46th annual field day   Dry Land Experiment Station, Lind. 1962

INTRODUCTION

The Dry Land Experiment Station, one of eight Washington Agricultural Experiment Stations, was established in 1910 near Ritzville. Largely through the efforts of Spokane businessmen, the Milwaukee Railroad, and Adams County, a site was leased from Adams County approximately 3 miles northeast of Lind. Buildings were erected, and the Station moved to its present location in 1915.

Originally, the Station was operated with county, USDA, and state funds. At present it is 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, forages, flax, safflower, sunflower, and sorghum. The last four have been tested only one or so years during the past decade.

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 that institution. 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.

Walter L. Nelson, Supt.

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

Research with barley 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 and should be easier to combine.

Table 2 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 3 bushels higher than Gem for the 21 trials. Unitan outyielded Gem in 14 of the 21 trials. In the Great Plains Regional Barley Nursery, Unitan was the highest yielding 6 row barley in 4 out of the 5 years tested and was second the other year. It has the highest average yield of all entries since 1957. These data indicate Unitan has a wide range of adaptability.

Production from 25 acres of foundation seed will be available for spring planting in 1963. This registered seed will be available from the Washington State Crop Improvement Association. Limited supplies of foundation seed will be available by 1964.

CLIMATIC DATA

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.

Table 1 lists the average temperatures and precipitation for each month. 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 1. 40 Year Average Temperature and Precipitation at Dry Land Experiment Station, Lind

Month	Temperature °F			Precipitation
	Max.	Min.	Mean	40 yr. av. (in.)
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

Approximately 90 per cent of the rainfall is between October 1 and June 30. This rainfall pattern coincides with the normal winter wheat growing season. Low evaporation rates during much of this period increase the efficiency of the moisture storage and use during both summer fallow and the crop year.

Table 2. Yield in Bushels of Four Barley Varieties at the Locations Listed and for the Number of Years Listed

	Lind 5	Pullman 5	Dusty 3	Pomeroy 3	Walla Walla 2	Horse Heaven 1	Harr-ington 1	Water-ville 1	Av. 21*
Unitan	36. 7	76..0	51. 7	57. 7	60. 9	20. 4	38. 1	36. 1	52. 8
Gem	33. 9	69. 9	50. 7	58. 4	54. 5	23. 4	32. 5	30. 9	49. 6
Piroline	33. 7	71. 9	46. 1	59. 4	69. 4	20. 2	37. 4	26. 4	50. 8
H. Hanna	30. 1	65. 8	39. 4	49. 9	55. 3	16. 4	34. 0	22. 0	44. 3

*Average of all 21 trials.

Winter Wheat

The winter wheat breeding and testing program is designed to develop varieties of good quality adapted to early deep seeding. Over 100 advanced generation lines which are resistant to stripe rust are now in yield trials. Twenty five of these are Burt x Itan selections and have been screened for milling and baking quality in a 5-pound milling trial. Further testing for yield and quality during the next two years will determine if any of these selections are adapted to the Big Bend and should be released. About 12, 000 stripe rust resistant lines involving over 50 crosses are being screened this year for winter hardiness, milling and baking quality and growth characteristics. Most of these crosses have adequate smut resistance in their breeding.

Testing for disease resistance is in cooperation with the Plant Pathology Department, WSU, Pullman. Quality testing is conducted at the USDA Western Wheat Quality Laboratory, WSU, Pullman. These cooperating agencies make possible a better and more rapid evaluation of selections in the breeding program.

Since 1956, five varieties of winter wheat have been released to farmers in Eastern Washington. Columbia and Itana hard red varieties, and Burt, a hard white variety are recommended for the low rainfall areas. Omar, a soft club, and Gaines, a common white variety, are recommended for the intermediate and high rainfall areas. Extension circulars describing each of these varieties are available. Table 3 compares the yield of these and other varieties in percentage of Kharkof (Turkey).

Gaines was released in 1961. Approximately 500, 000 bushels of seed will be available for Washington growers for seeding in the fall of 1962. Gaines is recommended for the areas which are adapted to Omar and Brevor.

Gaines is a short-strawed, bearded, white chaff wheat developed by Dr. O. A. Vogel, USDA, Pullman. It has good mature-plant resistance to stripe rust, and will take some rust in the early growth stages. It is as smut resistant as Burt. Normal plant height in the 10 to 13" rainfall area varies from 24 to 32". Gaines is a pastry type wheat with acceptable milling and baking quality.

Gaines is not as adapted to early seeding as Omar, Itana, and Columbia, Gaines requires a higher moisture content in the soil for good germination.

It is quite similar to Burt in this respect. Good stands of Gaines were obtained in 1961 when deep seeded in a good moisture level. Gaines is a little slower to emerge than Omar or Itana, and appears to be quite comparable to Burt.

Preliminary data indicate some high temperature dormancy of some seed lots. A high temperature germination test is advised before seeding if soil temperatures are high.

Nitrogen fertilizer applications for Gaines in the 10 to 13" rainfall areas should be increased by 25 to 40 per cent. Suggested rates are 60 pounds in the 10-inch area increasing with rainfall to 90 pounds in the 13-inch rainfall area. As a general practice, summer fallow applications are recommended. The above recommendations are for early seeding, and should be decreased for late seeding to 50 to 70 pounds in this rainfall area.

Table 3. Comparative Yields of Winter Wheat Varieties in Per Cent of Kharkof Grown at Lind, Harrington, Waterville, and Horse Heavens, for Number of Years Indicated, Dry Land Experiment Station

Variety	Lind		Harrington		H. Heavens		Waterville		Av. all Locations
	Years Grown	Yield % of Kharkof	Years	Yield	Years	Yield	Years	Yield	
Gaines	2	134	2	159	2	108	2	120	140
Burt	7	127	10	124	5	124	7	121	124
Omar	4	112	6	124	5	124	4	118	122
Elgin	18	112	10	120	5	125	7	113	117
Brevor	10	111	10	117	5	119	7	116	116
Itana	7	111	10	109	7	115	6	115	113
Cheyenne	4	117	5	120	5	119	4	109	116
Tendoy	4	107	4	110	4	112	3	109	110
Columbia	7	91	10	104	7	109	6	112	104
Golden	20	99	10	96	5	111	7	101	102
Rio	7	98	10	101	7	102	6	100	100
Kharkof	21	100	10	100	7	100	7	100	100

Spring Wheat

The spring wheat program at the Dry Land Experiment Station includes the testing and introduction of available spring wheat varieties from other areas, and the improvement of spring wheat varieties through breeding. Present emphasis is on incorporating resistance to leaf, stripe, and stem rust in adapted varieties, and improving the quality and protein content of these varieties. Considerable emphasis is being placed on breeding for protein and yield. Many of the recent crosses have included parents which can produce high protein with good yield. It appears that some progress has been made in this area.

The best of the new selections are Karn x Henry x Burt, and Awned Onas x Burt. At least two more years of data are necessary before these selections will be considered for seed increase for large scale testing. These are high protein bread type spring wheat selections with excellent milling and baking qualities.

Table 4 shows the yields of six spring wheat varieties grown in the Big Bend area for the last 7 years or more. Marfed is the highest yielding variety. It has rather poor quality at high protein, and is only an average milling variety. It is recommended for eastern Washington, and generally for areas of more than 11 inches of rainfall.

Table 4. Yield of Spring Wheat Varieties Grown at Harrington, Horse Heavens, Waterville, and Lind for Number of Years Indicated. Dry Land Experiment Station.

Variety	Harrington 10 years	Horse Heavens 7 years	Waterville 8 years	Lind 8 years	% Baart Yield, All Locations
Marfed	32. 2	23. 4	31. 5	23. 6	112
Lemhi	30. 3	20. 8	30. 9	21. 4	106
Federation	30. 0	20. 8	29. 2	21. 4	104
Idead	32. 1	21. 0	26. 9	19. 9	103
Baart	28. 4	20. 6	27. 9	21. 0	100
Henry	30. 5	19. 9	26. 1	19. 3	98

WHEAT DISEASES

Foot rot (Cercosporella sp.) has increased in the Big Bend area in recent years. Early seeding and the cold wet springs have been favorable for the development of this disease. Observational evidence indicates that harrowing, rotary hoeing and spring side-dressing may increase the severity of the infection. Experimental evidence of the effect of spring tillage on foot rot incidence is lacking.

In the fall of 1961, G. W. Bruehl, WSU Plant Pathologist, established a foot rot disease nursery at Lind on early seeded Gaines wheat. It is an exploratory disease nursery to study technics of artificial inoculation, determine quantitative measures of the disease damage, and to obtain preliminary data on the effect of spring tillage on foot rot.

The fall was extremely dry and the foot rot did not begin to infect the wheat until early in May. Even under these poor conditions for infection enough data has been collected to confirm a successful method on inoculation. These data indicate methods for screening wheat varieties for foot rot, and new methods of studying the effect of spring tillage on foot rot infection.

Stripe Rust

A severe stripe rust epidemic in the Pacific Northwest in 1961 reduced winter wheat yield extensively. In Washington, the actual damage varied over the wheat production area. Greatest damage occurred in the southeastern part of Washington where the infection started early in the winter. The least damage occurred in the northern part of the state where infection was not general until June. Prolonged high temperature in July had an adverse effect on yield and complicated the evaluation of the stripe rust damage.

At Lind, spores were abundant by mid March. All the leaves of susceptible varieties were completely infected during the growing season. The heads were invaded late in June.

The stripe rust damage was estimated by comparing 11 resistant and 9 susceptible winter club varieties of similar maturity date and yield potential in a yield trial. All of the resistant varieties had some leaf damage from the stripe rust, but at least 50 per cent of the leaf area was not infected. All susceptible varieties were 100 per cent infected. Average yield of the resistant and susceptible lines were 42. 5 and 27. 0 bushels per acres, respectively. The average yield decrease was 36. 5 per cent. In another trial, yield decrease was determined to be 33 per cent for the susceptible selections, and 15 per cent for selections with intermediate resistance.

The July heat hurt the resistant lines relatively more than the susceptible. Thus, in a normal year, the resistant lines should be even more superior than in 1961. The actual damage for stripe rust may be greater than determined.

Research on foliar spray as protectants was conducted in 1961 and is continuing in 1962. Results from this work by Dr. J. Walter Hendrix, WSU Plant Pathologist, indicated that there is no economical control by spray. Some experimental control was obtained, and this work will continue until all of the possibilities are investigated.

Soils and Fertilizer Studies

The soils and fertilizer research at the Dry Land Experiment Station is conducted cooperatively with the Agronomy Department, WSU, Pullman. This research is now under the leadership of Dr. Fred Koehler. During the past 10 years, extensive studies have been conducted on rates, date, and methods of fertilizer application. The results of these studies are reported in Washington Agricultural Experiment Stations Bulletins 602, 608, and 609.

Nitrogen fertilizer is the only one that has given significant yield responses on average summer fallow land in this area. Tests with sulfur and phosphate fertilizers have not given consistent yield responses, except in isolated areas where deficiencies are known. Testing of these two elements will continue to determine when they might be profitably included in the fertilizer program.

Research is being done on soil and fertilizers to determine water and nitrogen requirements of the growing wheat plant. Soil moisture is measured periodically during the growing season at 1 foot intervals to a depth of 8 feet. Plants are sampled periodically to determine nitrogen uptake. Water and nitrogen requirements of the wheat plant are measured at different stages of plant growth, and at different rates of fertilizer application. The results of the 1961 trial at the Dry Land Experiment Station are given in the following report by Dr. Fred Koehler.

Gaines and Omar wheat were seeded early and late in the fall of 1960 and different rates of nitrogen fertilizer used. Soil moisture measurements were made and plant samples taken periodically to determine soil moisture use, top growth and nitrogen uptake. Soil moisture use, and yields are as shown in Table 5.

Table 5.

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

Fertilizer greatly increased both yield and soil moisture use. When seeded early, Omar used slightly more soil moisture than did Gaines, whereas the reverse was true when the wheat was seeded late. The early seeded wheat used less soil moisture than did the late seeded wheat and made more efficient use of that moisture for grain production.

Where no fertilizer was applied Omar yielded as well as Gaines, whereas when nitrogen fertilizer was applied, Gaines considerably outyielded Omar. The very low yields of Omar when seeded late may have been partially caused by the severe infestation of stripe rust occurring at a much earlier stage of growth on it than on the early seeded Omar.

Total top growth, nitrogen uptake and protein content of grain are in Table 6.

Table 6.

	Nitrogen Applied lbs/A	Top growth		Nitrogen uptake		Grain protein	
		Gaines	Omar	Gaines	Omar	Gaines	Omar
		lbs/A	lbs/A	lbs/A	lbs/A	%	%
Early (9-7)	0	3100	3200	19	23	6.6	7.4
	35	4650	4100	35	29	6.6	6.7
	70	5100	4780	46	43	8.7	10.0
Late (10-16)	35	4040	3440	35	32	9.6	10.1
	70	4320	3370	52	35	11.3	12.0

Total top growth responded to nitrogen fertilization in about the manner as did yield, except that proportionally more straw was produced by the fertilized, early seeded wheat. Gaines wheat took up more total nitrogen than did Omar.

Protein content of the early seeded wheat was very low, and did not increase with the first increment of nitrogen added. However, the second 35 pounds of nitrogen markedly increased protein content of the grain. There is usually little increase in protein concentration of grain as long as appreciable yield increases are being obtained. Once yields approach maximum, then additional nitrogen fertilizer causes increases in protein content.

WHEAT MANAGEMENT STUDIES

The short straw varieties of the future will require different management if we are to reach new maximum yield levels. Farmers using new equipment adapted to stubble mulch farming, with proper fertilization, early seeding, and new varieties have increased wheat production 30 to 50 per cent in the low rainfall area. Gaines has the potential of increasing this yield another 20 per cent, but new disease and managements problems will have to be overcome before this potential is reached.

Studies at the Dry Land Experiment Station evaluated the response of Burt and Itana to three different dates of seeding at three levels of fertility from 1959 to 1961. A stubble mulch program of land preparation included fall stubble chiseling at 8", spring sweeping at 6", followed by rod weeding (deep), skew treading or rotary hoeing in packing attitude, and shallow rod weeding as necessary for weed control. The fertilizer was normally applied in the fallow year before seeding. This stubble mulch program has maintained a moisture level in the fallow at a depth satisfactory for deep seeding up to September 15 without additional fall moisture.

Tables 7 and 8 show the yield increase and the additional net income per acre based on market prices for each year. Early (August 15) planting and 60 pounds of nitrogen gave the highest yields. Net return from Itana averaged about $2 less on the September 15 date, and $8 less for the August 15 seeding date than Burt.

Table 7. Average Increase in Yield in Bushels per Acre of Burt at Different Dates of Seeding, and Rates of Nitrogen, 1959-61, Dry Land Experiment Station

Rate of Nitrogen	Seeding Date Average Yield Increase Bu/A		
	Oct. 15	Sept. 15	Aug. 15
0#, Check	.0	2.7	9.1
30#, Summer fallow	4.5	9.1	16.1
30#, Side-dress, Spring	4.4	11.5	15.4
60#, Summer fallow	7.1	13.0	17.4

Table 8. Increase in Dollars per Acre for Burt at Different Dates of Seeding and Rates of Nitrogen, 1959-61, Dry Land Experiment Station

Rate of Nitrogen	Seeding Date Average Net Return in Dollars/A Oct. 15	Sept. 15	Aug. 15
0#, Check	0	4.90	16.62
30#, Summer fallow	4.90	13.38	26.38
30#, Side-dress, Spring	4.64	17.60	25.08
60#, Summer fallow	6.57	17.53	26.29

These data indicated that early seeded wheat used the nitrogen and available moisture more efficiently than late seeded wheat. It points out the importance of good summer fallow practices which will make it possible to seed ear early to get maximum yields. Although not shown in these tables, the fertilizer efficiency was increased about 50 per cent at the two early dates of seeding. Limited management data with Gaines indicate that early seeding also favors high yields. The suggested fertilizer recommendations for Gaines are given in the winter wheat section of this brochure.

Table 9 gives the average yields of Burt and Itana at three rates and at two dates of seeding for the years 1959-61. The 60# seeding rate decreased the yield at the August 15 seeding date. At the October 15 date, 45 and 60 pounds were about equal. The 30 pound rate is a little light for maximum production. Seeding rate has very little effect on the yield when compared with the yield increases experienced by early seeding or rates of fertilizer.

Table 9. Average Yield of Wheat at Three Rates and Two Dates of Seeding, 1959-61, Dry Land Experiment Station

Date	Variety		Rate of Seeding in lbs/acre 30	45	60
August 15	Burt		35.9	35.8	33.2
	Itana		33.6	34.4	32.1
		Ave.	34.7	34.8	32.6
October 15	Burt		30.0	32.4	31.4
	Itana		26.3	25.7	26.7
		Ave.	28.1	29.0	29.0

On the basis of these results and other observations and trials not reported here, we recommend seeding August 15 to September 10; fertilizer rates of 40 to 60# of nitrogen, applied in the summer fallow before seeding; and seeding rates of 30 to 45# per acre for early seeding, 60# for late. Side-dressing fertilizer spring is recommended if excessive moisture or fall growth indicate more nitrogen is needed. Recommendations for Gaines are given in the winter wheat section of this brochure.

STUDIES ON THE CONTROL OF CHEATGRASS IN WHEAT

Through a financial grant made available by the Washington Wheat Commission to the Department of Agronomy, WSU, the research program on selective control of cheatgrass in wheat was expanded in 1959. Extensive field experiments were located on the Station and McGregor's Ranch at Hooper, in 1960, and again in 1961 at these locations and at two additional places near Dayton. This research was conducted by W. Powell Anderson. Mr. Anderson accepted another position in 1962, and the work is now being carried on by Don Rydrich. Studies this year are concentrated on screening of new chemicals and large scale trials in farmers' fields through eastern Washington with Atrizine and Simazine. The 2 years of work were summarized as follows by Mr. Anderson.

We have no recommendations to make yet on chemical control of cheatgrass. However, you might like to know our experimental results.

Simazine was used to control cheatgrass selectively in winter wheat when applied from the third week in November into the second week of January. The effective dosage was 1/2 to 3/4 lb/A (active ingredient) on light soils low in organic matter, and 3/4 to 1 lb/A on heavier soils. On soils of relatively high organic content, dosages up to 1 1/2 to 2 lbs/A have been safely applied.

Atrizine was also used for the selective control of cheatgrass from the third week in February into the second week of March. The effective rate is 1/2 to 3/4 lb/A (active ingredient), with the 3/4 lb/A rate more effective on light soils. On heavier soils, such as at Hooper 1/4 lb/A was highly effective in selectively controlling cheatgrass when applied during the fall and winter months. However, applications of Atrazine made earlier than February have generally resulted in severe wheat injury.

Although Simazine and Atrizine have been the most effective herbicides in our tests for the selective control of cheatgrass in winter wheat, these two materials do have several drawbacks. Perhaps the most serious of these is their relatively long active, residual life in soils of low organic content. At the Dry Land Experiment Station, both materials have remained active in the soil for at least one year and have severely damaged wheat sown a year after application. Another problem is that the necessary dosages required for control leave little leeway for error in mixing or applying the materials. On soils of low organic content, if the spray pattern should overlap, thereby doubling the dosage applied, severe wheat injury would result. On soils high in organic matter, overlapping of the spray pattern would not be as serious. A precaution must be followed with these materials. Since both are wettable powders, the spray reservoir tank <u>must</u> be equipped with an agitator capable of keeping the materials uniformly <u>mixed</u> throughout the water carrier.

To date, there are no recommendations for the use of either of these two chemicals. They have not been registered for use on growing wheat, and their residual properties must be studied further before any recommendation for their use can be made.

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 30 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 five rows. When properly established, these give excellent protection from the winds. Results to date indicate that Caragana is still the best erect shrub. Blue leaf honeysuckle and Nanking cherry 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 most promising deciduous tree. Green ash and Chinese elm are good but they do not show the promise of 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 have a much slower growth. Rocky Mountain juniper is showing the most promise in this group.

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 given better survival than seedling stock. Although transplanted stock is more expensive, the superior survival will compensate for the extra cost.

Table 8. Standard Species, Arrangement, and Spacing of Trees and Shrubs for Windbreak Plantings in the 8-10 Inch Rainfall Area

Row No.	Species	Growth habit	Spacing in row	Minimum distance from next row[a]
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.

[a]Rows can be spaced wider apart if cultivation equipment requires it.