importance in areas that are relatively frost free, but all of the wheat production area is subject to frozen soils during some parts of the winter. Summer fallow fields that are being left over the winter for a spring crop should be chiseled after the soils have frozen to a depth of 2 inches to leave the soil in a rough condition.

The initial spring tillage operation should be one to kill volunteer grain and weed growth and work up a mulch for weeding operations. As much stubble as possible should be left on the surface. The amount of straw that the drills can handle at seeding time should be left on the surface. Straw on the surface will reduce evaporation of water from the soil and will give good protection against wind erosion. The depth of spring tillage should be deep enough to insure that an adequate depth of mulch can be established, generally an inch deeper will be sufficient. Deeper tillage depths have no beneficial effects and, in some cases, especially on light soils, may have less moisture in the seed zone in the fall.

After the initial spring tillage with a sweep, offset disc, or similar implements, skew treading with the teeth in packing attitude will help firm up the soil, break up heavy straw, and kill small weed growth. Rotary hoes pulled backward or discs pulled with a small cutting angle are also effective in firming up the soil after initial tillage. Usually rod weedings after these operations are all that is necessary for weed control. Fields should not be allowed to "green up" before weeding, because when weeds get that large, they are using moisture rapidly. Research data at Lind indicate that a 4½ inch weeding depth is most effective in conserving soil moisture. In areas of cooler temperatures, a shallower depth may be as effective. In light sandy soils, skew treading may be too severe, and the rod weeder may be the only tool to use after initial tillage. If this is the case, weeding operations should take place as soon as possible after the initial spring tillage to seal off the moisture below the weeding depth.

Fertilizer applications may have an effect on soil moisture. Unless fertilizer is applied immediately before seeding, the application should be made early in the summer fallow season before soil temperatures are high to prevent moisture loss. Applications should be timed just previous to a normal weeding operation. This will disturb the soil moisture less than if the fertilizer operation is not followed by a weeding.

Research at the Dry Land Research Unit at Lind shows that early seeded wheat makes more effective use of moisture than late seeded wheat. The efficient use of moisture by early seeding is probably due, in part, to the increased growth made during cool temperatures. Late seeded wheat develops under higher temperatures especially during the stages of rapid growth of tillering, boot, and heading. In addition to rapid growth, the young cells of growing wheat require more water. Transpiration rates are higher in young cells than in maturing tissues. Early seeded wheat is in a more advanced stage when high temperatures occur. Early seeded wheat also develops a more extensive root system by spring, and is better able to supply nutrients moved down deep in the profile by winter moisture.

The problem of early seeding is to have enough moisture in the seeding zone for seeding in late August or September. Equipment is available which will seed to a depth of 6 to 7 inches and still not cover the seed more than 4 to 5 inches. Most of the deep furrow drills are on 14 inch row spacing. Results from this study at Lind and another trial at Dusty show row spacings up to 20 inches will not decrease yields in the range of 30 to 80 bushels per acre. With wider row spacing, furrowing can be deeper, and the total depth of seed coverage can be less. Row spacings of 20 inches would allow seeding to a depth of 8 inches and still not cover more than 5 inches. Wheat will emerge in light soils readily from this depth.

In summary, tillage should be designed to allow free penetration of water during the winter following harvest. During the summer fallow year the tillage and fertilizing operation should hold the moisture close enough to seed early in the fall. A seeding date of approximately September 1, with a range of 15 days either way, would cover the optimum seeding date for most of the dry land area. The following program of stubble mulch tillage is recommended for the 8 to 12 inch area:

1. After harvest, sweep where weed infestation occurs.
2. Late fall chiseling to a depth of 8 to 12 inches on spacings of not more than 24 inches. The deeper chiseling, or subsoiling, is recommended for areas of deep frost or heavy snowfall, and wider spacing can be used.
3. Initial spring tillage should be deep enough to ensure an adequate depth of mulch.
4. Follow soon after with skew treader, rotary hoe, light discing (disc almost straight), or rod weeder to firm up soil and establish mulch depth. The deeper mulches are recommended for areas of high summer temperatures.
5. Fertilizer should be applied in late spring, immediately before seeding, or with weeding.

6. Deep furrow seeding of recommended variety starting approximately August 20 in Douglas County, September 1, in areas similar to Lind, and September 10, in 11 to 12 inches of rainfall areas of Lincoln County. It is better to have a stand of wheat seeded 10 days too early, than a poor stand of wheat seeded at the optimum time or seeded late.
7. Seeding rate for early seeding should not exceed 45 pounds per acre, and 30 pounds is enough for early seeding that germinates well.

SNOW MOLD

G. W. Bruehl, Dick Nagamitsu, C. J. Peterson, and E. Donaldson

Our first wheat developed specifically as a snow-mold-resistant wheat was released this year. It is a semidwarf, common soft white wheat with bearded heads. All yield data available indicate that it yields competitively with other varieties in the area of intended use (western Douglas and Okanogan Counties). In the severe snow mold area, we recommend seeding between August 15 and August 20. Our experience indicates that these dates provide big enough plants to withstand the mold, and earlier seeding would probably only waste moisture.

The test weight is below that of Luke. It matures earlier than the other wheats adapted to that area. Its quality is satisfactory. Sprague has little after-harvest dormancy so it can be seeded soon after harvest, so far as we know.

Moro and Luke did well in parts of the mold area last year, with Luke significantly outyielding Moro where Luke survived well. Under severe conditions, Sprague survived and Luke and Moro, the two other wheats with some resistance, died.

Snow mold resistance is being rapidly advanced into wheats adapted to other parts of the state. We hope to provide protection from winter fungi for all wheat grown in the northern half of Washington. Luke comes the closest to filling that order to date.

No fungicide is known that will safely and economically control the snow molds of wheats, so we continue to stress breeding for resistance.

WINTER WHEAT IMPROVEMENT

C. J. Peterson, R. E. Allan, and D. W. George

The objective of the ARS-WSU Wheat Breeding Program is to improve the efficiency of wheat production in the Pacific Northwest. In order to attain this objective the agronomic characteristics and the disease resistance of our present varieties must be improved. New varieties need to be able to better utilize new management systems. Diseases constantly change and new varieties must be developed to meet these changes.

The rapid development of new varieties depends upon an extensive screening program where breeding material is subjected to as many hazards as possible. We maintain screening nurseries in areas of the Pacific Northwest where we obtain data on flag smut, common bunt, dwarf bunt, snow mold, *Cercosporella* foot rot, *Fusarium* foot rot, *Cephalosporium* stripe, stripe rust, and leaf rust. In addition to this we screen the material under different soil management and environmental conditions.

Soil erosion caused by wind and water is a critical problem in the Pacific Northwest. The damage to the land and environment increases each year. One method of controlling erosion is to plant early in order to provide maximum soil cover. However, decreased grain yields due to infection of *Cercosporella* foot rot makes it unprofitable to seed early at the present time.

Our studies (Table 1) show that seeding our present varieties early may result in losses up to 50 percent. There is hope. We have developed a semidwarf line that is affected very little by *Cercosporella* foot rot. This line CI 15922 is a soft red winter wheat with poor milling and baking quality. It will never become a variety, but it demonstrates that it is possible to develop semidwarf lines with good foot rot resistance and is an excellent parent.

The recommended varieties continue to perform satisfactorily in absence of major disease problems. The grain yield of Nugaines, Luke, and Hyslop (Table 2) was about the same in 1971–72 at Pomeroy, Walla Walla, and Pullman. A new selection WA 5829 was the top yielding line in the three tests. WA 5829 is, however, less winterhardy than Nugaines. Paha, a soft white club, did well at Pomeroy. Some of the new club selections such as WA 5826 produced more grain than Paha and Moro.

Table 1

Effect of *Cercosporella* foot rot on grain yield (bu/a)

Variety	Control	*Cercosporella* foot rot	% Reduction
Nugaines	86	50	42
Luke	84	59	31
Hyslop	83	47	44
Sprague	63	38	39
WA 5829	102	60	41
CI 13438	71	38	46
Paha	67	58	14
CI 15922	92	99	(+8)

Table 2

Grain yields (bu/a) of 8 winter wheats in 1971–72 at Pullman, Pomeroy, and Walla Walla

	Pomeroy	Walla Walla	Pullman	Average
Nugaines	70.5	100.8	86.2	85.8
Luke	72.2	97.7	83.5	84.5
Hyslop	68.3	102.3	85.8	85.5
Coulee	61.0	72.7	70.4	68.0
Paha	75.2	90.1	69.4	78.2
CI 15922	70.8	95.2	88.2	84.7
WA 5829	79.8	105.2	95.3	93.4
WA 5826	78.5	93.5	71.1	81.0

DRY PEA AND LENTIL IMPROVEMENT

F. J. Muehlbauer and V. E. Wilson

The objective of the dry pea and lentil 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.

Besides root diseases, *Fusarium* wilt (race 1) has been present in the region since the early 1930's; but, the disease has not been a problem because most varieties grown since that time carry a single, dominant gene for resistance to the disease. In 1972, a pea field near Steptoe, Washington, was heavily damaged by this disease. It was subsequently shown that the variety grown in the field was susceptible to race 1 wilt. This case emphasizes how successfully race 1 wilt has been held in check through the use of resistant varieties and also how quickly the disease can return when susceptible varieties are grown. It is necessary, therefore, that any variety released for the Palouse region be resistant to race 1 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.

In 1971 a program was initiated to find host-plant-resistance to the pea weevil. That program was successful in identifying 16 lines of peas with apparent resistance to the insect. Using these lines, we have begun a hybridization program to transfer the resistance to commercial lines. 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.

The pea leaf weevil, since its appearance in 1969, is another insect that has become a serious problem in the Palouse region. The problem may be compounded in the future depending on the restrictions placed on the use of DDT, the only known control measure. Because of this problem, we have begun a screening program designed to identify lines of peas resistant to the pea leaf weevil. If any lines are identified, they can then be used to develop resistant varieties.

Pea and Lentil Varieties

'Latah' yellow peas outyielded the commercial 'First and Best' yellow peas by over 300 pounds per acre in the comparative yield tests in 1972. Compared to commercial yellow peas, the variety is considerably more uniform with larger seed. It is somewhat later maturing.

'Tekoa,' the uniform large seeded lentil recently released, has shown yields comparable to commercial 'Chilean' lentils. A selection (66-18), showing higher yields than Tekoa, was reselected because of a high incidence of seedcoat mottling. The reselected line is currently being compared with Tekoa and other advanced lines in the uniform yield trials.

Seven lines of lentils were seeded in the fall of 1972 by L. W. Hudson, Horticulturist at the Plant Introduction Station. All seven lines survived the winter and presently are in very good condition. The prospects for winter lentils seem very good based on the results of this past year.

OAT BREEDING AND EVALUATION

C. F. Konzak, M. A. Davis, G. W. Bruehl,
K. J. Morrison, and P. E. Reisenauer

Oat research at W.S.U. is limited in scope with objectives to maintain or improve tolerance to barley yellow dwarf virus (BYDV) while improving yield, lodging resistance, and test weight. Little cross breeding work is being done; emphasis is placed on the evaluation of varieties from other stations. Recently, however, we have been exploring possibilities for improving protein content and quality and have made made a few crosses toward that objective. Cooperation with the California breeders has made possible the isolation of lines with increased tolerance to BYDV from our cross of Cayuse x CI2874, two of the most BYDV tolerant sources isolated so far. The 1973 advanced oat nurseries grown under irrigation at the W.S.U. Royal Slope Research and Extension Unit and under dry land conditions at Pullman include lines from that program now in their semi-final evaluation. The unusually wide adaptability of Cayuse seems readily recoverable in the progeny of the Cayuse/CI2874 cross. The lines being tested show promise for better yields, increased tolerance to BYDV, and equal or better test weight and groat percentage. The desired improvements in test weight seem more difficult to obtain, but new crosses have been made between sources of increased test weight and a line with the highest tolerance to BYDV isolated so far. This same line, now in regional tests, was used in crosses also with other sources for BYDV tolerance and with potentially high protein germplasm sources from the USDA World Collection. Protein analyses are provided through the kind cooperation of the USDA Quality Laboratory at Madison, Wisconsin.

A small mutation study is being conducted cooperatively with the Aberdeen, Idaho station and USDA to isolate materials with improved straw characteristics for irrigated culture, and a new mutation study was initiated in 1973 to improve the kernel size and test weight of the promising BYDV tolerant line mentioned above from the Cayuse/CI2874 cross.

The 1973 Northwestern States Regional Oat Nursery included largely new entries, mainly from the W.S.U. and Aberdeen, Idaho research programs. The six new W.S.U. entries are from the Cayuse/CI2874 cross, while several of the Idaho entries also have Cayuse as a parent. The remaining entries are promising lines from other programs in the United States and Canada. Cayuse has consistently maintained near the highest average performance in this nursery at all 16 locations over the past 7 years.

DURUM WHEAT BREEDING AND EVALUATION

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Durum wheat research at W.S.U. is more limited in scope than that for hard red and soft white spring bread wheats, and the focal point of the work is toward the development of varieties primarily for irrigated culture. Yield trials are conducted at only two locations in the State; the main research is carried out at the W.S.U. Royal Slope Research and Extension Unit, and advanced materials are tested also near Ellensburg through the cooperation of Busch Bros. and W.S.U. Extension Agent Mr. P. E. Bloom. However, the W.S.U. durum research program also enjoys close cooperation from breeding programs in California and North Dakota. Cooperative Western Durum Nurseries are grown in these states as well as in Idaho and Oregon. One high yielding, semidwarf durum variety, Wandell, was released in 1972. It has good quality and disease resistance, but its high yellow berry susceptibility and small seed size are weaknesses.

Objectives in durum breeding include increased yield to levels competitive not only with soft and hard red spring wheats, but also to levels competitive with winter wheats. Current varieties and lines are competitive with the best performing soft and hard red spring wheat varieties and test selections.

Also required in new varieties are semidwarf growth habit with lodging resistance, and resistances to mildew, stripe rust, and leaf rust. Most varieties and lines used as parental materials for crosses or mutation work carry high levels of rust resistance and some carry high mildew resistance also. Quality improvement remains the major problem. A rapid method for screening early generation materials (single plants) for semolina color has been developed permitting as much as an 80% reduction of F_3 progenies carried on to field testing from crosses of good x poor color durums. Larger seeds and more tolerance to yellow berry than Wandell also are required, but appear easily obtainable both in induced mutant material and in breeding lines. Future emphasis will be placed more on attaining the degree of "cooking tolerance" considered important for highest quality pastas. The cooperation of the USDA Hard Red Spring and Durum Wheat Quality Laboratory at Fargo, North Dakota is being utilized and two public supported laboratories in Italy and one laboratory in Argentina will cooperate in the evaluation of our advanced materials and sources of desirable high quality. Many valuable new breeding materials have been obtained already through the cooperation of Argentine and Italian scientists.

Along other lines, parental materials are being developed which carry greater cold resistance than Wandell, considered important to the objective of consistent high yield performance and protection from injury by late spring frosts. As a part of this effort, winter durum lines and introductions from Turkey, Afghanistan, and the U.S.S.R. are being evaluated for cold tolerance, vernalization requirement, and winter survival in screening tests at Pullman and Lind. No materials from this program yet have sufficient cold resistance combined with desirable agronomic characteristics to include them in fall sown yield tests.

Durum wheat has greater potential as a crop for Washington than is indicated by the limited production. Washington durum will find a place in both domestic and export markets. World consumption of pasta products made with durum wheat semolina is rapidly increasing and local uses are expected to increase when locally produced supplies of high quality durums are greater. Consumer preference is notably higher for spaghetti and other pasta products made of 100% high quality durum wheat semolina.

Durums will also fit well into crop rotations, especially for potato growers and current varieties seem well adapted to the Ellensburg and Columbia Basin areas. The added advantage of the differential in freight rates also assures a market for an increased production of durum by Washington State wheat growers, reducing their dependence on markets for soft white wheats.

It should be noted, however, that durum wheats are a distinct class of wheat and must be maintained separately from soft white and hard red wheats as the quality and market value of both will be impaired. High protein content is an important marketing factor for durums. Current durum varieties, including Wandell, do not perform well under dry land conditions and are recommended only for culture under irrigation.