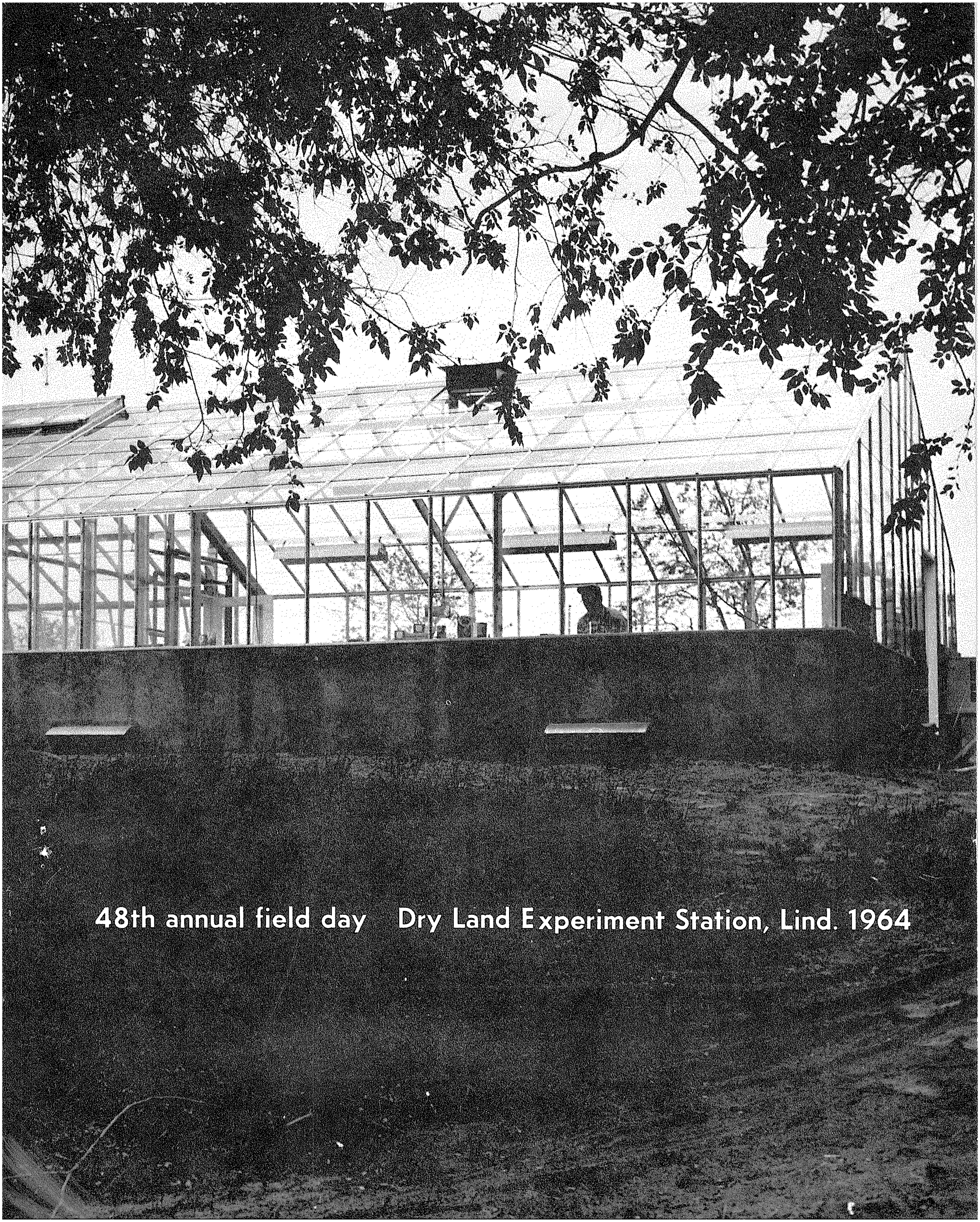

48th annual field day   Dry Land Experiment Station, Lind. 1964

INTRODUCTION

The Dry Land Experiment Station, one of eight Washington Agricultural Experiment Stations, was established in 1910 near Ritzville. In 1915 Adams County donated $6000 and leased 320 acres of land to establish the permanent experiment station at the present location. Public spirited men in Spokane donated $3200, and the Chicago Milwaukee & St. Paul Railway Co., $1000 to get the new station underway. The office of Cereal investigation of U. S. D A. included a yearly grant of $2500 and assistance from the Pullman station.

The Dry Land Experiment Station is now supported entirely by state funds. The farm consists of 320 acres of land. Approximately 260 acres are devoted to crop production experiments. The remainder consists of grass and rough land. Elevation is 1625 feet at headquarters but varies from 1550 to 1705 feet over the acreage.

A summer fallow-cereal crop-summer fallow rotation system is used with cereals, the only crops grown on plot land. Other than wheat, the crops tested include barley, grasses and forages, oil crops, and plant introductions.

The station is primarily a site for applied research with concentration on wheat breeding and testing, soil management, and management of cereal crops. Limited fundamental research is conducted in cooperation with the Plant Pathology, Agronomy, and Entomology Departments of Washington State University. Such research is done under supervision of staff members from WSU. Other cooperators are the Soil Conservation Service, Bureau of Plant Industry, and the U. S. Weather Bureau.

Field Day is held each June to give the farmers, ranchers, and townspeople of central Washington a chance to see the experimental work and to report on the work in progress. Visitors are welcome at the station at any time.

CLIMATIC EFFECTS ON WHEAT PRODUCTION

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 Sept. 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. 40 year average temperature and precipitation at Dry Land Experiment Station, Lind.

Month	Temperature °F.			Precipitation 40 yr. av. (in.)
	Max	Min	Mean	
January	34	22	28	1.07
February	42	24	33	.91
March	53	32	42	.72
April	63	35	49	.62
May	72	42	57	.77
June	83	45	64	1.00
July	90	52	71	.21
August	90	50	70	.30
September	79	45	62	.60
October	65	38	52	.96
November	47	29	38	1.12
December	37	26	31	1.23
				9.51

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.

The average frost free period (32°) is 143 days, from 14 May to 4 October. Extremes of temperatures and rainfall recorded at this station are: maximum high, 113°, minimum low -26°, maximum annual rainfall 22.7", minimum annual rainfall 4.8". Average winter snow fall is about 12", but most of the winter precipitation is in the form of rain.

Table 2. Efficiency of moisture utilization in winter wheat production at selected locations under summerfallow.

Location	Av. Yield Bu/A	Av. Precipitation annual	Fallow	Precipitation Per Bu/Yield
Lind, Wash. **	35.9	9.4	18.8	.53
North Platte, Nebr. *	37.5	19.1	36.5	.97
Huntley, Mont.	25.8	15.3	31.0	1.56
Hays, Kan. *	27.9	23.7	45.3	1.64
Colby, Kan. *	20.6	20.0	40.0	1.94

*Data from Johnson, W. C. Agron. Journal 54:29-35, 1964.
**Data from Winter Wheat Drill Strip Plots 1954-63. Dry Land Exp. Station.

The data in table 2 points out the relative efficiency of moisture utilization in the low rainfall areas of Eastern Washington as compared to other wheat producing areas. The areas selected were the more efficient areas of production in the Great Plains. Factors affecting the high efficiency of moisture utilization in this area are deep soil for maximum water storage capacity and cool season rainfall for low evaporation loss. The relative efficiency of water use in wheat production is 2 to 4 times as great at Lind than in major wheat producing areas of the Great Plains.

It is important that we consider this climatic advantage in the research for the low rainfall areas of Eastern Washington. Varieties developed at the Dry Land Experiment Station are adapted to early deep seeding to take advantage of the fall growing season for maximum root development. A quick spring recovery in the winter wheat varieties makes for maximum development during the cool spring months, maturing the wheat before high temperature increases transpiration and decreases water efficiency. Soil management research is designed to study the effects of tillage, seeding, and fertilizing on moisture storage and utilization for maximum yield.

RESEARCH ON CEREAL CROPS

The objective of the Dry Land Experiment Station cereal breeding and testing program is to develop new varieties of cereals adapted 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 breeding of new varieties. Actual breeding and selection are done on the station.

Final testing is at selected locations in the Big Bend. These sites are presently located on the Bill Schmidtman farm, Waterville; Robert Kramer farm, Harrington; and Volmer and Bayne farm, Horse Heaven Hills.

All experimental work at the outlying locations is conducted by the same methods as the work at the Station. Fifty to 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 Station will determine the value of any new selection for the Big Bend Area.

Barley

Barley research is limited to variety testing of standard varieties and new selections from WSU and other experiment stations. Regional nurseries of barley are grown on the station, and a limited number of barley varieties at the off station sites.

In 1962, Unitan spring barley was released to Washington growers. It is recommended for areas of less than 15 inches of rainfall. Unitan is a cross of Glacier x Titan. The cross and preliminary selections were made by R. F. Eslick at Montana State College, Bozeman. It was released in 1960 to Montana growers. Unitan is a six-rowed, semi-smooth awned white chaffed with white kerneled feed barley. Kernel characteristics are similar to Gem. The head is slightly nodding, long, and semi-lax. The beards tend to drop off if allowed to stand. It matures 3 to 6 days later than Gem. Unitan is 1 to 3 inches taller than Gem, and similar in lodging characteristics. Unitan has a more even top line than Gem. Unitan combines better than Gem. Table 3 compares the yield of Unitan to Gem, Piroline (a high yielding two row variety under test), and Heines Hanna. The average yield of Unitan was 4 bushels higher than Gem for the 35 trials over seven years. Unitan is a consistently good yielding variety. Some of the years it out yields Gem by wide margins, but in other years will yield about the same as Gem. Adequate seed supply of Unitan is now available.

Table 3. Yield in bushels per acre of four varieties at locations for number years listed.

Variety	Lind 7	Pullman 7	Dusty 4	Pomeroy 4	Walla Walla 4	Horse Heaven 3	Harrington 3	Waterville 3	Av.
Unitan	39.1	87.9	55.7	70.2	70.8	23.2	48.8	50.3	58.4
Gem*	35.6	75.6	55.9	70.5	73.4	28.0	48.6	44.4	54.2
Piroline	38.4	80.5	53.1	66.4	72.9	24.2	47.0	39.8	55.3
H. Hanna	32.8	73.0	44.4	53.0	60.8	19.2	43.8	38.5	47.9

*Gem yield at Pullman average of 5 years.

Winter Wheat

Hard red winter varieties with high yield and good quality, adapted to early seeding and with good disease resistance are the breeding goals at the Dry Land Experiment Station. Two selections from the cross Burt x Itana are in the final stages of testing. Breeders seed is now in production for possible release in 1965. These selections are equal to Burt in yield, smut resistance, slightly better stripe rust resistance, and are superior in winter hardiness and emergence characteristics. Quality is better than Turkey or Rio. In the following five tables these two selections are compared to other varieties at the locations they have been tested.

Tables 4, 5, 6, and 7 give the comparative agronomic characteristics of selected winter wheat varieties at four locations. At three locations Gaines is the highest yielding variety and has been outstanding in the Harrington area. Burt, Cheyenne, and Itana have been the best varieties for the Horse Heaven hills. Itana is too susceptible to stripe rust and suffered severe damage in 1960-61. Omar has been the recommended club variety because of its smut resistance, however Elgin has equal yield. Variety recommendations are Gaines and Omar in the Harrington area; Burt and Cheyenne in the Horse Heaven area; Burt, Gaines and Itana for the Waterville area; and Burt, Gaines, and Omar in the Lind area.

Table 4. Summary of agronomic characteristics of winter wheat varieties grown near Harrington in rod row plots 1952-62.

Variety	Plant height	Test weight	Yield Bu/A	Yield % Kharkof	No. years grown	Last year grown
Gaines	29	58.2	56.1	152.1	3	1962
Burt	33	61.2	47.7	124.3	11	1962
Omar	39	59.3	45.8	120.2	6	1962
Elgin	34	60.4	46.1	120.1	11	1962
Brevor	33	61.4	44.6	116.2	11	1962
Itana	37	61.7	42.3	110.2	11	1962
Columbia	34	62.1	40.3	104.2	10	1961
Rio	37	61.6	39.0	100.9	10	1961
Kharkof	39	61.4	38.4	100.0	11	1962
Golden	38	58.8	36.8	95.8	11	1962

Table 5. Summary of average agronomic characteristics of winter wheat varieties grown near Waterville in rod row nurseries 1951-63.

Variety	Plant height	Test weight	Yield Bu/A	Yield % Kharkof	No. years grown	Last year grown
Gaines	27	60.6	50.2	134.2	4	1963
Burt x Itana -215	34	63.0	46.0	131.4	1	1963
Burt x Itana -34	34	62.8	44.1	126.0	1	1963
Omar	33	59.6	39.1	120.8	8	1963
Burt	32	61.3	35.5	120.1	9	1963
Brevor	31	60.9	37.9	120.0	10	1963
Cheyenne	37	61.7	39.8	115.0	6	1963
Elgin	30	59.9	37.1	114.7	10	1963
Tendoy	39	61.8	39.7	114.3	5	1963
Itana	37	61.9	38.5	114.3	9	1963
Columbia	33	62.0	36.7	113.5	10	1963
Rio	34	62.1	32.7	102.0	11	1963
Kharkof	37	61.8	33.2	100.0	9	1963

Table 6. Summary of average agronomic characteristics of winter wheat varieties grown in the Horse Heaven Hills in rod row nurseries, 1951-63.

Variety	Plant height	Test weight	Yield Bu/A	Yield % Kharkof	No. years grown	Last year grown
Burt x Itana -34	28	58.2	24.7	121.7	1	1963
Elgin	26	58.5	24.1	120.2	6	1961
Omar	26	58.2	23.6	118.0	6	1963
Cheyenne	30	59.6	22.8	117.5	6	1963
Burt	27	59.0	23.0	114.8	7	1963
Brevor	27	59.0	21.5	113.5	6	1961
Itana	29	60.3	22.1	111.9	8	1963
Burt x Itana -215	27	57.2	21.7	106.9	1	1963
Columbia	26	61.0	21.1	106.8	8	1963
Gaines	22	57.5	21.6	106.2	3	1963
Rio	28	60.4	20.0	101.0	8	1963
Tendoy	29	59.9	19.7	100.3	4	1963
Kharkof	30	60.1	19.8	100.0	8	1963

Table 7. Summary of average agronomic characteristics of winter wheat grown at Lind in rod row nurseries, 1950-63.

Variety	Plant height	Test weight	Yield Bu/A	Yield % Kharkof	No. years grown	Last year grown
Gaines	28	59.1	46.0	136.6	4	1963
Burt x Itana -215	37	59.0	48.2	129.1	2	1963
Burt x Itana -34	37	59.2	47.4	127.1	2	1963
Burt	30	60.5	35.1	123.2	9	1963
Cheyenne	34	60.5	36.7	118.6	6	1963
Elgin	27	59.1	31.5	115.6	13	1963
Itana	33	61.2	32.0	112.1	9	1963
Omar	32	58.7	34.7	111.9	6	1963
Brevor	29	59.8	30.7	111.6	12	1963
Tendoy	36	59.9	34.7	110.3	5	1963
Rio	31	61.5	27.6	101.1	13	1963
Kharkof	31	60.4	27.3	100.0	13	1963
Columbia	30	61.1	27.0	94.7	9	1963

Table 8 summarizes the agronomic data of winter wheat varieties grown at Lind in the drill strip field plots. These plots are planted and harvested with conventional equipment and compare more accurately with yields of farmers fields. Gaines, Burt and Omar are the superior yielding varieties with the exception of Elgin. Elgin was last grown in these plots in 1957, and the data are not comparable to the data for the other three varieties. The two new Burt x Itana selections looked very good in the test last year.

Table 8. Summary of agronomic data for winter wheat varieties grown at the Dry Land Experiment Station in drill strip plots, 1950-63.

Variety	+ or - Kharkof Date head.	+ or - Kharkof Ht in.	Winter* hardiness	Stripe* Rust	Bu/A Yield	Yield % Kharkof	Test wt.	Years grown
Burt x Itana 34	-2	-3	2	4	47.8	130.6	61.3	1
Elgin	+4	-3	5		32.5	128.7	59.5	5
Burt x Itana 215-1	0	-4	1	4	46.0	126.0	60.9	1
Gaines	+3	-12	4	3	44.6	122.6	60.9	4
Burt	-1	-4	4	5	35.9	115.6	60.4	9
Omar	+5	-5	5	7	36.7	114.6	58.6	7
Tendoy	0	-1	1	3	36.2	110.4	60.7	6
Cheyenne	-1	-2	1	3	35.0	109.4	61.0	7
Brevor	+2	-4	5	3	31.8	108.8	60.1	12
Itana	-1	-1	2	7	33.8	107.8	61.4	8
Golden	+2	+1	5		26.4	104.6	58.6	5
Triplet	-2	-2	4	5	29.1	101.0	60.6	11
Kharkof	0	0	1	3	29.2	100.0	60.8	12
Rio	+1	-1	1	3	28.8	98.7	60.6	12
Columbia	-3	-4	1	8	29.4	94.6	61.2	9

*Coded 1 to 9 scale, with 1 most hardy or resistant and 9 least hardy or resistant.

Extension circulars are available for all recommended varieties of winter wheat. Variety recommendations for all areas of the state for cereal varieties are given in EMP-14 available at your County Agents office.

Spring Wheat

Spring wheat breeding program at the Dry Land Experiment Station is designed to improve yield, protein content, quality, and disease resistance in adapted varieties. A comparison of the yield of spring and winter varieties shows a 12 to 15 bushel long time advantage in yield of winter wheat in this area. This spread is even greater in recent years and is now nearer 20 bushels. Higher yield is urgently needed in our spring varieties. Because of the lower yield record, spring wheat is second choice in wheat production. Higher yielding varieties would help in years when spring wheat has to be grown because of fall seeding conditions, winter kill, or for control of cheat grass.

Table 9 shows the yield of spring wheat varieties from nurseries at four locations. These data are an average of 9 to 11 years. Marfed is the highest yielding variety at all locations.

Table 9. Yield in bushels per acre of six spring wheat varieties from rod row nurseries at four locations, 1950-63.

Variety	Lind	Horse Heaven	Waterville	Harrington	Av. all locations
Marfed	23.7	21.0	31.0	32.8	27.2
Lemhi	21.9	19.0	29.9	29.6	25.2
Federation	22.2	19.1	28.6	29.6	24.9
Idaed	21.1	19.4	27.0	28.2	24.0
Baart	21.2	19.1	27.0	28.2	23.9
Henry	19.6	18.5	25.3	29.7	23.4

The data in table 10 compares six varieties for their different agronomic characteristics.

Table 10. Agronomic data for spring wheat variation grown at the Dry Land Experiment Station 1950-63 in drill strip plots.

Variety	+ or - Baart Date head.	Ht. in.	Bu/A Yield	Yield % Baart	Test wt.	Years grown
Marfed	+4	-4	23.4	117.0	58.7	14
Lemhi 53	+2	-4	22.0	108.0	56.8	8
Federation	+1	-5	21.3	106.5	58.4	14
Idaed	-4	-3	20.6	103.0	58.7	14
Baart	0	0	20.0	100.0	59.9	14
Henry	0	-3	20.0	100.0	58.2	14

Several spring wheat selections from the breeding program are in regional and state wide tests. Burt x Onas 52 selections show the most promise. Four years of tests at Lind in small plots indicate superior yield to Marfed. These selections need to be tested more widely to determine their range of adaptability. These are hard white types with bread baking quality. Other advanced material include Burt x Henry and Karn x Henry selections. These are the highest yielding hard red types but are not as promising as the Burt x Onas 52 selections. At least two more years of testing will be needed before any of these selections will be considered for possible release.

WHEAT DISEASES

The important wheat diseases in this low rainfall area for several years have been stripe rust, foot rot, and snow mold. Adequate varietal resistance and chemical control have almost eliminated the hazard from stinking smut.

Active research programs are underway in all of these disease problems. The Dry Land Experiment Station cooperates with WSU plant pathologists in control and breeding for resistance to these diseases.

Snow Mold

Snow mold is a serious problem on winter wheat in Douglas County and surrounding areas where deep snow cover over long periods during the winter are common. A project to study this disease is financed by Washington State Wheat Commission. The project leader is Dr. G. W. Bruehl. Assisting him with study and variety screening is W. R. Fischer who is stationed at the Wenatchee Tree Fruit Experiment Station. Hybridization is done at the Dry Land Experiment Station. The seeds are organized for planting and seeded with the assistance of Clarence Peterson and Jim Gray.

Considerable progress has been made in this program. The world collection of winter wheat varieties was screened during the past four years, with three years giving good screening for resistance. Crosses have been made to varieties with tolerance or resistance to snow mold. The first series of crosses have been screened in the cold chamber and in the field. Back crosses will be made on the hybrid material that came through the cold chamber this year. Definite progress in the transfer of resistance to snow mold has been made in the breeding program.

A technique has been developed for testing for snow mold under artificial conditions. Basically, the test subjects hardened plants to snow mold in dark chambers at temperatures of 32-36°F. until the disease develops to the desired degree. Plants are then returned to the greenhouse for comparison of injury and recovery ability. This test has been used for three years. Similar results were obtained in screening both hybrid and variety material in the artificial cold chamber and the field this year.

The use of an artificial technique for snow mold study is extremely important in breeding for resistance. Since the resistance that has been found to date is not a clear genetic immunity to the disease, transferring the available resistance is difficult. The Scientist is selecting for degree of tolerance to a disease and must be able to detect this tolerance. By controlling the intensity of the disease through artificial means, they can select for the maximum resistance possible. Natural field infections are too variable for adequate screening where this type of resistance occurs.

Experiments with fine coal dust and other blackening agents to speed up the melting of the snow cover were conducted this past winter. The snow melted 2 to 4 weeks sooner on plots with coal dust. Some finely powdered materials at only 100# per acre melted the snow up to 24 days sooner. In special situations where snow mold develops late in the season or has not progressed too far before February, it might be possible to use coal dust to speed up snow melting and effectively prevent a complete loss of a winter wheat crop.

Foot Rot Diseases

There has been a general increase in damage from foot rot (commonly known as straw-breaker disease) in the low rainfall areas. Contributing factors have been early seeding and favorable weather for foot rot development.

Increased funds for the foot rot research from Liquid Fertilizer Dealers, Washington Wheat Commission and WSU have accelerated the research. Project leaders are Dr. G. W. Bruehl and Dr. F. E. Koehler, with the Dry Land Experiment Station cooperating.

In 1963 extensive foot rot trials at this station were conducted. A heavy infection of foot rot was established artificially in healthy wheat. Comparisons were made of fall and spring tillage, rates of fertilizer and date of application, date of seeding, variety reactions and sulfur treatments.

Difference between commercial varieties were demonstrated. The following yield reduction in percent occurred at Lind between diseased and undiseased plots: Gaines, 33; Omar, 36; Itana, 46; Rio, 48, and Burt, 50. These results were verified by yields of wheat in heavily infected plots at Pullman, where Gaines and Omar yielded 42 bushels and Burt 23 bushels. Good resistance was found in tests at Puyallup in four wheat varieties, however none of these are adapted to Eastern Washington. The resistant varieties will be used in breeding programs. Gaines and Omar are the best yielding commercial varieties when infected with foot rot.

Nitrogen Fertilizer was not a factor in the amount or intensity of foot rot infection in 1963 in the Lind tests. Foot rot heavily infected both fertilized and unfertilized innoculated plots. On Gaines wheat seeded Aug. 24, fall side dressed diseased wheat yielded 10 bushels more per acre than spring side dressing at comparable rates of nitrogen. Spring skew-treading, and shanking with or without additional nitrogen increased the foot rot infection and decreased yields, some plots yielding as low as 7 bushels per acre.

In the fall of 1963 extensive tests on the effects of management, chemicals, strains of the organism and chemical control were established. The wheat was innoculated and good environment for infection occurred until January. The record dry windy spring stopped further infection, and little foot rot developed. It appears now that all of this work will have to be repeated next year.

From the data now available these recommendations can be made for areas that have a history of foot rot. Gaines and Omar are the best commercial varieties to seed. Early seeding increases foot rot incidence and damage, however infected early seeded wheat often yields more than late seeded wheat.

In the low rainfall area, nitrogen fertilizer should be applied pre plant or by fall side dress, preferrable pre plant. Spring tillage with fertilizer shanks, rotary hoe, skew teader or harrow all increase foot rot infection.

Stripe Rust

Stripe rust continues to be one of the most serious wheat diseases in the Pacific Northwest. During the past two years the low rainfall areas of Eastern Washington have not been damaged by stripe rust. However, stripe rust was present both years in the fall on young wheat in amounts that could have triggered heavy epidemics had weather conditions in the winter and spring been favorable for rust development. In 1963 the winter kill eliminated most of the spore bearing leaves except in Eastern Oregon where snow cover prevented winter injury. This area suffered severe rust damage in 1963. In 1964 the record dry spring and high winds prevented the stripe rust from reinfecting new leaves. As a result, no serious disease problem developed in the low rainfall area.

The only effective method of combating stripe rust is through breeding of resistant varieties. All commercial varieties recommended in Washington have seedling susceptibility. However, Gaines, Brevor, Burt, Rio, Cheyenne, Tendoy, and Turkey have various degrees of mature plant resistance. These varieties offer the best resistance until varieties are developed that are resistant in all stages of plant growth.

The Washington Wheat Commission financed a new section of the greenhouse for the Dry Land Experiment Station in 1964. This greenhouse will be equipped with air conditioned benches. These benches will make it possible to screen large numbers of breeding material for seedling resistance to stripe rust. A new variety of winter wheat resistant to stripe rust and adapted to the low rainfall areas of Eastern Washington would decrease the potential of epidemic because this is a major source of seedling infection. A large amount of breeding material is ready for testing in this greenhouse.

Research on foliar sprays as protectants has been conducted during the past several years. Until recently none of the material tested were economical to apply or gave adequate control. A new chemical looked promising in Oregon tests last year. Tests in Washington with this chemical this year are promising, but need further evaluation. The chemical is not recommended or labeled for use on wheat.

Stripe rust research is under the leadership of Dr. J. W. Hendrix, Experiment Station Plant Pathologist. Others working on stripe rust include Dr. L. H. Purdy, ARS, Plant Pathologist at WSU and Dr. R. A. Allan, WSU, ARS, Plant Breeder. The overall research program includes epidemiology studies, biological race studies, evaluation of varieties for resistance, and the breeding of new varieties for resistance.

> Stations Circular 424 entitled "Stripe Rust, What It Is and What to Do About It," is available at your County extension Office. This is an excellent review of the stripe rust problem written by Dr. J. Walter Hendrix, WSU, Plant Pathologist.

CHEATGRASS RESEARCH

Cheatgrass is the most serious weed problem of the low rainfall areas. In 1963 heavy infestation of cheatgrass cost the wheat growers an estimated $10 to $15,000,000 loss in extra tillage costs, and yield reduction from competition with wheat.

Under a Washington Wheat Commission grant, cheatgrass research has been conducted for the last five years. Major emphasis of this work has been on chemical control of cheatgrass in the wheat crop. The research is conducted by Don Rydrych from the main station at Pullman.

Over the last five years all the available chemicals which might have potential have been tested. None have proven to be effective in controlling cheatgrass as post emergence applications. Atrazine appeared to have considerable promise early in the testing program but has now been dropped from extensive testing. Erratic control with this chemical and long soil residual life in low organic soils are two major faults. The chemical has never been licensed by the manufacturer for use in growing wheat.

Two chemicals, Montsanto 45592, and UC 22463 are showing some promise as pre-emergence chemicals. Avadex is showing some activity as an incorporated chemical and is worked into the soil before or right after seeding. Control at Lind in 1963 and 64 with SWEP has also looked promising. Additional research will be conducted on these chemicals along with experimental chemicals as they are available.

Control of cheatgrass by chemical summerfallow or winter fallow has promise. Combinations of three chemicals have given good control of cheatgrass in late fall or early winter applications on stubble. The chemicals and combinations which are effective in tests to date are: Amitrol-T 1# and 2, 4, D Ester 2#; Amitrol-T $\frac{1}{2}$# and Atrazine $\frac{1}{2}$#; Amitrol-T $\frac{1}{2}$#, Atrazine $\frac{1}{4}$#, 2, 4, D Ester $\frac{1}{2}$#. These applications have given good control of cheatgrass, volunteer wheat, and broad leafed weeds until late spring or early summer. Tillage is recommended with these treatments, but may be delayed until late spring when new growth starts. Only 1# Amitrol and 2# 2, 4, D Ester have been approved for use in Washington for winter or chemical fallow. All of the chemical fallow combinations are most effective when applied post-emergence to the cheatgrass and volunteer wheat.

Production management is important in cheatgrass control. Management factors affecting cheatgrass control are discussed in EM 2335 available at your County Agents office.

WHEAT PRODUCTION MANAGEMENT

Wheat yields are very responsive to management practices in the low rainfall areas. Where annual rainfall is from 8 to 12 inches, management practices that conserve moisture are all important. Leggett (1) reported data over a wide range of moisture conditions of eastern Washington, and showed that every additional inch of moisture saved during either the fallow or crop year will increase yield of winter wheat by six bushels. Leggett and Nelson (2) reported soil storage of rainfall in the fallow year varied from year to year with a range of 16 to 52% of the total rainfall. An average of about 35% of the rainfall was stored by the end of the fallow year. There is still a big potential in fallow management to improve the moisture storage.

In 1963 five different methods of fallow management were tested. Moisture samples were taken in the first 6" and second 6" and the results are shown in table 11. Although this is only one year data, it does indicate that the method of tillage can influence the moisture level in the surface six inches. This is especially important in early seeding as it may mean the difference between a good or poor stand of wheat. A uniform stand of wheat is essential to maximum production.

Table 11. Increase in moisture percentage Sept. 15 in 0 to 6" soil depth from 5 different tillage practices, 1963.

Treatment	% increase in soil moisture 0-6"	% increase in soil moisture 6-12"	% soil moisture 0-6"	% soil moisture 6-12"
Sweep 6", Skew Tread, Rod weed. (3)	13.0	3.3	5.2	9.3
Sweep 9", Skew Tread, Rod weed. (3)	22.2	16.7	5.6	10.5
Tamden Disk 5", Rod weed. (3)	2.2	0.0	4.7	9.0
Skew Tread 4", Rod weed. (3)	0.0	0.0	4.6	9.0
Skew Tread 4", Sweep 6", June 1, Rod weed (3)	2.2	7.8	4.7	9.7

Shallow tillage by tamden disk and skew treader alone caused a hard compacted layer at about 4" depth. In August this layer became quite dry and appeared to increase the water movement from the soil to a depth of 8 inches as shown in the lowest moisture percentage at the 6 to 12" depth. The best tillage treatment for maintaining moisture near the surface was the deep sweeping with the skew treader to firm up the soil after the sweep. Emergence from deep seeding was faster on this treatment at 3 dates of seeding and the overall stand was superior. This one year trial is inconclusive, but coincides with observations over several years. The best early September deep seeding conditions have been on fallow that was spring worked to a 7-8" depth, then the soil compacted with a skew treader, rod weeders or rotary hoe. Shallow fallow preparation almost always resulted in poorer seeding moisture in September.

The date of seeding affects both yield and protein of winter wheat and the response to additional nitrogen. Data presented in table 12 shows the effects of date of seeding, rate of fertilizer and date of application on yield of Burt and Itana. The early seeding date gave the highest increase in yield at all rates of nitrogen fertilizer and the late date the lowest. Fertilizer response was about equal at the Sept. 15 and Aug. 20 date. The late date gave the poorest fertilizer response. The yield response from the 30# spring side dress and 30# summerfallow treatment was not significantly different except on the late seeding where side dressing thinned the stand reducing yield response.

Table 12. Average increase in yield in bushels per acre of Burt and Itana at different dates of seeding, and rates of nitrogen, 1959-61.

Rate of Nitrogen	Average Yield Increase Bu/A					
	Oct. 15		Sept. 15		Aug. 20	
	Burt	Itana	Burt	Itana	Burt	Itana
0#, Check	0	0	2.7	4.3	9.1	7.1
30#, Summerfallow	4.5	3.4	9.1	9.1	16.1	11.5
30#, Sidedress, Spring	4.4	1.4	11.5	7.7	15.4	11.5
60#, Summerfallow	7.1	3.5	13.0	12.2	17.4	13.0
Check yield	25.3	24.8	28.0	29.1	34.4	31.9

Seeding date affects the protein content of winter wheat. Late seeding increases the protein and early seeding decreases the protein content. Nitrogen fertilizer increases the protein content of wheat, however protein increases are not very great until the maximum yield response from nitrogen are reached. Spring sidedress application of fertilizer is slightly more effective in increasing protein content than fallow application of fertilizer on the earlier seeding date. Present premiums do not justify the application of very high rates of nitrogen to increase protein at the early dates of seeding. These results are shown in table 13.

Table 13. Average percent protein of Burt and Itana at different dates of seeding and rates of Nitrogen, 1959-61.

Rate of Nitrogen	Percent Protein					
	Oct. 15		Sept. 15		Aug. 20	
	Burt	Itana	Burt	Itana	Burt	Itana
0#, Check	9.5	10.3	8.2	9.5	7.7	8.7
30#, Summerfallow	10.9	11.8	9.5	10.4	8.9	10.3
30#, Sidedress, Spring	10.6	11.7	10.2	11.3	9.8	10.4
60#, Summerfallow	11.9	12.6	11.4	11.8	9.9	10.8
Average	10.7	11.6	9.8	10.8	9.1	10.1

Early seeding (Aug. 20 to Sept. 15) with nitrogen fertilizer has increased winter wheat yields at Lind as much as 17 bushels per acre over late seeding and no fertilizer. The highest yield with late seeding and fertilizer was still 8 to 10 bushels less than comparable early seeding. Early seeded winter wheat must either use moisture more efficiently or develop superior root systems and utilize more total moisture. This is true because both early and late seeding dates have the same amount of soil moisture and rainfall in these trials.

Not enough data are available to answer this question, however data in table 14 show that both date of seeding and rate of nitrogen application influence moisture usage. Added nitrogen at both dates of seeding increased moisture uptake, however the early seeding used less moisture to produce equal or higher yields.

Late seeded wheat develops under higher temperatures, especially during the rapid growth stages of late tillering, boot and heading. These are stages of growth when total leaf area is great and cells have a high transpiration rate. Early seeded wheat develops under cooler temperatures during these stages of growth and is more mature when hot weather arrives. As the wheat matures, transpiration rate decreases and less total moisture is needed.

Table 14. Total soil moisture usage and yield of Gaines and Omar wheat at different dates of seeding and rates of nitrogen application at Lind, 1961.*

Seeding Date	Nitrogen Applied lbs/A	Soil Moisture Used		Yield	
		Gaines	Omar	Gaines	Omar
		inches	inches	Bu/A	Bu/A
Early (9-7)	0	4.0	5.5	18	18
	35	5.8	6.0	33	28
	70	5.8	6.3	36	29
Late (10-16)	35	6.6	6.4	33	21
	70	7.3	6.7	35	21

*Unpublished data from F. E. Koehler studies.

Yields in this trial were influenced by a heavy infection of stripe rust. Omar was damaged more than Gaines, especially at the late seeding date. Additional data is needed for accurate conclusion on moisture usage as influenced by seeding date and nitrogen level.

Recommendations for winter wheat production management based on data available for the 8 to 11" rainfall area are as follows:

1. Summerfallow program of late fall chiseling of stubble, and an initial spring tillage to depth of 6 to 8" with sweep or offset disk. This should be followed immediately with sub-surface packing by skew treader, or disk running with little angle, or rotary hoe, or rod weeder. Rod weed as necessary for weed control. When cheatgrass is a problem this method will have to be altered for additional cheatgrass tillage.

2. Fertilizer should be applied in summerfallow for winter wheat either late spring or early summer or immediately before seeding. Nitrogen is the only fertilizer giving universal response. Sulphur and or phosphorus may be needed where nitrogen alone does not respond. Rates of 25 to 60# of nitrogen are recommended for this area.

3. Early deep seeding (Aug. 20 to Sept. 15) winter wheat of a recommended variety, is recommended. Use year old seed whenever possible to eliminate high temperature dormancy of new seed. Seeding rates of 30 to 45# per acre are recommended for early seeding.

4. Seed late only if moisture is not adequate for early deep seeding. Late seeding is not a reliable weed control measure.

(1) Leggett, G. E., Relationships between Wheat Yield, Available Moisture and Available Nitrogen in Eastern Washington Dry Land Areas, Washington Agricultural Experiment Station Bulletin 609, 1959.

(2) Leggett, G. E. and Nelson, W. L., Wheat Production as Influenced by Cropping Sequence and Nitrogen Fertilization in the 10 to 15 Inch Rainfall Area of Eastern Washington. Washington Experiment Station, Bulletin 608, 1959.

TREES AND SHRUBS FOR DRY-LAND PLANTING

Several species of trees and shrubs are included in the Station forestry project for farm-home landscaping and windbreaks. The first plantings are over 35 years old. Plantings have been made at intervals since the original planting. The station planting is one of the best in the West for studying trees and shrubs adapted to dry land conditions.

Initial observation tests of wood species are carried on at the Soil Conservation Nursery at Pullman. Secondary tests are carried on cooperatively at experiment stations at Prosser and Lind, Washington, and Moro, Oregon. The present testing program at Lind was started in 1928 by the Dry Land Experiment Station and the Department of Forestry and Range Management, Washington State University.

A standard dry land windbreak planting consists of minimum of three rows. When properly established, these give excellent protection from the winds. Results to date indicate the Caragana is still the best erect shrub. Blue leaf honeysuckle, Nanking Cherry, and Bladder Senna are showing considerable promise. Russian olive is the recommended species of intermediate shrub. Hawthorn and a strain of wild crab apple are showing promise.

Black locust is still the best deciduous tree. Green ash and Chinese elm may be used, but they are not as good as black locust. Austrian pine is the outstanding evergreen tree, being superior to both Scotch and Ponderosa pine. Douglas fir and Blue spruce can be grown but require more care and grow much slower. Rocky Mountain juniper is an outstanding medium height evergreen. Rocky Mountain juniper is more difficult to establish than other evergreens, but is extremely hardy and vigorous once established.

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

Table 15. Standard species, arrangement, and spacing of trees and shrubs for windbreak plantings in the 8-10 rainfall area.

Row No.	Species	Growth habit	Spacing in row	Minimum distance from next row*
1	Caragana	Erect shrub	3 ft.	18 ft.
2	Russian Olive	Intermediate Shrub	6 ft.	18 ft.
3 & 4	Black Locust	Deciduous tree	12 ft.	18 ft.
5	Austrian pine Scotch pine Ponderosa pine	Evergreen	12 ft.	27 ft.

*Rows can be spaced wider apart if cultivation equipment requires it.